STOIDIS AURATA (ARANEAE: SALTICIDAE), A SPIDER PREDATOR OF ANTS[1]

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ABSTRACT

Stoidis aurata (Hentz), a salticid spider occurring in a variety of leaf litter habitats, was observed in the field attacking ant workers. In the laboratory it fed on 21 of 23 ant species offered, representing 17 genera in 5 subfamilies. *S. aurata* had difficulty in overcoming workers of genera *Aphaenogaster, Crematogaster, Tetramorium,* and *Formica,* and did not consistently attack the larger individuals of *Pogonomyrmex badius* (Latreille), *Camponotus abdominalis floridanus* (Buckley), or the workers of *Odontomachus ruginodis* (Wheeler). The hard exoskeletons of *Cyphomyrmex rimosus minutus* Mayr and *Trachymyrmex septentrionalis* (McCook) apparently protected the workers of these 2 species from capture by *S. aurata.* The spider attacked from directly in front of the ant 91% of the time; 77% of these captures were made by grasping the ant by the dorsum of the alitrunk. No other salticid was observed, either in the field or the laboratory, to feed on ant workers, even though individuals of 20 other salticids were tested under similar conditions. Two species of jumping spider, *Plexippus paykulli* (Audouin) and *Thiodina sylvana* (Hentz), were observed feeding on alate ants.

Spiders have been overlooked as predators of ants even though ant workers are the greatest available energy source to some spider species; investigation of this predation is needed in both terrestrial and arboreal habitats. Repeated observations and notations on such spiders as *Achaearanea tepidariorum* (C. L. Koch) feeding on the red imported fire ant, *Solenopsis invicta* Buren, in laboratory ant cultures, underline the importance of such research. The spider *Stoidis aurata* (Hentz) (Fig. 1), a small (4-5mm) salticid commonly found in shaded, leaf litter habitats in Florida and neighboring states, was observed on several occasions feeding on ant workers of the genera *Aphaenogaster* and *Crematogaster.* Organized research on this spider as an ant predator was initiated.

That a cursorial spider would feed on a wide variety of unrelated ants is not unexpected. Most salticid spiders patrol either plant foliage or soil surface in search of prey and undoubtedly come in contact with many ant workers. Defenses against such predators as spiders differ with each ant subfamily and even from species to species. Ponerine, myrmicine, and pseudomyrmicine worker ants characteristically possess a protective sting apparatus. The morphology of the sting mechanism and the use of the sting in given situations varies from 1 ant species to another. Dolichoderine and formicine ants do not sting but depend on toxin exuded from the tips of their abdomens and the use of their mandibles. Structure and function of the poison apparatus of ants have been discussed by Hermann (1969), Blum and Hermann (1969), and

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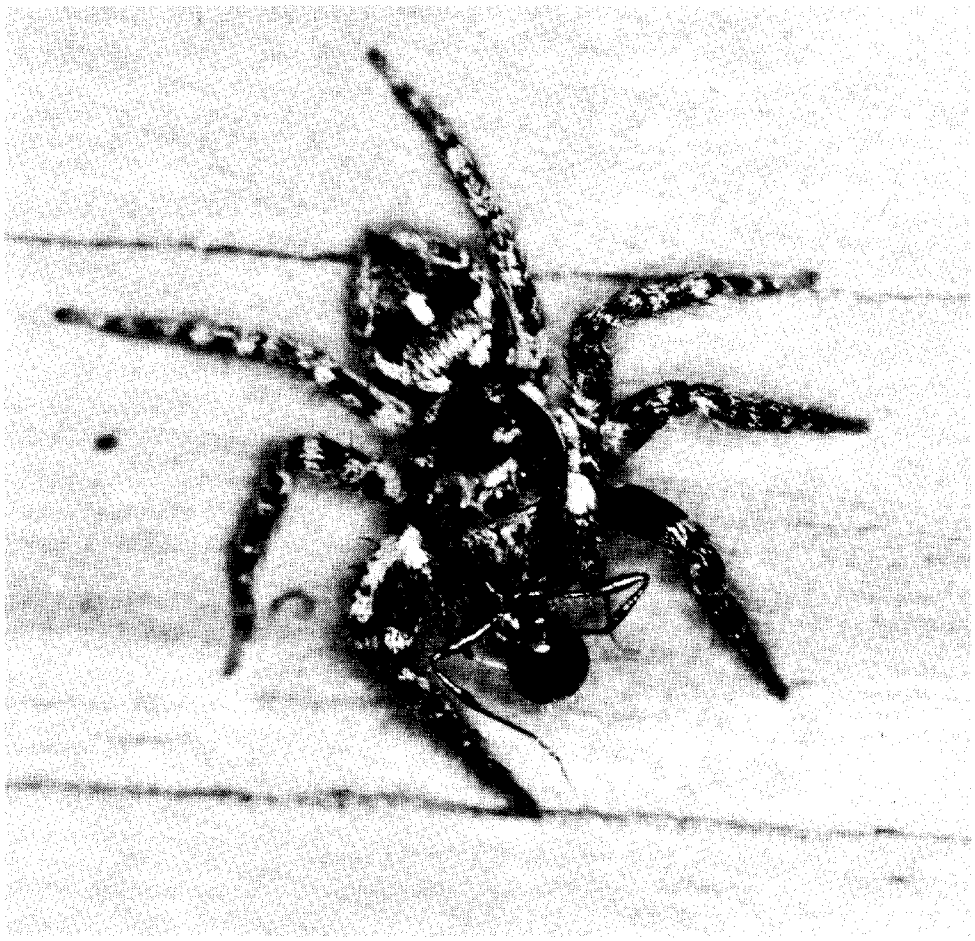

