

## SHORT COMMUNICATION

### SPIDERS FEEDING ON EARTHWORMS

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**ABSTRACT.** A house spider (*Tegenaria atrica* C.L. Koch 1843, Agelenidae) was observed, filmed and photographed while feeding on an earthworm. An extensive search in the literature revealed that several arachnologists had noted spiders feeding on earthworms, altogether in 11 different families. Earthworm-eating spiders belong mostly to larger sized species dwelling near the ground in woodlands and grasslands. Since earthworms have a high protein content, they could be a welcome supplement to the spider's usual insect diet.

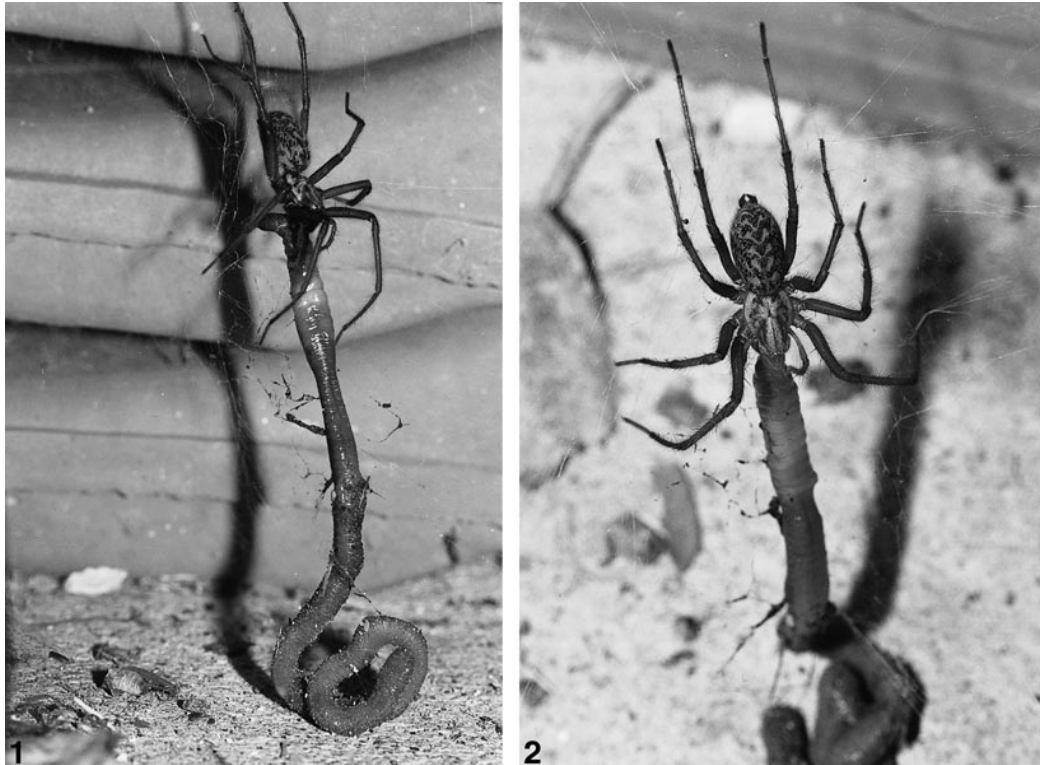
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Most spiders are polyphagous predators that prey predominantly on insects and to a lesser extent on other spiders (Riechert & Harp 1987; Nentwig 1987; Nyffeler et al. 1994). Spiders feeding on non-arthropod prey have rarely been reported (see Foelix 1996). That earthworms may be included in a spider's diet has not been recognized so far. However, this is exactly what was noted by one of us (H.M.) in September 1999 in Herznach, Switzerland: a *Tegenaria atrica* C.L. Koch 1843 (Agelenidae) was observed, filmed and photographed while feeding on an earthworm of 14 cm length (Figs. 1, 2). Bristowe's book "*The Comity of Spiders*" (1941), which includes a long chapter on 'The Food of Spiders,' revealed nothing on this peculiar type of feeding. Likewise, books on the biology of earthworms make no reference to spiders as enemies (see Edwards & Lofty 1972; MacDonald 1983; Lee 1985). Thus, the question arises whether our observation on *Tegenaria* was an isolated case or whether similar incidences have been noticed elsewhere.

