New record of a parasitoid worm (Mermithidae, Nematoda) in a spider of the genus *Trochosa* (Lycosidae)

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Abstract. A nematode from the family Mermithidae (Nematoda) was recorded parasitizing a spider of the genus *Trochosa*. The subadult *Trochosa*-female was found in a semi-dry calcareous grassland in the valley Leutratal, south of the city of Jena, Thuringia, Germany.

Keywords: wolf spider, mermithid worm, parasitism

Zusammenfassung. Neuer Nachweis eines parasitischen Fadenwurms (Mermithidae, Nematoda) in der Spinnengattung *Trochosa* (Lycosidae). Ein Fadenwurm der Familie Mermithidae (Nematoda) wurde als Parasit der Gattung *Trochosa* festgestellt. Das subadulte *Trochosa*-Weibchen wurde im mäßig trockenen Kalkgrasland des Leutratals südlich von Jena (Thüringen) gefangen.

Although spiders are often described as top-predators in arthropod communities, there are nonetheless various invertebrate animals that feed on spiders. In this context, Pompilidae (spider wasps) are often cited, a hymenopteran family comprising of about 100 species in Central Europe, which have specialized on spiders as a source of food for their offspring (Bellmann 2010). Also larvae of other hymenopterans, such as some Ichneumonidae and Sphecidae (Eberhard 2000, Bellmann 2010), some larvae of dipterans such as species of the genus *Ogcodes* (Acroceridae) and of the family Tachynidae (König 1894, Allard & Robertson 2003, Bellmann 2010, Kehlmaier et al. 2012) are known as parasites in or on spiders, or in their cocoons (see e.g. Finch 2005, Helsdingen 2011 for a review). Little is known about the relevance of nematode parasitism in spiders. All known natural nematode parasitoids of spiders belong to the family Mermithidae, namely the genera *Agamermis*, *Arachnomermis*, *Aranimermis*, *Hexamermis* and *Mermis* (Poinar 1985, 2000, Penney & Bennett 2006). A fossil species, *Heydenius araneus*, was also described (Poinar 2000). Mermithids can also be found in mosquitoes, grasshoppers, butterflies, damselflies or cockchafers. For many mermithids, the host species is still unknown (Nickle 1972).

Until now, there is little knowledge about their systematic classification due to difficulties in identification. Also, information about the life history of individual species is very fragmentary (Penney & Bennett 2006). Juvenile mermithids leave their host and then move on to soil or mud; some even live in freshwater, where they mature (Nickle 1972, Allard & Robertson 2003). Mating and development of the larvae into their first stadium occur in the soil. Afterwards, the larvae develop in arthropods (Hartwich 1992), in spiders usually after being ingested through a paratenic host or, rarely, through direct penetration by an infective larva after hatching out of an egg (Penney & Bennett 2006). The problem is that reliable identification of these animals is only possible having adult individuals, namely males (Allard & Robertson 2003). However, they are very difficult to find in soil and the rearing of post-parasite juvenile individuals in the laboratory is still difficult (Penney & Bennett 2006). Infected spiders often show an enlarged and deformed opisthosoma, deformed copulation structures or deformed legs. Moreover, they show changes in behaviour such as sluggishness, slower reaction times to predators and a tendency to move towards water (Allard & Robertson 2003, Pizzi 2009).

Study area, material and methods

The infected *Trochosa*-spider was found amongst contents of pitfall traps used during a biodiversity study in a semi-dry grassland near the motorway A4 in the valley Leutratal, south of the city of Jena (Germany). The investigated area is characterized as mesophilic grassland in the lower part which then changes to semi-dry calcareous grassland in the upper part of the slope. Above the grassland, the area is

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Fig. 1: Place of discovery of the infected spider: Grassland, dominated by tor-grass (*Brachypodium pinnatum*), which is interspersed with dogwood (*Cornus sanguinea*). – Photo: M. Meyer, June 2013

characterized by pine-forests, shrubs or barren calcareous sunny slopes.

As a preservative, we used 1.2-propandiol (VWR International GmbH, Darmstadt, Germany) (dilution 1:2) which was mixed with quinine sulphate (4 gram per litre) (VWR International GmbH, Darmstadt, Germany) to deter small mammals from entering and eventually perishing in the traps. To reduce surface tension, we used some drops of a surfactant (common washing liquid). The traps were installed at the end of April and emptied approximately every two weeks from April to September.