Fig. 1. *Stoidis aurata* female with captured *Solenopsis invicta* worker.

others. The toxicity of ant poison to spiders is unknown, but the poison of several ant species tested is toxic to many other arthropods (Blum et al. 1958, Blum and Callahan 1960). Many species of ants possess powerful mandibles with which they can maintain a vise-like grip on their foes. Appendages of many arthropods are often either severed by ant bites or pulled from the body.

Records of spiders consistently feeding on ants, other than alate forms, are few. Weber (1957) mentioned *Triaeris patellaris* Bryant (Oonopidae) attacking *Cyphomyrmex costatus* Mann. *Oecobius annulipes* Lucas (Oecobiidae) was reported by Glatz (1967) to feed mostly on *Plagiolepis pygmaea* Latreille under natural conditions and on *Lasius flavus* Fabricius in the laboratory. Hoelldobler (1970) reported *Steotoda fulva* (Keyserling), family Theridiidae, feeding on the harvester ant, *Pogonomyrmex badius* (Latreille). Whitcomb (1974) observed an unidentified species of wolf spider (Lycosidae) in the Mato Grosso of Brazil lined up at night along foraging trails of *Atta* spp., feeding on passing workers. Recent field work on fire ants *Solenopsis invicta* and *S. geminata* (Fabricius) (Whitcomb, unpublished data) has brought attention to several other spiders in the families Theridiidae, Gnaphosidae, and Thomisidae that captured ants.

No previous records of *Stoidis aurata* or any other species of Salticidae

that fed on ant workers were encountered. Several members of this family are ant mimics, yet have never been observed to feed on ants (J. Reiskind, personal communication). Salticids of the genus *Cotinusa* have been observed in an apparent symbiotic relationship with the dolichoderine ant *Tapinoma melanocephalum* (Fabricius) in the West Indies (Shepard and Gibson 1972).

Materials and Methods

All of the spiders and most of the ants used for testing were collected from various leaf litter or adjacent habitats in the vicinity of Gainesville, Florida. The ant species *Xenomyrmex stolli floridanus* Emery was collected in Collier Co., Fla.

In the laboratory, single spiders were caged in 60 × 15 mm plastic petri dishes. A total of 20 individuals of *Stoidis aurata* was used, 12 females and 8 males. Second larval instars of cabbage looper, *Trichoplusia ni* (Hubner), were used to sustain the spiders before the experiment was initiated. The spiders were given only water for the 3 days prior to testing. This length of time proved to be intermediate between satiation and starvation for an average spider of this species. In an earlier experiment with 12 specimens, the spiders began showing distinctly shrunken abdomens indicating starvation in about 6-7 days.