An extensive literature search was conducted in order to find any information available on spiders feeding on earthworms. The search was based largely on the "Liste des Travaux Arachnologiques" (1968–1999), published by the International Society of Arachnology (for-

merly the C.I.D.A., Paris, France). In addition, an international arachnology discussion group was contacted via Internet. Altogether about 30 reports on spiders consuming earthworms were gathered (Table 1). Spiders from 11 different families are known to feed on earthworms. In two instances an unidentified species of *Tegenaria* (possibly *agrestis* (Walckenaer 1802)) was found by Yann Evenou (pers. commun.) preying on earthworms in the field, thus confirming our observation on *Tegenaria*. Furthermore, Günter Schmidt (pers. commun.) fed *Tegenaria ferruginea* (Panzer 1804) in captivity with earthworms of 8–10 cm length.

One of the earliest published reports on spiders consuming earthworms is that of Gerhardt & Kaestner (1937). Spiders from the mygalomorph genus *Atypus* Latreille 1804 (Atypidae), which inhabit silk tubes in the ground, were observed pulling earthworms into the tube and eating them. However, Bristowe (1958) expressed some reservations: "... Some early naturalists thought *Atypus* must emerge at night to hunt prey, whilst others were convinced that she subsisted on earthworms ..." and further "the idea that *Atypus* feeds largely on earthworms gains no support from examination or tests." Nevertheless, he admitted: "... experiment with



Figures 1, 2.—Spider feeding on an earthworm. 1. *Tegenaria atrica* trying to pull up its victim, an earthworm, onto its sheet web; 2. Dorsal close-up view of *Tegenaria* feeding on the front end of an earthworm.

worms placed on the surface 'finger' has shown that they get torn in the encounter, leaving at most a part of their bodies in the spider's possession which cannot readily be hauled into the tube. Although *Atypus* may suck the worm's juices for a time, she does not appear to finish the meal." Crome (1967) successfully fed *Atypus affinis* Eichwald 1830 in captivity with earthworms.

*Hadronyche versuta* (Rainbow 1914) (Hexathelidae), a mygalomorph spider from Australia that dwells in a silk tube burrow in the ground, also includes earthworms in its diet (Brunet 1998). Still another case of a mygalomorph spider feeding on earthworm prey was observed by Ricardo Ott (pers. commun.) in the rainforest of the Amazon: a large *Theraphosa blondi* (Latreille 1804) (Theraphosidae) was feeding on an earthworm of 30 cm length. Theraphosidae, representing 12 different species and 8 genera, have been seen preying on earthworms in captivity (Yann Evenou

& Jakob Walter pers. commun.). According to Brunet (1998), insects and earthworms form the staple diet of the mygalomorphs. Large earthworms (up to 20 cm) were also fed in captivity to the fishing spider *Dolomedes fimbriatus* (Clerck 1757) (Pisauridae) (Schmidt 1957).

Feeding on earthworms is probably a rarity among spiders (Wolfgang Nentwig pers. commun.). Spiders that spin a catching web in the higher strata of the vegetation, with which they capture small winged insects from the aerial plankton, will rarely, if ever, get in contact with earthworms. Although the orb web spider *Araneus diadematus* Clerck 1757 accepted earthworms in captivity (Nyffeler unpubl. data; Table 1), it is not expected to show this behavior in the field. During hundreds of hours of field observations, spiders feeding on earthworms were seen very rarely (Nyffeler 1982) or not at all (Zimmermann & Spence 1989). Feeding on earthworms seems to occur

Table 1.—Spiders feeding on earthworms (published and unpublished observations).

