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# Observations on cannibalism and feeding on dead arthropods in *Scydmaenus tarsatus* (Coleoptera: Staphylinidae: Scydmaeninae)

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**ABSTRACT.** *Scydmaenus tarsatus* MÜLLER & KUNZE, 1822, an ant-like stone beetle associated with decaying plant matter, is demonstrated to scavenge on dead arthropods (pseudoscorpions, immature isopods and adult flies). For the first time a conspecific aggression and cannibalism is reported to occur in Scydmaeninae under laboratory conditions.

**Key words:** entomology, behavior, Coleoptera, Staphylinidae, Scydmaeninae, Scydmaenini, *Scydmaenus*.

## INTRODUCTION

Data concerning prey preferences and feeding behavior of ant-like stone beetles of the large and cosmopolitan genus *Scydmaenus* LATREILLE are exceptionally scarce. BROWN & CROWSON (1980) mentioned that two adults of *S. tarsatus* MÜLLER & KUNZE kept on a Petri dish were observed to pick up oribatid and mesostigmatid mites; however, 'actual feeding was not observed, but dead shells of mites appeared in the dishes in the morning' (BROWN & CROWSON 1980). SCHMID (1988) reported that adults of the same species are specialized predators of Oribatida and Uropodina mites; and MOLLEMAN & WALTER (2001) demonstrated that several undetermined Australian species of *Scydmaenus* also fed on armored mites. Most recently prey preference experiments carried out on a large group of *S. tarsatus* yielded different results, i.e. beetles ignored armored mites and fed only on live soft-bodied acaridid mites and Collembola (JALOSZYŃSKI 2012).

In the present study, results of further observations on feeding-related behavior of *S. tarsatus* are reported. Laboratory experiments revealed a broader spectrum of food accepted by beetles and provided additional data on potential feeding preferences and behavior of this common, but still poorly studied species.

#### MATERIALS AND METHODS

Adults of *Scydmaenus* (s. str.) *tarsatus* MÜLLER & KUNZE, 1822 were collected by sifting a large compost heap in Włocławek, Central Poland, in June 2011. Beetles were placed in 100 ml plastic containers filled with the compost (about 20 beetles per container) and transferred to the laboratory. Feeding experiments and observations were carried out as reported previously (JAŁOSZYŃSKI 2012). Total 50 individuals were observed for 4 weeks; Petri dishes (diameter 3 cm) half filled with plaster of Paris and containing several small particles of compost were used as arenas for beetles. Ten individuals (5 males and 5 females) were kept on each arena. The arenas were moistened every second day with 0.2 ml of distilled water sprinkled on compost particles and kept at ambient temperature (22–24°C) in the dark.

Beetles were fed with live springtails *Ceratophysella denticulata* (BAGNALL, 1941) (Hypogastruridae). In scavenging experiments, the feeding was ceased for one day and freshly killed adults of small flies (undetermined genus of Sphaerocerinae, Sphaeroceridae), various pseudoscorpions and immature terrestrial isopods *Trachelipus rathkii* (BRANDT, 1833) (Trachelipodidae) were placed on beetle arenas. These arthropods were abundant in the compost inhabited by *S. tarsatus*. Observations were made directly after providing the potential food and were carried out under a dim light for a period of time long enough to record the entire feeding process. Photos were taken with an Olympus C-750UZ digital camera with Reynox MSN-505 close-up lens and a home-made flash diffuser. Damages made during a cannibalistic attack and feeding were observed using a LEO 435 VP scanning electron microscope (SEM); the specimen was spur-coated with gold without previous cleaning or dehydrating.