A single worker ant was placed into the petri dish with the spider and the resulting confrontation observed as long as necessary, in most cases 15-60 sec. Twenty-three species of ants in 17 genera representing 5 subfamilies were chosen so that we could observe the reaction of the spider to the various offensive and defensive weapons used by the ants. In all cases, major workers were tested and, where appropriate, minor workers were also used.

Each of the 2 female spiders was offered 4 ant workers, 1 at a time. Each of 2 male spiders was offered 3 ants similarly. This was repeated for all 23 species of ants. Each encounter was discontinued after 15 min if the spider had not captured the ant. The spiders were chosen at random, omitting individuals already used.

Additional spiders of the appropriate sex were used, if necessary, to complete 14 encounters. These were necessary in any 1 of the following situations: 1) the spider became disoriented because of removal of test ant, 2) the spider became satiated, 3) the spider was affected by ant poison, 4) the spider would not attack the ant because it apparently was too large, too fast, or for unknown reasons.

Other salticid species tested were individuals belonging to 13 genera and 20 species. Each spider was caged in a 60 × 15 mm or 100 × 15 mm plastic petri dish, depending upon the size of the spider. Each spider was offered consecutively major workers of *Pheidole dentata* Mayr and *Solenopsis invicta*, with the exception of the smallest species such as a *Habrocestum* sp. female which were offered *Xenomyrmex stolli floridanus* and minor workers of *Pheidole morrisi* Forel. Preliminary diet was not as strictly observed as in *Stoidis aurata*, but the spiders had not been fed for at least 2 days.

Results and Discussion

A synopsis of the results is reported in Table 1. Of the 23 species tested 10 species were captured in at least 13 out of 14 encounters; 16 species were taken in at least 50% of the encounters. Four species were taken 4 to 6 times. An

TABLE 1. SPECIES OF ANTS OFFERED TO *Stoidis aurata* AND ATTACK RESPONSES BY THE SPIDER.

Ant species tested	Size Ant/spider	No. of spiders tested (minimum 2♀, 2♂)	No. of successful captures in 14 attempts	No. attacked:		
				from in front	by alitrunk	from front & by alitrunk
Ponerinae						
Odontomachus ruginodis (Wheeler)	>>	6	1* **	0	1	0
Pseudomyrminae						
Pseudomyrmex brunneus (F. Smith)	<	4	14	11	13	10
Myrmicinae						
Aphaenogaster ashmeadi Emery	=	5	8* **	8	6	6
A. floridana M. R. Smith	=	5	7* **	7	5	5
A. lamellidens Mayr	=	6	2*	2	2	2
A. tennesseensis (Mayr)	≤	6	8*	8	6	6
Crematogaster clara Mayr	<	7	7	6	5	4
C. verminulata Emery	<	6	9	8	5	5
Cyphomyrmex rimosus minutus Mayr	<	4	0	0	0	0
Monomorium viridum Brown	<<	5	13	12	11	10
Pheidole dentata Mayr	<	4	14	13	12	11
Ph. morrisi Forel	<	4	14	12	13	11
Pogonomyrmex badius (Latreille)	>>	5	6	5	4	2

TABLE 1. (CON'T.)

Ant species tested	Size Ant/spider	No. of spiders tested (minimum 2♀, 2♂)	No. of successful captures in 14 attempts	No. attacked: from in front	No. attacked: by alitrunk	No. attacked: from front & by alitrunk
Solenopsis geminata (Fabricius)	≤	6	13	12	11	9
S. invicta Buren	≤	4	14	13	13	12
Tetramorium guineense (Fabricius)	≤	5	7*	7	7	7
Trachymyrmex septentrionalis (McCook)	<	4	0	0	0	0
Xenomyrmex stolli floridanus Emery	<<	4	14	14	4	4
Dolichoderinae						
Conomyrma flavopecta (M. R. Smith)	<	6	14	13	12	12
Formicinae						
Camponotus abdominalis floridanus (Buckley)	>>	6	6* **	2	3	0
Formica pallidefulva Latreille	>>	5	4* **	4	3	3
Paratrechina longicornis (Latreille)	<	4	14	14	13	13
Prenolepis imparis (Say)	<	4	14	13	10	9
			203	184	159	141

*Only 1 or no successful male attacks or males did not attack.
**At least one case where spider was repulsed by ant during 1st attack, but ant was injured and spider returned to feed upon it.