The infected spider was detected in one trap installed on June 11 and emptied on June 24, 2013. The plot where it was found is located in the northwest of the village "Leutra" near a pine-forest edge (50.8703, 11.5625 WGS84). The plant community is dominated by tor-grass (*Brachypodium pinnatum*) which is interspersed with dogwood (*Cornus sanguinea*) (Fig. 1). The female spider had only reached a subadult developmental stage such that identification to species level was impossible. Due to the maculation on the prosoma (two dark longitudinal stripes on a bright median stripe, Heimer & Nentwig 1991), the spider belongs to the genus *Trochosa*. As nearly all other identifiable individuals of the genus *Trochosa* caught during this study belonged to *Trochosa terricola* Thorell, 1856, it is highly likely that this individual belongs to this species as well. Other species of the genus *Trochosa* that are known from the locality are *Trochosa ruricola* (De Geer, 1778) and *Trochosa spinipalpis* (F. O. P.-Cambridge, 1895) (Malt & Schäller 1998), but both do not usually occur on dry grasslands (Engelhardt 1964, Bellmann 2010). The spider and the mermithid have been deposited at the Institute of Ecology, Friedrich-Schiller-Universität Jena.

Results and discussion

The mermithid was obviously in the act of emerging from the spider. A part of it, with a length of about one centimetre, was already visible between the spinnerets. After extracting the worm surgically, it was found to have a length of about 19 cm (Fig. 2). The opisthosoma of the spider was approximately 3 mm long. The worm was white, ivory-coloured to pale brownish in colour and had an irregular surface structure. Especially at the tapered ends, it was slightly transparent. The ends were rounded. Because the mermithid had not reached an adult stage, identification to species level was not possible.

Parasitism of spiders by mermithids is obviously not uncommon – in some spider populations, the infection rate reaches more than 8 %. The infection rate is higher in populations near streams, which may be due to the fact that most adult mermithid worms live in mud or freshwater (Nickle 1972, Allard & Robertson 2003). In general, parasitism by mermithids can occur in most spider families, as well as harvestmen (Poinar 1985), but also in scorpions and pseudoscorpions (Poinar & Ćurčić 1992). The wolf spiders (Lycosidae) exhibit the highest number of species (22) known for being infected by mermithids (Engelhardt 1964, Penney & Bennet 2006). This applies in particular to the genus *Pardosa*, but also to various species of the genera *Alopecosa*, *Arctosa*, *Geolycosa*, *Hygrolycosa*, *Rabidosa*, *Schizocosa* and *Sossipus* (Penney & Bennett 2006). For the genus *Trochosa*, only one case of parasitism by mermithids was known in an individual of *Trochosa robusta* (Simon, 1876) (Engelhardt 1964). For the remaining species of the genus *Trochosa*, no parasitism by mermithids has been described until now. However, parasitism of spiders by mermithids also occurs in most other spider families (see Penney & Bennett 2006 for a review). This could probably be because most of these mermithids undergo an indirect developmental process, i.e. they use insects as paratenic hosts which, for their part, then get consumed by spiders afterwards. This may explain the parasitism of spider species with different feeding habits (Poinar & Benton 1986).

Mermithid worms continue to be a mystery, especially because identification is still problematic. Since detection is more or less a matter of chance (e.g. individuals emerging of the spider) it is difficult to gain an overall view of this group.

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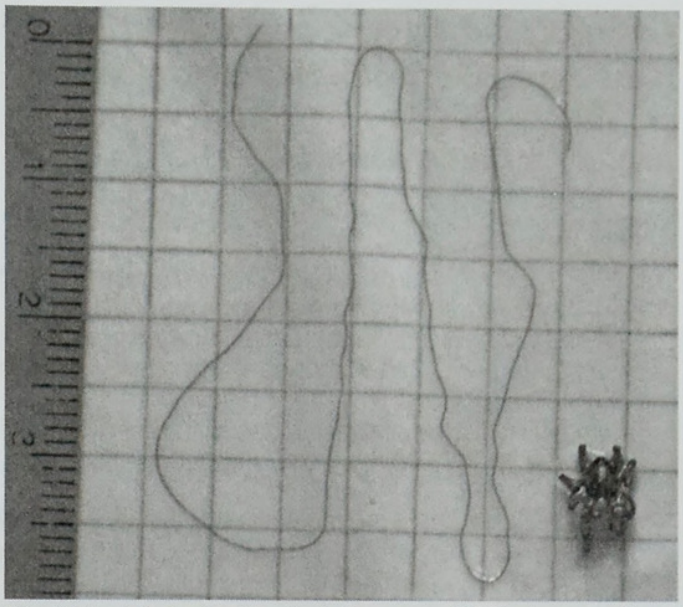

Fig. 2: The infected spider (opisthosoma slightly damaged) and the mermithid. – Photo: M. Meyer, February 2014, edited by T. Kronestedt.

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