#### RESULTS AND DISCUSSION

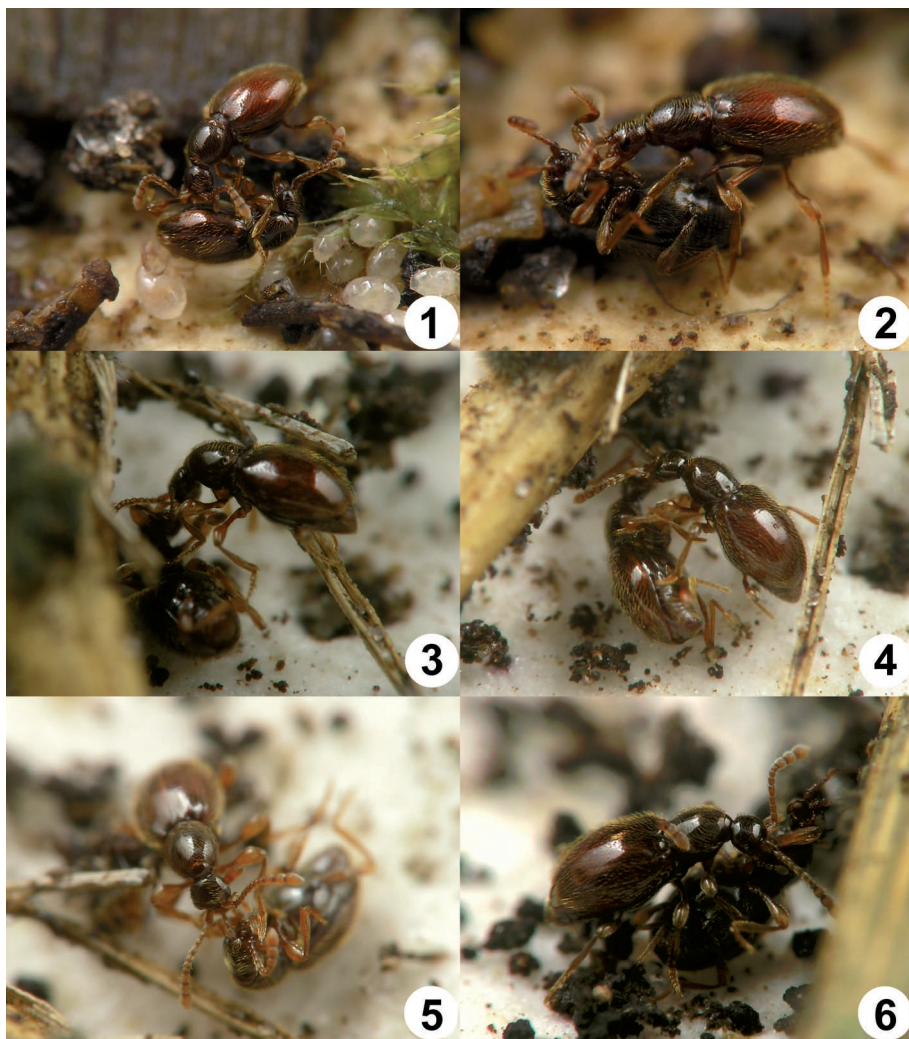
##### *Conspecific aggression and cannibalism*

During experiments carried out previously (JAŁOSZYŃSKI 2012), two cases of aggressive behavior between individuals of *S. tarsatus* were observed. Both involved a male attacking and killing another male. The attackers behaved in a similar way as during hunting, but a behavior that could be unambiguously interpreted as feeding was not observed. Another, later observation of a male attacking, killing and feeding on a female, followed by a SEM examination of abandoned remains, proved that cannibalism in *S. tarsatus* occurs, at least under laboratory conditions.

The three cases of conspecific aggression mentioned above were observed in groups of beetles fed *ad libitum* with live *Ceratophysella* springtails. One victim was a fully active male, attacked on the seventh day of the experiment. The beetle was captured by gripping the temporal/postgenal region of the head with mandibles of the attacker. The

grip was maintained for nearly one hour; the victim responded by intensive movements of legs and antennae; it was dragged around in various directions and lifted up several times. The dead body was abandoned shortly after the beetle's movements ceased. A lateral damage covering over 25% of the head capsule (including one eye) was found in the dead victim; other body parts remained apparently intact.

Another act of aggression was observed in the fourth week of the experiment and the victim was a weakened male, barely able to walk. It was attacked by another male and struggled for nearly 1.5 hr. Initially the attacker tried to secure a grip between



1-6. Conspecific aggression and cannibalism in *Scydmaenus tarsatus* MÜLLER & KUNZE, 1822. Photographs taken in small observation arenas (3 cm Petri dish) containing ten specimens

