

Review Article

Helminth fauna of *Talpa* spp. in the Palearctic Realm

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Abstract

The helminth fauna of the genus *Talpa* in the Palearctic Realm is reviewed. Several helminth species reported in *Talpa* spp. by a number of authors are discussed, with reference to host specificity, parasite biology, and host ethology, ecology and phylogeny. Twelve species of cestodes were found, two of which exhibit stenoxenous specificity (*Staphylocystis bacillaris* and *Multitesticulata filamentosa*). Only three species of trematodes, *Ityogonimus lorum*, *Ityogonimus ocreatus* and *Combesia macrobursata*, are exclusive parasites of *Talpa* spp. The largest group are nematodes, with 37 species. Species of *Tricholinstowia* are parasites of holarctic talpids and several species of distinct genera, such as *Capillaria*, *Soboliphyme* and *Trichuris*, are found only in *Talpa* spp. Only acanthocephalans of the genus *Moniliformis* have been reported in moles of the genus *Talpa*. On the basis of these helminthological findings, the close phylogenetic relationship between moles (Talpidae) and shrews (Soricidae) supports the separation of the ordinal levels Soricomorpha and Erinaceomorpha.

Studies on the helminths of *Talpa* spp. have traditionally focused on species description, faunistic data, and the ecology of communities. *Talpa* spp. are strictly fossorial mammals and are widespread in Eurasia (Stein, 1963). At present, ten species are recognized in this genus: *T. caeca*, *T. europaea*, *T. occidentalis*, *T. romana* and *T. stankovici* in Europe and *T. altaica*, *T. caucasica*, *T. davidiana*, *T. levantis* and *T. streetii* in central and eastern Asia (Nowak, 1999; Kryštufec *et al.*, 2001). The taxonomic distinction of *Talpa* spp. was established only recently by means of morphometric and allozyme studies in several species. However, the subspecific status of *T. europaea europaea*, *T. e. cinerea* and *T. e. pancici* remain unresolved (Kryštufec *et al.*, 2001). The distribution of moles is not regular. While *T. europaea* shows a wide distribution in Europe and east through to Russia, the remaining species are restricted to the following areas: Iberian Peninsula (*T. occidentalis*), Italy

(*T. romana*), Balkans (*T. stankovici*), south-eastern Bulgaria and northern Turkey (*T. levantis*), Caucasus (*T. caucasica*), southern Europe (*T. caeca*), Kurdistan and Iran (*T. streetii*), Iran (*T. davidiana*) and central Siberia and northern Mongolia (*T. altaica*) (Nowak, 1999; Kryštufec *et al.*, 2001). Although the helminths of several species of *Talpa* have been examined, the widespread *T. europaea* has received most attention. The ethology of *Talpa*, as burrowing mammals occupying subterranean habitats, determines its particular helminth fauna (Prokopic & Grulich, 1976; Andreani & Valle, 1988; Casanova *et al.*, 1996; Shimalov & Shimalov, 2001; Žasitytė & Griekienienė, 2001; Milazzo *et al.*, 2002; Ribas & Casanova, 2005). The subterranean way of life has led several mammalian taxa with diverse evolutionary histories to show similar behavioural, ecological and physiological adaptations (Nevo, 1999).

The helminth fauna of *Talpa* spp. in Europe includes species of Trematoda, Cestoda, Nematoda and Acanthocephala (table 1). Digeneans are intestinal parasites as adults, except the tissue larvae of *Alaria alata* (mesocercariae) in amphibians as intermediate hosts,

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Table 1. Helminth species of *Talpa* spp. cited in the literature.