Odontomachus ruginodis worker was taken only once. *Stoidis aurata* was unable to capture either of the 2 ants tested of the tribe Attini. With the exception of the fungus-growing ants, whether or not the ants were taken appeared to depend mostly on the size of the ant relative to the size of the

spider. The smaller ants, such as *Pheidole dentata, Ph. morrisi,* and *Paratrechina longicornis* (Latreille), were quickly attacked and killed. The ants struggled but were too small to endanger the spider and soon succumbed to the spider's venom. Generally the spiders would exhibit little extra precaution when attacking the smaller ants but would carefully stalk larger ants. The very small ant *Xenomyrmex stolli floridanus* was the only ant usually captured by the head. Other ant species were captured by the dorsum of the alitrunk 159 (78%) of a total of 203 captures (Fig. 2). Frontal attacks occurred in 184 (91%) of all captures. During frontal attacks, capture was by the alitrunk 141 times (77%) (70% of all captures). To attain a frontal position the spider would circle the ant until the spider was properly aligned. On several

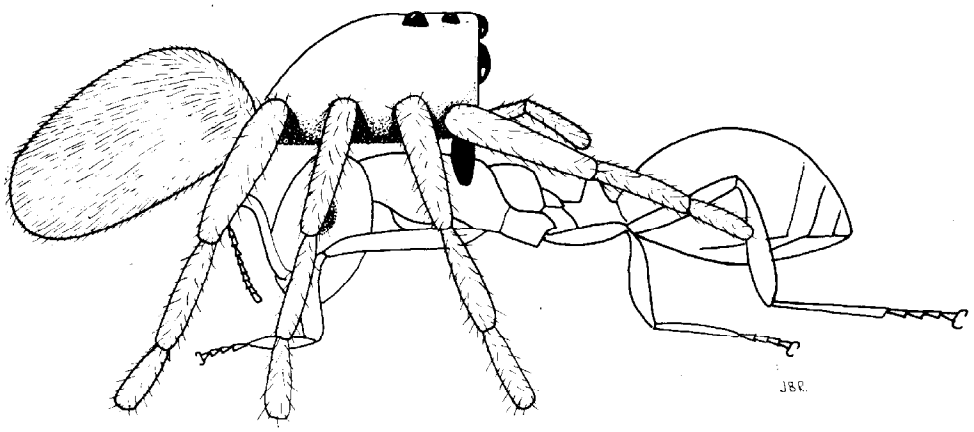

Fig. 2. Typical capture of ant by a frontal attack of *Stoidis aurata.*

occasions the spider could not align directly in front on the same plane as the ant because of the shape of the dish. In these instances the spider began its attack from the side or an oblique angle, jumped, turned in mid-air, and landed, simultaneously grasping the dorsum of the ant's alitrunk. Capture by the alitrunk made it difficult or impossible for the ant to defend itself. This capture behavior is similar to that observed by the senior author for other salticids but is apparently more closely adhered to by *Stoidis aurata* than by many salticid species. It is more similar to the behavior reported by Bristowe (1958) for *Segestria florentina* (Rossi) of the family Segestriidae and various crab spiders (Thomisidae) when capturing such insects as honeybees. The larger ants attempted to reach the spider to bite and sting or spray, but the spider used its first pair of legs to counter the thrust of mandibles or gaster. For more moderate-sized ants, the spider would raise its legs out of the ants' reach, but for small ants the spider's front legs were often used to aid in the capture by holding or turning the ant into proper position for grasping with the chelicerae. The capturing techniques for the larger ants, such as *Camponotus abdominalis floridanus* (Buckley) and *Formica pallidefulva* Latreille, were also used for less robust but elongate ants such as species of *Aphaenogaster.* Workers of *Solenopsis* (fire ants) were captured without difficulty, the spider grasping the ants by the dorsum of the head or alitrunk. No ant species grasped by the propodeum was able to defend itself.