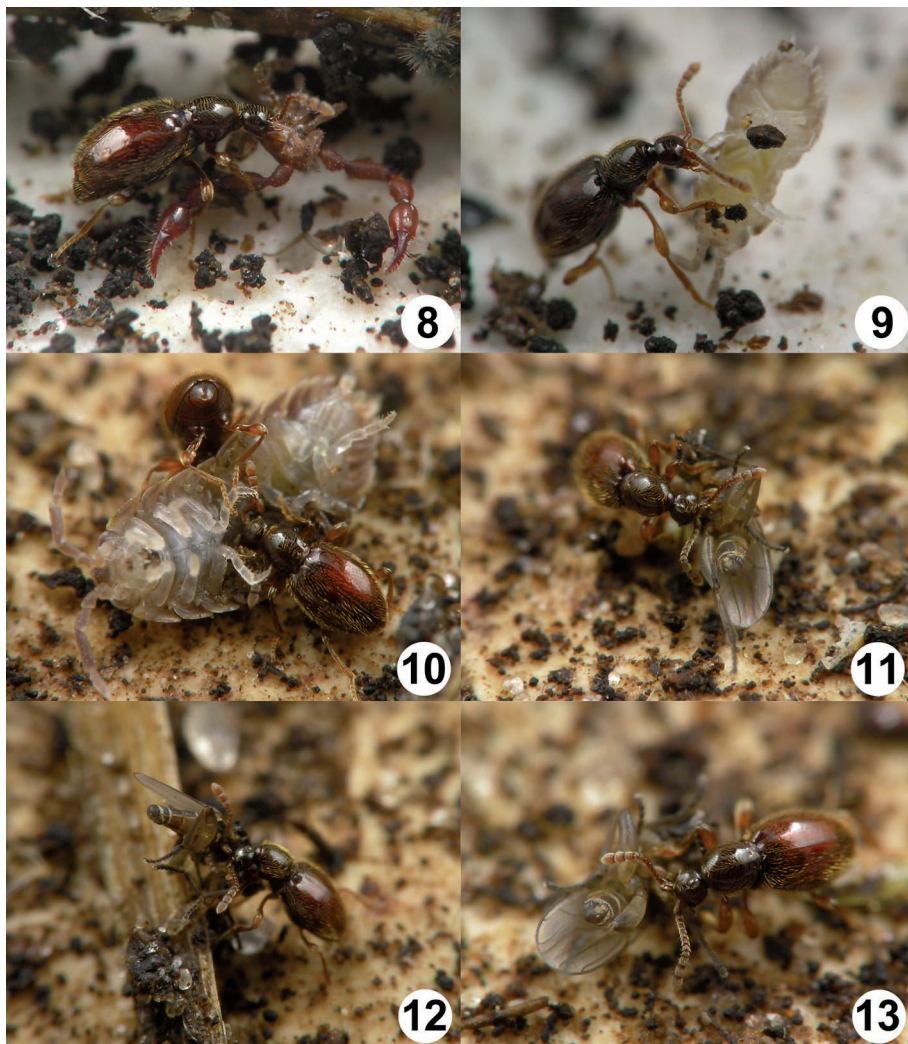
the pronotum and elytra, either by mounting the victim dorsally from behind or by approaching it frontally. This strategy was abandoned after nearly 15 min., when the attacker managed to insert one mandible under the lateral margin of elytron. The victim was turned legs up and the attacker searched for a grip on various places of the venter, including legs (Fig. 1). Eventually a firm grip was secured between the prothorax and mesothorax (Fig. 2), with one mandible inserted deeply in the ventral intersegmental membrane. The victim stopped moving a few min. later and was abandoned dead but without any noticeable damage to sclerotized cuticle.



7. Remains of a female *Scydmaenus tarsatus* attacked by a male; arrows indicate damage sites caused by feeding



The third case was observed on the fourth day of the experiment. A fully active female was captured in the morning by a male; the victim was gripped by its mouthparts (Figs. 3-5). The attacker inserted one mandible into the mouth of the struggling female. After nearly 5 hrs. the female still showed weak leg movements, while the attacker's grip remained the same. Ten hrs. after the attack the female did not show any movements, and the male was apparently feeding, moving its mandibles and frequently turning the victim's body around the grip site. At that time the mouthparts of



8-13. Scavenging of *Scydmaenus tarsatus* on dead arthropods under laboratory conditions; 8 – feeding on an undetermined pseudoscorpion; 9-10 – feeding on immature isopod *Trachelipus rathkii*; 11-13 – feeding on undetermined sphaerocerid flies

the victim were completely removed, but antennae and legs remained intact. 24 hrs. after the attack, the male was still feeding, but with its mandibles sank deeply in the intersegmental membrane between the prosternum and mesoventrite (Fig. 6). In addition to the mouthparts, also the antennal flagellomeres, terminal abdominal segments, fore and middle legs of the female were removed, and the male continued feeding for two more hrs. The remains were abandoned 26 hrs. after the attack. The SEM examination showed an extensive damage to the victim's body (Fig. 7).