Species	Family	Typical adult body length (♀)	Typical habitat
Araneomorphae:			
<i>Tegenaria atrica</i> C. L. Koch 1843	Agelenidae	15 mm	Woodland and gardens, under stones
<i>Tegenaria</i> sp. Latreille 1804	Agelenidae	15 mm	Grassland, ground
<i>Tegenaria ferruginea</i> (Panzer 1804)	Agelenidae	14 mm	Woodland, crevices in tree trunks
<i>Amaurobius ferox</i> (Walckenaer 1830)	Amaurobiidae	15 mm	Woodland, under stones and logs
<i>Amaurobius fenestralis</i> (Stroem 1768)	Amaurobiidae	8 mm	Woodland, under stones and logs
<i>Segestria florentina</i> (Rossi 1790)	Segestriidae	20 mm	Under stones and logs
<i>Araneus diadematus</i> Clerck 1757	Araneidae	15 mm	Woodland, grassland, bushes
<i>Xysticus</i> sp. C. L. Koch 1835	Thomisidae	7 mm	Grassland, low vegetation or ground
<i>Xysticus</i> sp. C. L. Koch 1835	Thomisidae	7 mm	Grassland, low vegetation or ground
<i>Pardosa</i> sp. C. L. Koch 1847	Lycosidae	6 mm	Marshland, low vegetation or ground
<i>Trochosa terricola</i> Thorell 1856	Lycosidae	14 mm	Woodland, grassland, under stones
<i>Dolomedes fimbriatus</i> (Clerck 1757)	Pisauridae	20 mm	Swampy areas, low vegetation
<i>Ancylometes rufus</i> (Walckenaer 1837)	Pisauridae	35 mm	Tropical rainforest, ground
<i>Ctenus amphora</i> Mello-Leitao 1930			
<i>Ctenus crulsi</i> Mello-Leitao 1930	Ctenidae	17 mm	Tropical rainforest, ground
Mygalomorphae:			
<i>Atypus affinis</i> Eichwald 1830	Atypidae	15 mm	Woodland slopes, ground
<i>Atypus</i> sp. Latreille 1804	Atypidae	15 mm	Slopes with low vegetation, ground
<i>Atypus affinis</i> Eichwald 1830	Atypidae	15 mm	Woodland slopes, ground
<i>Atypus affinis</i> Eichwald 1830	Atypidae	15 mm	Woodland slopes, ground
<i>Hadronyche</i> sp. L. Koch 1873	Hexathelidae	30 mm	Subtropical rainforest, ground
<i>Hadronyche versuta</i> (Rainbow 1914)	Hexathelidae	30 mm	Subtropical rainforest, ground
<i>Theraphosa blondi</i> (Latreille 1804)	Theraphosidae	100 mm	Tropical rainforest, ground burrow
<i>Theraphosa blondi</i> (Latreille 1804)	Theraphosidae	100 mm	Tropical rainforest, ground burrow
<i>Aphonopelma anax</i> (Chamberlin 1940)	Theraphosidae	60 mm	Grassland, scrubland, ground burrow
<i>Aphonopelma pallidum</i> (F.O.P.-Cambridge 1897)	Theraphosidae	40 mm	Subtropical scrubland, ground burrow
<i>Brachypelma albopilosum</i> Valerio 1980	Theraphosidae	70 mm	Tropical rainforest, ground burrow
<i>Brachypelma smithi</i> (F.O.P.-Cambridge 1897)	Theraphosidae	70 mm	Woodland, grassland, ground burrow
<i>Brachypelma vagans</i> (Ausserer 1875)	Theraphosidae	60 mm	Subtropical forest, ground burrow
<i>Chromatopelma cyaneopubescens</i> (Strand 1907)	Theraphosidae	50 mm	Subtropical scrubland, ground
<i>Grammostola iheringi</i> (Keyserling 1891)	Theraphosidae	100 mm	Tropical rainforest, ground burrow
<i>Grammostola pulchra</i> Mello-Leitao 1921	Theraphosidae	60 mm	Grassland, ground
<i>Hysteroocrates ederi</i> Charpentier 1995	Theraphosidae	70 mm	Tropical rainforest, ground burrow
<i>Lasiodora parahybana</i> Mello-Leitao 1917	Theraphosidae	70 mm	Rainforest, ground
<i>Poecilotheria regalis</i> Pocock 1899	Theraphosidae	60 mm	Monsoon forest, hollow trees

Table 1.—Extended.