Ants were sometimes able to defend themselves if captured by the head or pronotum. One of the most successful of these was *Crematogaster clara* Mayr,

which has the ability to flex its gaster upward and forward to apply a poison exuded from its modified sting (Buren 1958), providing a defensive advantage when attacked from the front by a spider (Fig. 3.). If the poison was successfully applied, the spider would immediately release its hold and back away; after observing the ant for a moment, the spider would leave, often rubbing the mouthparts or a leg against the substrate as if to rub off the poison. Three male spiders and 1 female spider reacted similarly and would no longer attack this ant species. The female spider attacked and killed 2 workers of *Prenolepis imparis* (Say), an ant the same size as *C. clara,* while a live *C. clara* worker was still in the dish with the spider. While this is a small sample (4), it may indicate a "learning" experience by the spider. Even though this may be viewed with skepticism, it is noteworthy that Reed et al. (1969) and Reed et al. (1970) have found experience can affect later behavior in the orb weavers *Argiope aurantia* (Lucas) and *Araneus diadematus* (Clerck). *Crematogaster vermiculata* Emery used the same defense as *C. clara,* although *C. vermiculata* was not as successful in defending itself. One *Monomorium viridum* Brown worker also defended itself in a manner similar to the *Crematogaster* species.

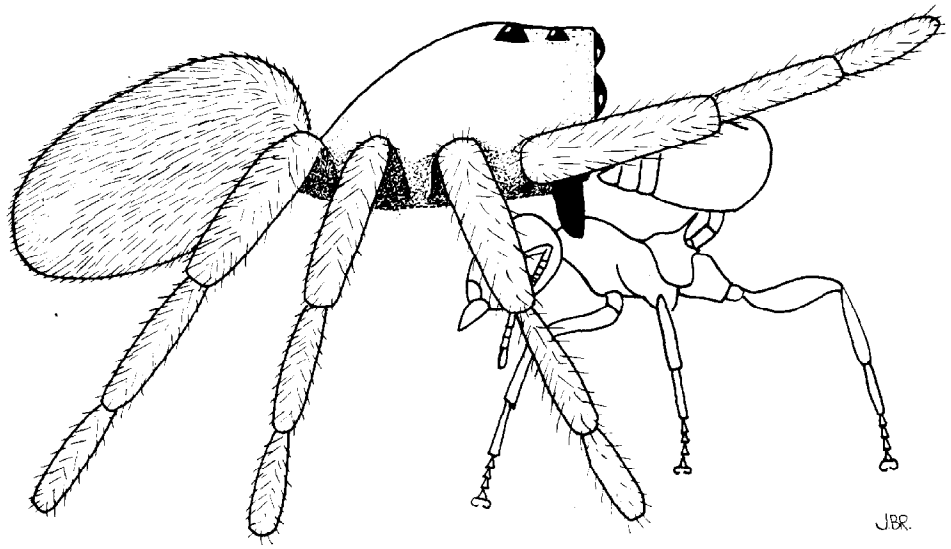

Fig. 3. Defense of *Crematogaster clara* against a frontal attack by *Stoidis aurata*. Drawing of *C. clara* adapted from Wilson (1958).

Four species of *Aphaenogaster*—*A. ashmeadi* Emery, *A. floridana* M. R. Smith, *A. lamellidens* Mayr, and *A. tennesseensis* (Mayr)—were fairly successful in defending themselves. These ants are about twice the size of the *Crematogaster* species and are about equal in size to the spiders. Their type of defense is similar to that of *Crematogaster,* as *Aphaenogaster* spp. also apply poison exuded from their sting, but the gaster is thrust beneath the alitrunk or to the side and forward. They were very effective in defending themselves against male spiders, with only 2 successful captures in 24 encounters, and approximate the maximum size ant that a male spider would attack. However, the only *Aphaenogaster* species which was able to defend itself consistently against female spiders was *A. lamellidens,* which appeared to have a more effective poison.

Another ant in the size range of *Aphaenogaster* spp., *Tetramorium guineense* (Fabricius), was not attacked by male spiders. Again female spiders had little trouble with 1 exception, the lone fatality of a spider in 322 encounters. A worker *T. guineense* was able to use its mandibles to grasp the spider's palp and then sting the spider, after which the spider died.

