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RESEARCH NOTES

PARASITISM OF PSEUDOSCORPIONS (ARACHNIDA) BY MERMITHIDAE (NEMATODA)

Records of nematode parasites of pseudoscorpions are rare and consist of brief reports by Vachon (1949) and Harvey (1982) who cite unidentified mermithids in European and Australian pseudoscorpions, respectively. Although Vachon mentioned that the nematodes he recovered appeared to resemble juveniles of the genus *Hexamermis*, it is not possible to base a reliable generic determination on immature mermithids. During a study on the life history and teratology of pseudoscorpions in the Balkan region (Ćurčić et al. 1991), one of us (B. P. M. Ć.) came across specimens containing nematodes. The present paper reports these finds and summarizes our knowledge of nematode-pseudoscorpion associations.

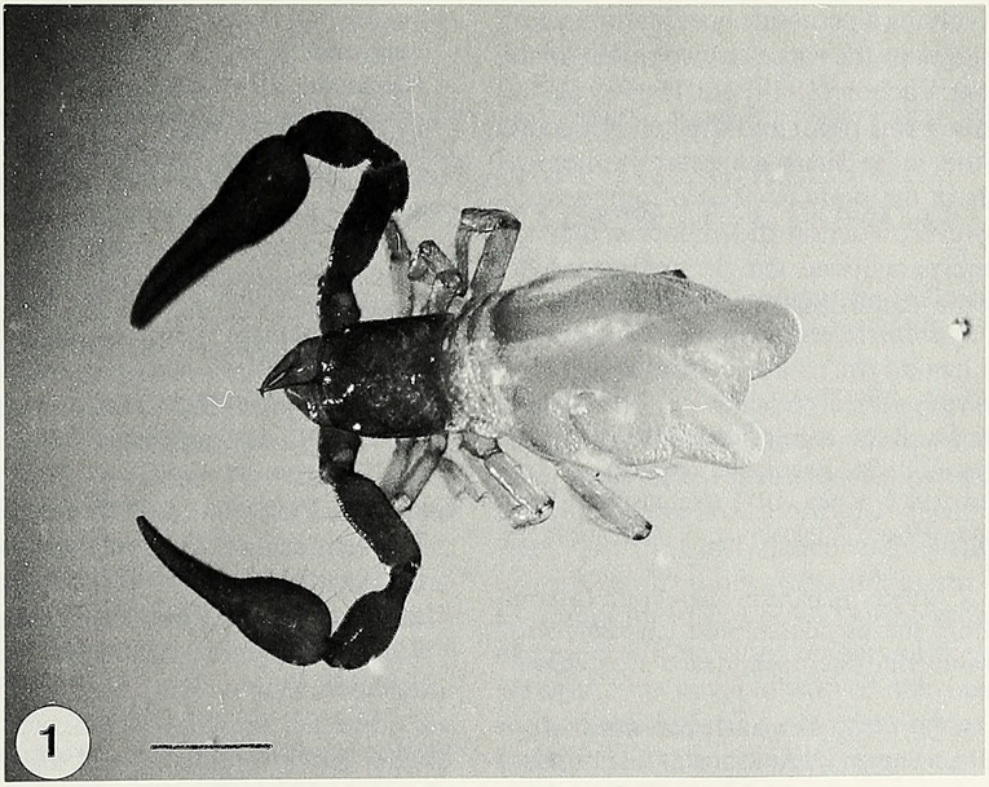
Samples of infected pseudoscorpions were obtained by sifting through leaf litter and humus over a period from April 1989 to September 1990 in a mixed oak forest in the village of Obrež, near Belgrade, Serbia, Yugoslavia. Six females and three males of *Roncus* aff. *lubricus* L. Koch (Neobisiidae) from a total of 2167 adults (1335 males and 832 females) were infected with representatives of the family Mermithidae of the order Mermithida (Fig. 1). This results in an overall infection rate of 0.4% for the adults, with a 0.2% infection rate for males and a 0.7% infection rate for females.

