

SHORT COMMUNICATION

Spiders feeding on earthworms revisited: consumption of giant earthworms in the tropics

Martin Nyffeler¹, Witold Lapinski², Andrew Snyder³ and Klaus Birkhofer^{4,5}: ¹Section of Conservation Biology, Department of Environmental Sciences, University of Basel, CH-4056 Basel, Switzerland. E-mail: martin.nyffeler@unibas.ch; ²Institute of Evolutionary Ecology and Conservation Genomics, University of Ulm, 89069 Ulm, Germany; ³Department of Biology, University of Mississippi, Oxford, MS 38677, USA; ⁴Department of Biology, Lund University, SE-223 62 Lund, Sweden; ⁵Chair of Ecology, Brandenburg University of Technology Cottbus-Senftenberg, 03046 Cottbus, Germany

Abstract. Predation on earthworms is common in some generalist predator species, as for example several ground beetle species (Coleoptera: Carabidae) that frequently feed on earthworms. In spiders (Araneae), however, such behavior is far less well documented. A survey of reports on spiders feeding on earthworms yielded a total of 44 naturally occurring predation events. Spiders from 14 families were observed feeding on earthworms in nature, and species from two additional families consumed earthworm prey in captivity. Earthworm predation by spiders has been observed in temperate, subtropical, and tropical regions in 18 different countries. Tropical spiders from the families Theraphosidae (Mygalomorphae) and Ctenidae (Araneomorphae) accounted for 59% of the reported predation events. Reports from French Guiana document the capture of giant earthworms (0.6–1 m in length) by the giant tarantula, *Theraphosa blondi* (Latreille, 1804). Predation on giant earthworms by large tarantulas has also been observed in rainforest habitats in Brazil, Ecuador, Peru, and Venezuela. Wandering spiders (Ctenidae) are known to feed on earthworms in Belize, Brazil, Costa Rica, French Guiana, Guyana, and Singapore. Quite obviously, larger-sized mygalomorph and araneomorph spiders in humid tropical rainforests are predators with broad feeding niches—including earthworms and vertebrate prey in addition to arthropod prey—and this is presumed to improve the survival of these spiders. By comparison, reports of earthworm predation in temperate climate are rarer, and recent molecular studies of the diet composition of lycosid and linyphiid spider species in Swedish arable fields suggest that earthworms are not a common prey of these species.

Keywords: Oligochaeta, Ctenidae, Theraphosidae, generalist predators, diet composition

Predation on earthworms is common in some generalist predator species, as for example several ground beetle species (Coleoptera: Carabidae) that frequently feed on earthworms (King et al. 2010). In spiders (Araneae), however, such behavior is far less well documented, as spiders are predominately predators of arthropods, with insects by far being the most dominant prey group (Nyffeler 1999; Birkhofer & Wolters 2012; Pekár & Toft 2015). In addition, some spider species are known to occasionally include small vertebrates in their diets (McCormick & Polis 1982; Henschel 1994; Menin et al. 2005; Nyffeler & Knörnschild 2013; de Carvalho et al. 2016; Nyffeler et al. 2017). Still other spiders use plant food to supplement their diets (Nyffeler et al. 2016). It has further been documented that some spider species also feed on unusual prey such as slugs, snails, velvet worms, polychaete worms, woodlice, amphipods, shrimps, crayfish, or freshwater crabs (McLay & Hayward 1987; Nyffeler & Symondson 2001; Nyffeler & Pusey 2014; Bhukal et al. 2015; Pekár & Toft 2015; Franco & Monge-Nájera 2016). According to a previous assessment by Nyffeler et al. (2001), spiders from eight families also feed on earthworms under natural conditions.

Over the last 15 years, new evidence of earthworm predation by spider species has been published in the scientific literature or on the internet. Here we update a previous assessment (Nyffeler et al. 2001) and discuss the overall evidence for earthworm predation in spiders to provide a more realistic view on the commonness and taxonomic or geographic patterns. We define earthworms as oligochaete worms represented by several families which live in the litter layer or in soil, and feed on dead organic matter (Lal 2006).

