

Distribution of *Pheromermis pachysoma* (Mermithidae) Determined by Paratenic Invertebrate Hosts

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Poinar et al. (6) described the unusual life cycle of the yellowjacket mermithid parasite, *Pheromermis pachysoma*, which included a paratenic host. Instead of hatching in their aquatic environment, as do most other mermithid species, the infective stages of *P. pachysoma* remain inside the eggs until they are ingested by aquatic invertebrates. After ingestion the infective second stage juveniles (one molt occurs inside the egg) hatch and penetrate through the intestinal wall, entering and coiling up in various tissues of the host. The nematodes remain viable throughout the life of the host but do not develop. Growth is finally initiated when these paratenic hosts are captured and used as nourishment for yellowjacket (*Vespula pennsylvanica*) larvae. The cycle is completed in the fall of the year when the parasitized adult yellowjackets emerge and visit a water source, allowing the nematodes to escape. The study by Poinar et al. (6) in California was the first record of *P. pachysoma* in the Americas; previous findings were restricted to England

and Germany. Since those findings more North American sites containing *P. pachysoma* have been found. This paper lists these localities and illustrates how new infestations can be determined by recognizing the juveniles in various aquatic invertebrates.

Adults of the caddis fly, *Limnephilus peltus* (Limnephilidae: Trichoptera), containing black spots on the body wall were collected at the Sagehen Creek field station located near Truckee, California (elevation approx. 2,000 meters). Adults and larvae of *Hesperophylax* sp. (Limnephilidae: Trichoptera) containing small dark circles were collected from Saskatchewan, Ontario, and British Columbia in Canada and from Wyoming, Arizona, Nevada, Oregon, South Dakota, Colorado, New Mexico, Utah, and California. Postparasitic mermithids were collected from parasitized yellowjackets in the Calderwood Reserve, North Carolina, and along the Hiwassee River near Wartburg, Tennessee. Similar mermithids were collected from *Polistes annularis* in Louisiana and from *Dolichovespula arenaria* in California.

Coiled juveniles of *P. pachysoma* appeared as black spots on *L. peltus* adults (Fig. 1) and as small dark circles on larvae

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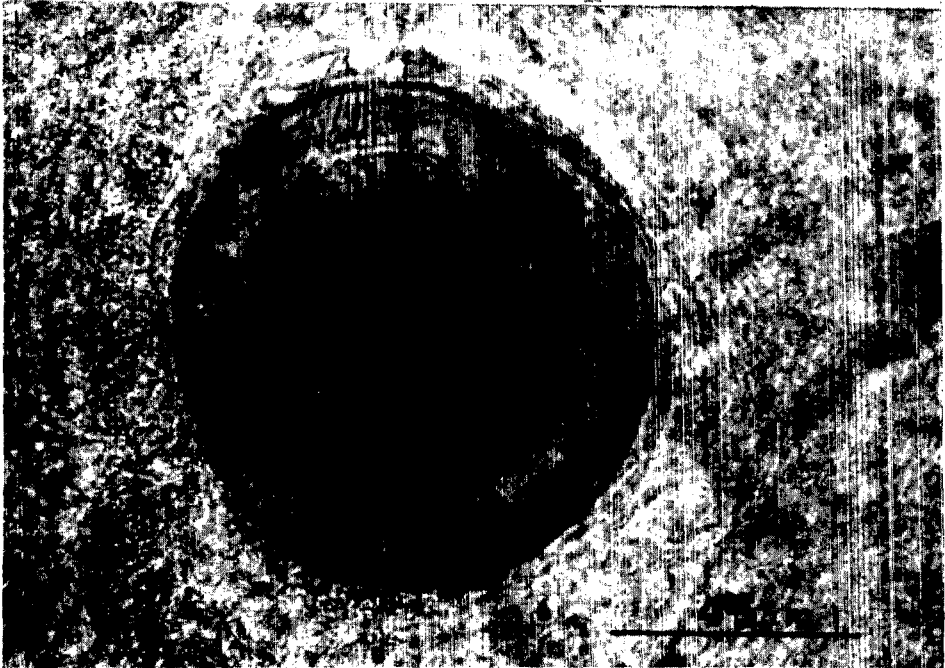
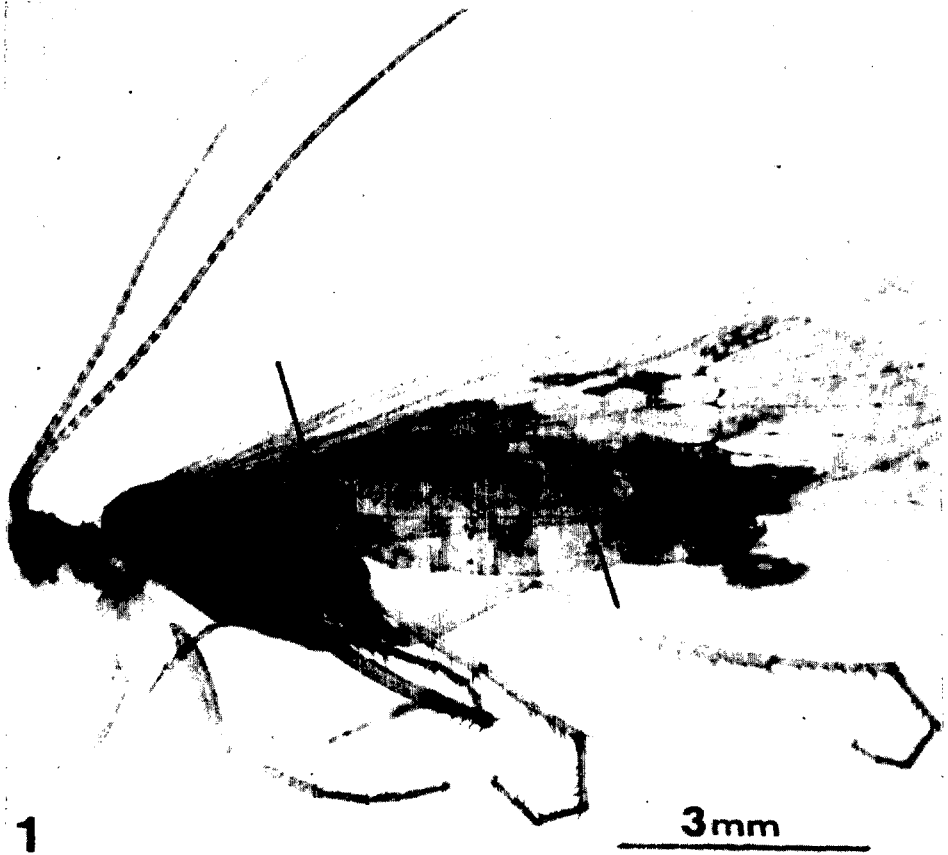