Web type	Location of observation	Source
Sheet (ecribellate)	Field	This paper
Sheet (ecribellate)	Field	Yann Evenou (unpubl.)
Sheet (ecribellate)	Captivity	Günter Schmidt (unpubl.)
Sheet (cribellate)	Captivity	Günter Schmidt (unpubl.)
Sheet (cribellate)	Captivity	Günter Schmidt (unpubl.)
Snare (ecribellate)	Field	Yann Evenou (unpubl.)
Orb (ecribellate)	Captivity	Martin Nyffeler (unpubl.)
None	Field	Nyffeler (1982)
None	Field	Jakob Walter (unpubl.)
None	Field	Vogel (1971)
None	Field	Yann Evenou (unpubl.)
None	Captivity	Schmidt (1957)
None	Field	Ricardo Ott & Clarissa Azevedo (unpubl.)
None	Field	Hubert Hoefler (unpubl.)
Silk tube burrow	Field	Savory (1926)
Silk tube burrow	Field?	Gerhardt & Kästner (1937)
Silk tube burrow	Captivity	Bristowe (1958)
Silk tube burrow	Captivity	Crome (1967)
Silk tube burrow	Captivity	David Rowell (unpubl.)
Silk tube burrow	Field	Brunet (1998)
None	Field	Ricardo Ott (unpubl.)
None	Captivity	Yann Evenou (unpubl.)
None	Captivity	Yann Evenou (unpubl.)
None	Captivity	Yann Evenou (unpubl.)
None	Captivity	Yann Evenou (unpubl.)
None	Captivity	Yann Evenou (unpubl.)
None	Captivity	Yann Evenou (unpubl.)
None	Captivity	Yann Evenou (unpubl.)
None	Captivity	Jakob Walter (unpubl.)
None	Captivity	Yann Evenou (unpubl.)
None	Captivity	Yann Evenou (unpubl.)
None	Captivity	Yann Evenou (unpubl.)
None	Captivity	Yann Evenou (unpubl.)

among spiders that dwell on the ground—under stones and logs, in the leaf litter and moss-covered patches, in cracks in the soil, and in earth burrows and silk tube burrows—or on low vegetation near the ground in woodlands and grasslands (i.e., habitats where earthworms are abundant) (Table 1). Web-building and nonweb-building spiders alike have been observed eating earthworms. They belong predominantly to larger species (> 10 mm body length, see Table 1), though there are exceptions. For instance, Nyffeler (1982) found a crab spider of the genus *Xysticus* C.L. Koch 1835, about 7 mm in length, sucking an earthworm of approximately 2 cm in length. *Xysticus* spp., nonweb-building spiders equipped with powerful front legs and supposedly potent venom, are able to subdue prey 2–3 times their own size (see Gertsch 1979; Nentwig & Wissel 1986). Among web-building spiders reported feeding on earthworms (Table 1), species that make sheet webs (i.e., *Tegenaria* and *Amaurobius*) or use a silk tube (i.e., *Atypus* and *Hadronyche*) dominate. Such webs function as effective traps for the capture of crawling prey organisms. Surprisingly, some nocturnal ground-surface dwellers (e.g., Gnaphosidae and Dysderidae)—expected often to encounter earthworms—are missing in the table.