An extensive bibliographic search was conducted to identify all published reports on predation on earthworms by spiders using the ISI Web of Science Thomson-Reuters database, Scopus database, Google Scholar, Google Books, and Google Pictures. Social media

sites were also searched for content indicating earthworm predation by spiders. Furthermore, inquiries among biologists were undertaken for unpublished reports on this topic. In total, we found 44 reports of predation on earthworms by spiders, about half of which had previously been published in the scientific literature (Appendix 1).

Overall, spiders from 14 families (Agelenidae, Atypidae, Ctenidae, Hexathelidae, Lycosidae, Pisauridae, Salticidae, Segestriidae, Sicariidae, Sparassidae, Tetragnathidae, Theraphosidae, Theridiidae, Thomisidae) have been reported to feed on earthworms in nature, and individuals from two more families (Amaurobiidae, Araneidae) accepted earthworm prey in captivity (Appendix 1). It should be noted that the majority (>75%) of reported cases of predation on earthworms refers to spiders that forage as active hunters without the use of a catching web (see Fig. 1A for an exception).

So far, predation on earthworms has been reported from all continents except Africa and Antarctica (Appendix 1). This type of predator-prey interaction occurs in temperate, subtropical, and tropical climates. In the temperate regions of Europe and North America, earthworms consumed by spiders usually are members of the family Lumbricidae (e.g., Fig. 1B). A case of this trophic interaction was filmed in a park in Amsterdam, Netherlands. This video documents a crab spider (*Xysticus ulmi* (Hahn, 1831)) killing an earthworm about 13 times longer than itself (online at <https://www.youtube.com/watch?v=a9lf3tKw1E0>). In another instance, a small linyphiid spider (*Macrargus rufus* (Wider, 1834)) was seen feeding on a potworm (Enchytraeidae) in a forest habitat in Belgium (Rudy Jocqué, pers. comm.). This incident is not included in our assessment (Appendix 1), since potworms are not regarded as earthworms in the strict sense (see Sims & Gerard 1985). However, due to the close taxonomic relationship between potworms and earthworms (both



Figure 1.—Photographic evidence of earthworm predation by spiders. A. Redback spider (*Latrodectus hasselti*) with unidentified earthworm prey in its web in a garden in Melbourne, Australia (photo by Iain Duncan). B. Crab spider *Xysticus ulmi* killing a lumbricid earthworm in a park in Amsterdam, Netherlands (Copyright: Sammy Jean Cunze, itsVision.tv). C. *Theraphosa blondi* pulling a captured giant earthworm (presumably *Rhinodrilus* sp.) into its burrow in rainforest in French Guiana (photo by C.E. Timothy Paine). D. *Ctenus* sp. feeding on an earthworm in rainforest in Guyana (photo by Andrew Snyder). E. Ctenid spider feeding on an unidentified earthworm in rainforest in Belize (photo by Anton Sorokin). F. *Heteropoda maxima* feeding on an unidentified earthworm near Ban Koenphavang, Laos (photo by Peter Jäger).

being oligochaete worms with similar *modus vivendi*), we feel that this case should be mentioned in this review.

In the northern part of South America, large fossorial tarantulas have been observed catching and consuming giant earthworms (Appendix 1). A very impressive predation event was observed in a tropical rainforest at the Nouragues Biological Station, French Guiana. A giant tarantula, *Theraphosa blondi* (Latreille, 1804), was recorded feeding on a giant earthworm of 50–60 cm length. The spider was sitting in its burrow and half of the earthworm was pulled into the burrow while the other half was visible (W. Lapinski, pers. obs.). Another impressive scene was observed in the same area near Nouragues. Here, a *T. blondi* individual was seen slowly pulling a giant earthworm of approx. 1 m length into its burrow (Fig. 1C; C.E. Timothy Paine, pers. comm.). Paine stated “...The earthworm was stretched across a trail through the rainforest, grasping (as best he could) to anything for friction. The tarantula was pulling the earthworm from about 1/3 of the way along the body. So the earthworm was trying to cling to the soil with both ends. It was stretched taut...” The way the giant earthworm was pulled into the burrow resembles the way snakes are captured and pulled into