Previously it was demonstrated that *Scydmaenus tarsatus* feeds readily on soft-bodied arthropods (acaridid mites and springtails), and ignores Oribatida and Uropodina (JALOSZYŃSKI 2012). Species of Scydmaenini and Cyrtoscydmini that are predators specialized on armored mites were shown to utilize natural body openings of their victims to reach to soft tissues (SCHMID 1988; MOLLEMAN & WALTER 2001). Ant-like stone beetles insert one mandible into the mouth, genital or anal opening of an oribatid mite and by manipulating the victim's body (turning it around the grip site with fore legs) they break out movable parts (i.e., mouthparts and genital or anal plates). Interestingly, the male of *S. tarsatus* used a similar strategy when attacking a female. The initial grip was by the victim's mouthparts, and most likely the damage caused by inserting the mandible deeply into the mouth caused the female's death. During feeding, the female's mouthparts were completely removed, and only later, when the liquefied contents of the head capsule was devoured, the attacker removed the terminal abdominal segments of the victim (Fig. 7). Finally, the male disarticulated the prothorax from the remaining body trunk. It seems that the male was able to digest all or most of soft tissues of its victim during this prolonged feeding.

The conspecific aggression observed under laboratory conditions may be induced by unusual circumstances, e.g. overcrowding. In natural substrates inhabited by *S. tarsatus*, rich in potential prey and providing appropriate shelters, the beetles can avoid contacts with other individuals. Therefore, the behavior described herein does not necessarily occur in nature. However, the beetles are capable of cannibalism and these data can be potentially important for planning or interpreting laboratory rearing experiments.

#### *Scavenging on dead arthropods*

In previous observations (JALOSZYŃSKI 2012), scavenging of *S. tarsatus* on dead organisms was not observed. In subsequent experiments, when various freshly killed arthropods were provided, some beetles readily fed on this type of food. Dead, but intact pseudoscorpions and immature *Trachelipus* isopods did not attract any attention of beetles, but the same prey with damaged cuticle (cut in pieces or punctured with a pin) turned out to be suitable food for *Scydmaenus*. The beetles readily fed on various undetermined species of pseudoscorpions (Fig. 8), always devouring only the opisthosoma (often entirely, which took 20-60 min.) and abandoning the more heavily sclerotized anterior body part and legs. In the case of isopods (Figs. 9, 10) the observed feeding lasted only 5-20 min. and was usually restricted to the ventral part of the prey. When dead pseudoscorpions and isopods were provided together, the former food was eaten by beetles while the isopods were usually left untouched. Small sphaerocerid flies (Figs. 11-13) were also readily accepted by beetles and disrupting their cuticle

was not necessary to initiate feeding. Freshly killed flies were apparently as attractive to *Scydmaenus* as dead pseudoscorpions and were favored over isopods. In all observed cases (ca. 15), beetles nearly completely devoured the ventral part of thorax and nearly entire abdomen of the fly, and the remaining body parts were abandoned after 10-50 min. Beetles were never observed attempting any attack on live isopods, flies or pseudoscorpions.

Since the arthropods used in experiments naturally inhabit the same substrates as *S. tarsatus* and usually occur in large numbers, it is possible that scavenging on their remains plays a role in feeding of this species. Most species of Scydmaeninae inhabit the forest floor, typically living in the leaf litter, mosses or rotting wood, and densities of their populations seem relatively low. However, decaying plant matter is usually quickly decomposed by a large number of saprophagous organisms, including isopods, fly larvae, earthworms and various mites; in such substrates populations of *S. tarsatus* may also reach relatively high densities. Under such conditions unspecialized, opportunistic predation and scavenging may prove beneficial over narrowly specialized life mode, and is more likely to occur than in scattered forest populations of other Scydmaeninae.

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