On the other hand, several ant species which caused the spider to release its hold were injured by the bite and succumbed to the spider's venom in 3-5 min, after which the spider returned to the ant in 3-15 min and began feeding upon it. These ant species were generally large and soft-bodied and included the 4 *Aphaenogaster* species tested, *Camponotus abdominalis floridanus, Formica pallidefulva,* and the single worker of *Odontomachus ruginodis* (Wheeler) that was captured. Since they were confined together, the spider could by chance encounter the disabled ant again, but spiders are not usually scavengers. In fact, in the majority of instances of this type, it was apparent that the spider was watching the ant and was waiting for it to become immobile before beginning to feed.

Formica pallidefulva is an ant somewhat larger than the spider and was one of the most difficult for the spider to overcome. When grasped by the thorax, the ant bent its gaster underneath and forward quickly enough to spray poison on the spider's mouthparts, resulting in a reaction essentially similar to but even more effective than that exhibited by spiders repelled by *Crematogaster clara.* Another factor in the spider's inability to capture *F. pallidefulva* was that the ant moved too rapidly around the petri dish for the spider to be able to stalk it. The few workers captured had stopped to groom themselves. This speed factor may be important with salticids because of their method of hunting. Drees (1952) reported that another jumping spider, *Salticus scenicus* (Clerck), also apparently had a preference for prey which moved in a particular range of speed. At the other extreme, *Stoidis aurata* often took longer than usual in noticing and capturing the small, slow-moving *Monomorium viridum.*

In 2 species of ants, *Cyphomyrmex rimosus minutus* Mayr and *Trachymyrmex septentrionalis* (McCook), the workers were uninjured by spider attacks, apparently because the spiders could not penetrate the hard exoskeletons of the ants. The workers of these 2 species were not aggressive; when attacked, they would appress their appendages to their bodies and remain motionless. However, a dealate queen of *T. septentrionalis* apparently did not have the same protection and was captured.

Individual spiders were sometimes observed to kill 6-8 ants in 2-3 hr. A large ant, such as *Camponotus abdominalis floridanus,* could satiate a *Stoidis aurata* female for as long as 2 days.

Some insight into prey preference was gained by introducing a second instar larva of the cabbage looper and a major worker of *Pheidole dentata* simultaneously into a petri dish with a male spider. The spider immediately attacked the ant and killed it. The ant was removed before it could be consumed. The spider then twice attacked the looper but released it unharmed each time. The ant was placed back into the dish; the spider went directly to the ant and began feeding upon it. Similar results were observed in 7 other instances.

The 20 other species of salticids tested refused to accept worker ants. These jumping spiders could generally be divided into 2 groups, 1) those which assumed a defensive posture and retreated from the ant, and 2) those which

paid little or no attention to the ant. In the former group were *Hentzia grenada* (Peckham) male, *H. palmarum* (Hentz) female, male, *Metacyrba floridana* Gertsch female, male, *M. undata* (DeGeer) female, *Metaphidippus galathea* (Walckenaer) female, and *Sarinda hentzi* (Banks) immature. The latter group included *Eris marginatus* (Walckenaer) male, *Marpissa sulcosa* Barnes male, *Menemerus bivittatus* (Du Four) female, *Peckhamia picata* (Hentz) male, *Pellenes* sp. 1 female, *Pellenes* sp. 2 immature, *Plexippus paykulli* (Audouin) female, *Phidippus audax* (Hentz) female, male, *P. clarus* Keyserling female, *P. otiosus* (Hentz) male, *P. regius* C. L. Koch female, male, *P. whitmani* (Peckham) female, and *Thiodina sylvana* (Hentz) female, male. A very small *Habrocestum* sp. female attacked workers of *Xenomyrmex stolli floridanus* and minor workers of *Pheidole morrisi* but immediately released them. A *Plexippus paykulli* female killed and ate an adult winged male of *Camponotus abdominalis floridanus.* A *Thiodina sylvana* female was observed in the field feeding on an alate male of another *Camponotus* sp.

These 20 salticid species were selected at random and tested only in the laboratory; *Stoidis aurata* was observed first in the field feeding on ant workers and then tested thoroughly in the laboratory. Possibly there are other salticids which feed on ant workers, but these will most likely be found by careful observations in a variety of natural habitats: this feeding will then need to be verified in the laboratory. It is also possible that any spider species exerting an important influence on a worker ant population could be quite specialized. On the other hand, our experience has been that the capture of alate ants is much more general, not only among salticids, but among other spiders as well.

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