| Helminth species ¹ | T.e. | T.c. | T.o. | T.r. |
|---|------|------|------|------|
| TREMATODA | * | * | | * |
| <i>Alaria alata</i> (Goeze) larvae | * | | | |
| <i>Combesia macrobursata</i> (Chertkova & Rodonaja) | * | | | |
| <i>Euparyphium melis</i> (Schrank) | * | | | |
| <i>Ityogonimus lorum</i> (Dujardin) | * | | * | |
| <i>I. ocreatus</i> (Goeze) | * | | * | * |
| <i>Neoglyphe locellus</i> (Kossak) | * | | | |
| <i>Nephrotrema truncatum</i> (Leuckhart) | *? | | *? | |
| <i>Omphalometra flexuosa</i> (Rudolphi) | * | | *? | |
| CESTODA | | | | |
| Cestoda gen. sp. | *? | *? | *? | *? |
| <i>Amoebotaenia lumbrici</i> (Villot) larvae | * | | | |
| <i>Dilepis undula</i> (Schrank) | * | | | |
| Hymenolepididae gen. sp. | * | | | |
| <i>Hymenolepis barrosii</i> (Moniez) | * | | | |
| <i>Multitesticulata blanchardi</i> (Mola) | * | | | |
| <i>M. filamentosa</i> (Goeze) | * | | * | |
| <i>Polycercus paradoxa</i> (Rudolphi) larvae | * | | | |
| <i>Spirometra erinacei europaei</i> (Rudolphi) larvae | * | | | |
| <i>Staphylocystis bacillaris</i> (Goeze) | * | | | * |
| <i>Taenia crassiceps</i> (Zeder) larvae | * | | | |
| <i>T. hydatigena</i> Pallas larvae | * | | | |
| <i>T. mustelae</i> (Gmelin) larvae | * | | | |
| <i>T. taeniaeformis</i> (Batsch) larvae | * | | | |
| NEMATODA | | | | |
| Nematoda gen. sp. | *? | *? | * | *? |
| <i>Agamospirura minutissima</i> Sharpilo, larvae | * | | | |
| <i>Aonchotecha europea</i> Mas-Coma & Galan-Puchades | | | * | |
| Ascaridiidae gen. sp. larvae | | | * | |
| <i>Ascarops strongylina</i> (Rudolphi) larvae | * | | | |
| <i>Calodium hepaticum</i> (Bancroft) | * | | | |
| <i>Calodium soricicola</i> Yokogawa & Nishigori | * | | | |
| <i>Capillaria coeca</i> Matsaberidze | | * | | |
| <i>Capillaria talpae</i> (Siebold) | * | | | * |
| <i>Capillaria</i> sp. | * | | | |
| <i>Capillaria</i> sp. aff. <i>talpae</i> | | | * | |
| Capillariinae gen. sp. | | | * | |
| <i>Eucoleus oesophagicola</i> Soltys | *? | | *? | |
| <i>Julinea</i> sp. | * | | | |
| <i>Liniscus incrassatus</i> (Diesing) | * | | *? | |
| <i>L. capillaris</i> (Linstow) | * | | * | |
| <i>Longistriata vigisi</i> Petrow & Savinov | * | | | |
| <i>Parastrongyloides skrjabini</i> Petrow & Savinov | * | | | |
| <i>Parastrongyloides winchesi</i> Morgan | * | | * | * |
| <i>Physocephalus sexalatus</i> (Molin) larvae | * | | | |
| <i>Porrocaecum depressum</i> (Zeder) larvae | * | | | |
| <i>Porrocaecum</i> sp. larvae | * | | * | |
| <i>Soboliphyme hirudiniformis</i> Kirschenblat | * | | * | |
| <i>S. occidentalis</i> Ribas & Casanova | | | * | |
| <i>Soboliphyme</i> sp. | *? | | *? | |
| <i>Spirocerca lupi</i> (Rudolphi) larvae | * | | | |
| <i>Spirurata</i> sp. | * | | | |
| <i>Spirura moldavica</i> Andreiko | * | | | |
| <i>S. talpae</i> (Gmelin) | * | | * | * |
| <i>Thomix marii</i> Ruchladjew | * | | | |
| <i>Trichinella spiralis</i> (Owen) | * | | | |
| <i>Trichuris felii</i> Ribas & Casanova | * | | | |
| <i>Tricholinstowia dessetii</i> Valle | * | | | |
| <i>T. linstowi</i> (Travassos) | * | | * | * |
| <i>T. morenishi</i> Cameron & Parnell | * | | | |
| <i>T. mornanti</i> Durette-Desset & Vaucher | * | | * | |
| <i>T. talpae</i> (Morgan) | * | *? | | *? |
| <i>T. vigisi</i> Petrow & Savinov | * | | | |
| <i>Tricholinstowia</i> spp. | *? | * | | *? |

Table 1. Continued

| Helminth species ¹ | T.e. | T.c. | T.o. | T.r. |
|--|------|------|------|------|
| ACANTHOCEPHALA | | | | |
| <i>Moniliformis circumflexum</i> (Molin) | * | | | |
| <i>M. spiralis</i> Subrahmanian | | | * | |
| <i>Moniliformis</i> sp. | | | * | |