burrows by this tarantula species (Rick West, pers. comm.; Gordon 1993). The observer watched the scene for about 10 minutes, took photos (Fig. 1C), and left. When he returned to the scene about one hour later, spider and earthworm had disappeared. Although it has not been documented that the spider actually killed and ate the earthworm, it can be strongly suspected that the spider devoured the earthworm out of human sight after pulling it into its burrow (C.E. Timothy Paine, pers. comm.). According to Rick West (pers. comm.) at least half a dozen theraphosid spider interactions with earthworms witnessed in tropical rainforests have all been predation events where the earthworm was dragged into the spider’s burrow, killed, and consumed. Based on photos (Fig. 1C) the captured giant earthworm most likely belonged to a species in the genus *Rhinodrilus*, placed in the family Rhinodrilidae by some taxonomists (Tomas Pavlíček, pers. comm.; Csaba Csuzdi, pers. comm.) and in the family Glossoscolecidae by other taxonomists (Emmanuel Lapied, pers. comm.). In another instance, a *T. blondi* individual consumed an earthworm of 30 cm length near Manaus, Brazil (Nyffeler et al. 2001). Other incidents of *T. blondi* consuming earthworms occurred in the Kaw Mountains, French Guiana (Rick West, pers. comm.) and in Guyana (Lewis

2014). Furthermore, large tarantulas – *Theraphosa apophysis* (Tinter, 1991) and *Megaphobema velvetosoma* Schmidt, 1995 – were witnessed feeding on giant earthworms in Venezuela, Ecuador, and Peru (Rick West, pers. comm.).

A second group of tropical rainforest spiders frequently consuming earthworms are wandering spiders from the family Ctenidae (Fig. 1D & E; Andrew Snyder, pers. obs.). The earthworm depicted in Fig. 1D most likely belongs to a species placed in the family Rhinodrilidae (Csaba Csuzdi, pers. comm.; Tomas Pavlíček, pers. comm.) or Glossoscolecidae (Emmanuel Lapied, pers. comm.). Such incidents of ctenids consuming earthworms have been observed and photographed in Belize, Brazil, Costa Rica, French Guiana, Guyana, and Singapore (Appendix 1). *Ctenus* spp. in particular are abundant inhabitants of tropical rainforests (Portela et al. 2013). They are mainly nocturnal spiders that forage by ambushing prey on the leaf litter and low understory vegetation (Almeida et al. 2000; Salvestrini & Gasnier 2001; Gasnier et al. 2002). These medium-sized to large spiders may have 0.7–2.2 g body mass and are capable of catching prey ranging from 0.5–1.5 g (Lapinski & Tschapka 2013, 2014). A giant huntsman spider (*Heteropoda maxima* Jäger, 2001; Sparassidae) with a legspan of approx. 20 cm has also been observed feeding on an earthworm in Laos (Fig. 1F; Peter Jäger, pers. comm.). This spider species typically lives near cave entrances (Jäger 2001).

Large tarantulas such as *T. blondi* reach body weights of 25–65 g, with a maximum of up to >100 g (Saul-Gershenz 1996; Zachariah et al. 2007; Smith 2008). Such heavy spider species have high energy requirements and can be expected to feed on large prey organisms such as small vertebrate species (McCormick & Polis 1982; Menin et al. 2005). A giant earthworm, which can reach a body weight of >100 g (Moreno & Paoletti 2004), is a very profitable prey item for these giant tarantulas. Furthermore, giant earthworms are high quality prey characterized by high protein content (Moreno & Paoletti 2004) and may not pose a large risk to predators due to their limited defense abilities. The observation of spiders feeding on giant earthworms is generally important, as little is known about the natural enemies of giant earthworms (e.g., O'Donnell et al. 2005; Strüssmann et al. 2013).