In terrestrial ecosystems, most of the net primary production is used by detritivores and decomposers in the soil, resulting in a huge earthworm biomass which serves a variety of predators as food (see MacDonald 1983; Halaj & Cady 2000). Earthworm tissue has a high protein content ( $\approx 60$ –70%, dry weight) (MacDonald 1983; Lee 1985); thus an earthworm should be a welcome meal to a spider. Table 1 includes, among others, species from the families Pisauridae, Hexathelidae and Theraphosidae, which exhibit opportunistic feeding (broad diets) (e.g., Zimmermann & Spence 1989; Brunet 1998; Yann Evenou pers. commun.). It is not surprising that the diets of these nonspecific feeders also include earthworms. Such species are adapted to a broad range of prey types that optimizes their survival during periods of food shortage. Predation on earthworms may be of ecological significance for some larger spiders (e.g., mygalomorphs) by supplementing their insect diets (see Brunet 1998).

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## LITERATURE CITED

- Bristowe, W.S. 1941. The Comity of Spiders. Vol. II. Ray Society, London.
- Bristowe, W.S. 1958. The World of Spiders. Collins, London.
- Brunet, B. 1998. Spiderwatch: A Guide to Australian Spiders. New Holland Publishers, Sydney.
- Crome, W. 1967. Wirbellose Tiere. Rowohlt Taschenbuch Verlag, Hamburg.
- Edwards, C.A. & J.R. Lofty. 1972. Biology of Earthworms. Chapman & Hall, London.
- Foelix, R.F. 1996. Biology of Spiders (2nd ed.). Oxford Univ. Press and Thieme Verlag, New York.
- Gerhardt, U. & A. Kaestner. 1937. 8. Ordnung der Arachnida: Araneae = Echte Spinnen = Web-spinnen. In Handbuch der Zoologie (W. Kükenthal & T. Krumbach, eds.). de Gruyter, Berlin.
- Gertsch, W.J. 1979. American Spiders (2nd ed.). Van Nostrand, New York.
- Halaj, J. & A.B. Cady. 2000. Diet composition and significance of earthworms as food of harvestmen (Arachnida: Opiliones). American Midland Naturalist 143:487–491.
- Lee, K.E. 1985. Earthworms, Their Ecology And Relationships With Soils And Land Use. Academic Press, London.
- MacDonald, D.W. 1983. Predation on earthworms by terrestrial vertebrates. Pp. 393–414. In Earthworm Ecology. (J.E. Satchell, ed.). Chapman and Hall, London, New York.
- Nentwig, W. 1987. The prey of spiders. Pp. 249–263. In Ecophysiology of Spiders. (W. Nentwig, ed.). Springer-Verlag, Berlin, New York.
- Nentwig, W. & C. Wissel. 1986. A comparison of prey lengths among spiders. Oecologia 68:595–600.
- Nyffeler, M. 1982. Field Studies on the Ecological Role of the Spiders as Insect Predators in Agroecosystems. Ph.D. dissertation. Swiss Federal Institute of Technology, Zurich.
- Nyffeler, M., W.L. Sterling & D.A. Dean. 1994. How spiders make a living. Environmental Entomology 23:1357–1367.

- Riechert, S.E. & J.M. Harp. 1987. Nutritional ecology of spiders. Pp. 645–672. *In* Nutritional Ecology of Insects, Mites, and Spiders. (F. Slansky & J.G. Rodriguez, eds.). John Wiley, New York.
- Savory, T.H. 1926. British Spiders (Their Haunts And Habits). Clarendon Press, Oxford.
- Schmidt, G. 1957. Einige Notizen über *Dolomedes fimbriatus* (Cl.). *Zoologischer Anzeiger* 158:83–97.
- Vogel, B.R. 1971. Individual interactions of *Pardosa*. *Armadillo Papers* 5:1–12.
- Zimmermann, M. & J.R. Spence. 1989. Prey use of the fishing spider *Dolomedes triton* (Pisauridae, Araneae): An important predator of the neuston community. *Oecologia* 80:187–194.

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