¹ From: Alvarez *et al.* (1991); Andreani & Valle (1988); Andreiko (1969); Baer (1932); Bernard (1969); Casanova *et al.* (1996); Casanova & Ribas (2004); Chertokova & Rodanaya (1965); Cordero del Campillo *et al.* (1994); Davies (1932); Dollfus (1961); Esteban *et al.* (1987); Feliu *et al.* (2001); Frankland (1959); Furmaga (1959); Genov & Dimitrova (1966); Joyeux & Baer (1967); Matsaberidze (1967); Merkusheva & Bobkova (1981); Milazzo *et al.* (2002); Mola (1907); Nicoll (1923); Petrochenko (1958); Petrov & Savinov (1959); Petrov & Tchertkova (1959); Poglayen *et al.* (2003); Prokopic (1957); Prokopic (1959); Prokopic (1972); Quentin & Krishnasamy (1975); Prokopic & Grulich (1976); Shimalov & Shimalov (2001); Sprehn (1932); Zarnowski (1955); and Žasitytė & Grikenienė (2001). T.e., *Talpa europaea*; T.c., *Talpa caeca*; T.o., *Talpa occidentalis*; T.r., *Talpa romana*; *reported; ? reference lacks level of host species.

small mammals and birds as paratenic hosts (mesocercariae) and adult parasites of carnivores (Smyth, 1995). Only three species of adult trematodes are exclusive parasites of *Talpa* spp.: *Ityogonimus lorum*, *Ityogonimus ocreatus* and *Combesia macrobursata*. The rest are found in a number of small mammals, mostly insectivores (*Neoglyphe locellus*, *Nephrotrema truncatum*, *Omphalometra flexuosa*) and carnivores, rodents, insectivores and lagomorphs (*Euparyphium melis*). The genus *Ityogonimus* Lühe, is a parasite of Holarctic talpids, and now includes three species; *I. lorum* and *I. ocreatus* parasites of *Talpa* spp. in the Palaearctic, and the Nearctic *I. scalopi* from *Scapanus orarius* in America (Turner & McKeever, 1980). *Combesia macrobursata* was first described in the genus *Plagiorchis* Lühe and later transferred to a new genus *Combesia* Mas-Coma, Roset & Montoliu as type species, in the subfamily Matoviinae Mas-Coma, Roset & Montoliu with *Mathovivus galemydis* Mas-Coma, Roset & Montoliu, a parasite of *Galemys pyrenaicus* (Insectivora, Talpidae) (Mas-Coma *et al.*, 1985). The phylogenetic relationship between *Talpa* and *Galemys* was recently demonstrated by molecular methods (Mouchaty *et al.*, 2000). Moreover, previous studies (Sobolev *et al.*, 1939; Vaucher, 1975) have confirmed the presence of several helminth species in these two hosts. At present, the genera *Omphalometra* comprises two species, *O. flexuosa* (syn. *O. petrovi* Savinov) and *O. desmanae* Sobolev, Maskov & Maskov (syn. *Skrjabinomerus desmanae*), both of which are parasites of talpid insectivores and have strong specificity in the Palaearctic Region (Odening, 1959; Prokopic, 1959). *Omphalometra flexuosa* is a parasite of *Talpa* spp. and *G. pyrenaicus*; and *O. desmanae* of *Desmana moschata* (Talpidae) (Sobolev *et al.*, 1939). The systematic status of *O. flexuosa* var. *peyrei* Timon-David, a parasite of *G. pyrenaicus* remains unclear (Vaucher, 1975).

Only four of the 12 cestode species cited in *Talpa* spp. (table 1) exhibit stenoxenous specificity: *Hymenolepis barrosii*, *Multitesticulata blanchardi*, *Multitesticulata filamentosa* and *Staphylocystis bacillaris*. In contrast, *M. blanchardi*