Tropical spiders from the families Theraphosidae and Ctenidae accounted for 59% of the reported incidents of earthworm predation by spiders. Spiders from these families are typical generalist predators with broad feeding niches (Brunet 1998; Lapinski & Tschapka 2013; Lewis 2014; de Carvalho et al. 2016; Rick West, pers. comm.). The fact that they capture a large variety of different prey types including arthropods, vertebrates and even earthworms is presumed to improve their survival in humid tropical rainforests (also see Nyffeler et al. 2017). In temperate regions, predator-prey interactions between spiders and earthworms seem to be less common, as indicated by recent molecular tests on lycosid and linyphiid species in arable fields in Sweden (Roubinet et al. 2017). On the other hand, temperate region earthworms (Oligochaeta: Lumbricidae) can compose a substantial portion (up to almost 50%) in the diets of arachnids of the genera *Leiobunum* C.L. Koch, 1839 and *Hadrobunus* Banks, 1900 (Opiliones: Sclerosomatidae) (Halaj & Cady 2000); such earthworm-eating harvestmen, however, are facultative predators getting access to earthworm prey rather by scavenging.

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Appendix 1.—Records of spiders feeding on earthworms (44 records from the field and 3 records from spiders in captivity).

Spider taxonomic classification	Country	Type of evidence	Source
MYGALOMORPHAE			
Theraphosidae			
<i>Theraphosa apophysis</i> (Tinter, 1991)	Venezuela	Field observation	Rick West (pers. comm.)
	Venezuela	Field observation	Rick West (pers. comm.)
	Venezuela	Field observation	Rick West (pers. comm.)
	Venezuela	Field observation	Rick West (pers. comm.)
<i>Theraphosa blondi</i> (Latreille, 1804)	Brazil	Field observation	Nyffeler et al. (2001)
	French Guiana	Photo	C.E. Timothy Paine (pers. comm.)
	French Guiana	Field observation	Rick West (pers. comm.)
	French Guiana	Field observation	Witold Lapinski (pers. obs.)
	Guyana	Field observation	Lewis (2014)
	N. South America	Photo	Francesco Tomasinelli ^A
<i>Megaphobema velvetosoma</i> Schmidt, 1995	Peru	Field observation	Rick West (pers. comm.)
	Ecuador	Field observation	Rick West (pers. comm.)
Atypidae			
<i>Atypus affinis</i> Eichwald, 1830	United Kingdom	Field observation	Savory (1926)
Hexathelidae			
<i>Hadronyche versuta</i> (Rainbow, 1914)	Australia	Field observation	Brunet (1998)
ARANEOMORPHAE			
Agelenidae			
<i>Eratigena atrica</i> (C.L. Koch, 1843)	Switzerland	Field observation	Nyffeler et al. (2001)
<i>Tegenaria</i> sp.	France	Field observation	Nyffeler et al. (2001)
Amaurobiidae			
<i>Amaurobius fenestralis</i> (Stroem, 1768)	In captivity	Observation in captivity	Nyffeler et al. (2001)
<i>Amaurobius ferox</i> (Walckenaer, 1830)	In captivity	Observation in captivity	Nyffeler et al. (2001)
Araneidae			
<i>Araneus diadematus</i> Clerck, 1757	In captivity	Observation in captivity	Nyffeler et al. (2001)
Ctenidae			
<i>Ancylometes rufus</i> (Walckenaer, 1837)	Brazil	Field observation	Nyffeler et al. (2001)
<i>Ancylometes</i> sp.	Belize	Field observation	Anton Sorokin (pers. comm.)
<i>Ctenus amphora</i> Mello-Leitão, 1930	Brazil	Field observation	Thierry Gasnier (pers. comm.)
	Brazil	Field observation	Thierry Gasnier (pers. comm.)
<i>Ctenus cruksi</i> Mello-Leitão, 1930	Brazil	Field observation	Thierry Gasnier (pers. comm.)
	Brazil	Field observation	Thierry Gasnier (pers. comm.)
	Brazil	Field observation	Thierry Gasnier (pers. comm.)
<i>Ctenus curvipes</i> (Keyserling, 1881)	Costa Rica	Photo	Philipp Ric. Figueroa ^B
<i>Ctenus</i> sp.	Guyana	Photo	Andrew Snyder (pers. obs.)
	French Guiana	Photo	Anonymous ^C
	Singapore	Photo	Christopher Teo ^D
	Singapore	Photo	Adrian Cho ^E
	South East Asia	Photo	Joseph Ang ^F
	South East Asia	Photo	Eldie Aaron Justim ^G
Lycosidae			
<i>Pardosa</i> sp.	USA	Field observation	Vogel (1971)
<i>Trochosa terricola</i> Thorell, 1856	France	Field observation	Nyffeler et al. (2001)
Unknown	USA (Pennsylvania)	Field observation	Darryl Moran ^H
	USA (Michigan)	Field observation	Anonymous ^I
Pisauridae			
<i>Dolomedes</i> sp.	Germany	Video	Peter Blendowski ^J
Salticidae			
<i>Platycryptus undatus</i> (De Geer, 1778)	USA (Michigan)	Field observation	Ross (2008)
Segestriidae			
<i>Segestria florentina</i> (Rossi, 1790)	France	Field observation	Nyffeler et al. (2001)
Sicariidae			
<i>Loxosceles intermedia</i> Mello-Leitão, 1934	Brazil	Prey found in web	Fischer et al. (2006)
Sparassidae			
<i>Heteropoda maxima</i> Jäger, 2001	Laos	Photo	Peter Jäger (pers. comm.)
Tetragnathidae			
<i>Meta menardi</i> (Latreille, 1804)	United Kingdom	Prey found in web	Smithers (1996)
Theridiidae			
<i>Latrodectus hasselti</i> Thorell, 1870	Australia	Photo	Iain Duncan (pers. comm.)