Fig. 1. Adult of *Limnephilus peltus* containing black spots representing the infective stages of *Pheromermis pachysoma*.

Fig. 2. A single infective stage of *Pheromermis pachysoma* coiled in the body wall of an adult *Hesperophylax* sp.

and adults of *Hesperophylax* sp. (Fig. 2). Adult and postparasitic juveniles of *P. pachysoma* were also collected from the site that contained *L. peltus*. Size of the juvenile and shape of the stylet were used to identify the mermithid species.

Up to 200 tightly coiled infective stage juveniles of *P. pachysoma* occurred in each adult caddis fly; the coils measured 60–100 μm in diameter and occurred primarily in the abdominal wall with some in the wall of the thorax and legs. The center of the coil was dark; a short cylindrical tube-like structure sometimes could be seen arising from the center of this mass. The significance of this remains unknown. The postparasitic juveniles collected from yellowjackets in Tennessee, North Carolina, Louisiana, and California were also *P. pachysoma*, but no paratenic hosts were collected in those areas.

These findings demonstrate that the nematode, *P. pachysoma*, not only occurs in its original location at Hopland, California (about 700 meters elevation), but also at higher elevations (2,000 meters) in the Sierra Nevada mountains. It also occurs as far north as Saskatchewan, Canada, and as far south as Louisiana. Therefore, it can be surmised that *P. pachysoma* is probably distributed throughout North America, possibly wherever the yellowjacket hosts occur.

Caddis fly larvae that feed on detritus, such as members of the Limnephilidae, make good paratenic hosts, but many other invertebrates are also suitable. Poinar et al. (6) found crane fly larvae (Tipulidae), beetle larvae, and ephemeropterid nymphs naturally infected and experimentally infected mosquito larvae (*Culex pipiens*) and mayfly nymphs (*Callibaetis pictus*) with *P. pachysoma*. In Europe, juveniles of *P. pachysoma* were recovered from trichoptera larvae in Austria (Kaiser, personal communication).

Invertebrates other than insects may also be infected with juveniles of *P. pachysoma*. The mermithid juvenile reported in the oligocheete, *Limnodrilus silvana*, (7) came from the Sagehen Creek area in California. This area is now known to contain *P. pachysoma*, and a re-examination of the specimens confirmed their similarity to juveniles of the wasp mermithid.

Predaceous nematodes may also serve as paratenic hosts to mermithid juveniles by

ingesting mermithid eggs during feeding. *Nanomermis nemicola* was described from the body cavity of *Monochus subtenuis* in Virginia. From the description and habits of this nematode (3,4), it appears to be a mermithid juvenile using *M. subtenuis* as a paratenic host. Small coiled nematodes in the body cavity of *Tripyla setifera* and *Bathyodontus mirus* were observed (1) and subsequently named *Nanomermis tripylae* and *Idioblastus elachistus* (2). The true identity of these mermithids remains unknown. There are probably a number of mermithids using paratenic hosts to reach their developmental host. *Pheromermis myopis*, a parasite of *Tabanus* larvae, appears to have this type of cycle (8).

In the development of *P. pachysoma*, a paratenic host is an obligatory step in the life cycle, since the eggs do not hatch in the gut of adult yellowjackets (6). This makes further characterization of the type of paratenic host difficult in light of the complicated terminology discussed by Odening (5). Invertebrate hosts carrying the infective stages of *P. pachysoma* and other mermithids might be called euparatenic hosts, since there is no growth or development of the parasite as occurs in metaparatenic or paraparatenic hosts. However, euparatenic hosts are generally considered to be additional and not obligatory hosts. The exact terminology describing these hosts must await further clarification of these terms.

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