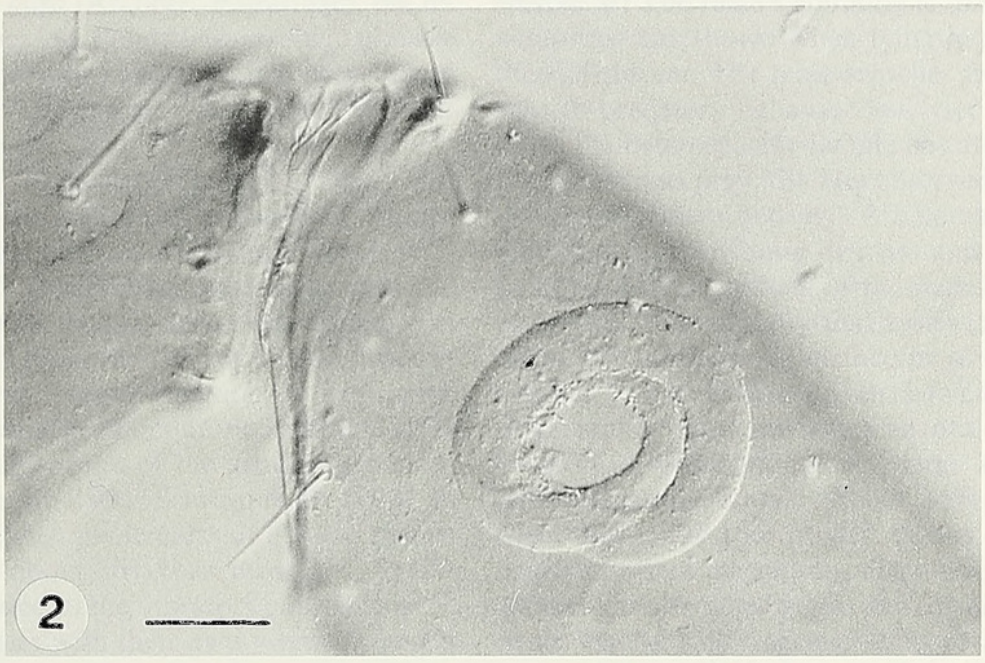
Two specimens of *Neobisium carpaticum* Beier collected from Mt. Avala near Belgrade were also associated with nematodes. The first specimen, a deutonymph, had a small, coiled nematode (length = 349 μm; width = 22 μm) in the pedipalpal femur (Fig. 2). This may represent an early developmental stage of a mermithid nematode, although further growth would be restricted in this region of the host. The second specimen was a "dauer" stage of a representative of the order Rhabditida attached by its head to an abdominal sclerite of a mature female host. The specimen was 567 μm long and 38 μm wide and represented a third stage juvenile enclosed in its second stage cuticle. Such phoretic associations between soil arthropods and rhabditoid nematodes are not uncommon.

Three mermithid-parasitized individuals of *Roncus* aff. *lubricus* were dissected and the nematodes removed. In all three hosts, the internal tissues, including the gonads, were atrophied and the body cavity was completely occupied by the parasites (Fig. 1). Two of the three hosts contained two parasites each while the third contained a single mermithid. Often, when two mermithids are present in a host, one is a female and the other is a male (Poinar, pers. obs.). Such a ratio favors reproductive activity and continuation of the life cycle.

Nematodes removed from parasitized *Roncus* aff. *lubricus* were cream colored and ranged in length from 4.8 to 6.6 mm ($\bar{x}$ = 5.7; n = 5). The greatest body width ranged from 164 to 189 μm; ($\bar{x}$ = 178 μm; n = 5). Four of the mermithids were in their late parasitic stage and the cuticle had thickened in preparation for the following free-living post-parasitic stage. In these individuals a prominent cuticular appendage was present, ranging from 31–44 μm in length ($\bar{x}$ 40 μm; n = 4). The fifth mermithid was still in the middle of its parasitic stage and did not yet possess an appendage. In all specimens, both anterior and posterior ends were rounded and six faint head papillae could be detected. Cuticular cross fibers were not evident. The trophosome extended anteriorly into the head region and posteriorly into the tail region. It is likely that these parasites belong to a new species and possibly genus. However, descriptions of mermithids should be based on adult characters which are still unavailable to us.

Mermithid nematodes parasitize a wide variety of terrestrial invertebrates. Among the Arachnida, they have been reported from spiders and harvestmen (Poinar 1985) (Poinar & Early 1990) and scorpions (Poinar & Stockwell 1988) as well as pseudoscorpions. Of the two spider mermithids whose biology has been investigated, both were shown to have indirect cycles involving spider predation on paratenic hosts containing the infective stages of the mermithids (Poinar & Benton 1986) (Poinar & Early 1990). This type of cycle may be widespread in predaceous hosts





Figures 1, 2.—1, Two parasitic mermithid nematodes filling the body cavity of a pseudoscorpion, *Roncus* aff. *lubricus*. Bar = 540 μm. 2, A coiled unidentified nematode in the pedipalpal femur of a deutonymph of *Neobisium carpaticum*. Bar = 36 μm.

and may occur in the present case with the pseudoscorpion mermithids. With spiders, the paratenic hosts are often aquatic detritivores such as the immature stages of Trichoptera and Ephemeroptera. When mature and ready to emerge, the nematodes apparently drive the parasitized hosts to a water source; the mermithids then exit the hosts. After maturation to the adult stage, mating and oviposition occur. Immature insects ingest the nematode eggs, which hatch in their alimentary tracts. The newly emerged infective stage mermithids penetrate the paratenic host's gut wall and enter the hemocoel where they remain until being ingested by a spider.

It was not possible to determine whether the life cycle of the pseudoscorpion mermithid is

indirect, involving a paratenic host, or direct with the adult stages in the same environment as the host. Neither Vachon (1949) nor Harvey (1982) commented on this point and their short reports provide little more than the establishment of mermithids in the body cavities of pseudoscorpions. However, Vachon did mention that the ovary of the parasitized female was atrophied, similar to the conditions found in the present study.

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