Appendix 1.—Continued.

Spider taxonomic classification	Country	Type of evidence	Source
Thomisidae			
<i>Xysticus ulmi</i> (Hahn, 1831)	Netherlands	Video	Dagmar Cunze ^K
<i>Xysticus</i> sp.	Switzerland	Field observation	Nyffeler (1982)
	Switzerland	Field observation	Nyffeler et al. (2001)

^A Francesco Tomasinelli: online at <http://www.arkive.org/goliath-bird-eating-spider/theraphosa-blondi/image-G112597.html>

^B Philipp Ric. Figueroa: online at <https://www.flickr.com/photos/80335180@N06/16578886018>

^C Anonymous : online at <https://www.flickr.com/photos/60313790@N08/5539782616>

^D Christopher Teo: online at <https://www.flickr.com/photos/snapperholic/3372187502/in/photolist-68ZkRQ>

^E Adrian Cho: online at <https://www.flickr.com/photos/adriancho/3351350135>

^F Joseph Ang: online at <https://www.flickr.com/photos/parampita2009/3351265515/in/album-72157612958642434/>

^G Eldie Aaron Justim: online at <https://www.shutterstock.com/de/pic-432352723/stock-photo-wandering-spider-with-a-worm-prey.html?src=2sqDzsMDQZEOGel9dmvmig-1-23>

^H Darryl Moran: online at <https://www.flickr.com/photos/dwmoran/5880202140/in/photostream/>

^I Anonymous: online at <http://i.imgur.com/FNYHAG7.jpg>

^J Peter Blendowski: online at <https://www.youtube.com/watch?v=a89RyuDstus>

^K Dagmar Cunze: online at: <https://www.youtube.com/watch?v=a9lf3tKw1E0>