is known only from the original description as *Taenia blanchardi*, later transferred to the genus *Viscoia* Mola. *Multitesticulata filamentosa*, on the contrary, is widespread in *Talpa* spp. in Europe (Prokopic & Grulich, 1976; Casanova *et al.*, 1996). At present, the synonymy of these two species is accepted (Smith, 1986). *Hymenolepis barrosii* is also known only from this original description from *T. europea* and is now considered as *Hymenolepis sensu lato* because of insufficient description and the unavailability of type material (Smith, 1986; Khalil *et al.*, 1994). *Staphylocystis bacillaris* is an interesting parasite from a biogeographical point of view. This species is found in the European mole and in *T. romana* (Milazzo *et al.*, 2002). In the Iberian Peninsula, *S. bacillaris* has not been reported (Cordero del Campillo *et al.*, 1994; Casanova *et al.*, 1996; Ribas & Casanova, 2005) while in the Italian Peninsula it is restricted to moles living in the Aspromonte Massif in the region of Calabria (south Italy) (Milazzo *et al.*, 2002). In the late Pleistocene, southern Calabria (Aspromonte) was considered a 'fossil island' separated from peninsular Italy by the paleogeographic barrier located in the Catanzaro isthmus (Caloi *et al.*, 1991). Phylogeographical factors may account for the geographical distribution of *S. bacillaris* in the peninsulas of southern Europe (Michaux *et al.*, 2004). The remaining cestode species in *Talpa* spp. are larval stages (table 1). Of these, three are adult parasites of birds (*Amoebotaenia lumbrici*, *Dilepis undula*, *Polycercus paradoxa*) and five of carnivores (*Spirometra erinacei*, *Taenia crassiceps*, *Taenia hydatigena*, *Taenia mustelae*, *Taenia taeniaeformis*) (Smith, 1986). The larval stages (*A. lumbrici*, *D. undula* and *P. paradoxa*) are found in several species of small mammals. Larvae of *S. erinacei europaei* have been reported in mammals, reptiles, amphibians and birds, and *Taenia cysticercus* is harboured by murid rodents (Smith, 1986).

Nematodes in *Talpa* spp. are the most numerous group (table 1). These species are mostly found in the gastrointestinal tract (25 species), muscle, mesenteric tissues or in body cavities (ten species), and in the urinary bladder (two species). Specific nematodes of *Talpa* spp. are found in the intestine (*Capillaria coeca*, *Capillaria talpae*,

Tricholinstowia spp. and *Trichuris felii*) and stomach (*Soboliphyme hirudiniformis*, *Soboliphyme occidentalis* and *Spirura talpae*). The systematic confusion in *Capillaria* spp. in moles remains unresolved and more studies are required to discriminate between *C. talpae* and other morphologically similar species (Casanova *et al.*, 1996). *Tricholinstowia* spp. Travassos are parasites of Holarctic talpids. *Tricholinstowia talpae* was originally described in the genus *Morganiella* Travassos, and later transferred to *Morganostrongylus* Fahmy as type species. The synonymy of *T. linstowi*, the type species of this genus, and *Morganiella talpae*, was proposed by Durette-Desset & Vaucher (1974). Six species of *Tricholinstowia* have been established: *T. dessetii*, *T. linstowi*, *T. morenishi*, *T. mornanti*, *T. talpae* and *T. vigisi*. The species of the genus *Soboliphyme* are parasites of insectivores (eight species) and carnivores (one species) and show apparent host specificity (Ribas & Casanova, 2004a). Characteristics of the host–parasite relationships in *Soboliphyme* spp. and the biogeographical distribution have been described by Ganzoring *et al.* (2003). Three species of this genus have been reported in European *Talpa* spp.: *S. caucasica* Matsaberidze from *T. caucasica*, *S. hirudiniformis* from *T. caeca* and *T. europea*, and *S. occidentalis* from *T. occidentalis* (Ribas & Casanova, 2004a). The presence of one species of the genus *Trichuris* (Roeder) in *Talpa* is unusual. In insectivores, while members of the subfamily Capillariinae are commonly reported, members of Trichurinae are considered rare, with only five species known in these hosts: *T. busuluk* Polozhentsev in *Sorex araneus* (Soricidae) in the former USSR (Middle Volga); *T. mettami* (Baylis) in *Aterix* or *Aethechinus* (Erinaceidae) in Uganda; *T. neomi* Lyubarskaya in *Neomys fodiens* (Soricidae) in Tatar (former USSR); *Trichuris* sp., parasite of *Mogera* sp. (Talpidae) in Japan; and *T. felii* in *T. europaea* in Spain (Ribas & Casanova, 2004b). *Longistriata* spp. are parasites of Soricomorpha hosts. In western Palaearctic talpids, two species of *Longistriata* with apparent host specificity are known, *L. vigisi* in *T. europaea* and *L. mogerae* in *Mogera robusta* (Petrow & Savinov, 1959; Petrow & Tchertkova, 1959; Shimalov & Shimalov, 2001). Several adult *Talpa* nematodes are also found in insectivorous hosts: *Calodium soricicola*, *Eucoleus oesophagicola*, *Liniscus capillaris*, *Liniscus incrassatus*, *Parastrongyloides winchesi* and *S. soricis* (Ribas & Casanova, 2005). The life cycles of *Ascarops strongylina* and *Physocephalus sexalatus* are indirect, with larval stages occurring in dung beetles and other beetles as first intermediate hosts and wild and domesticated Suidae acting as definitive hosts. Infective larvae of these parasites are encapsulated in the tissues of several species as paratenic hosts, such as small mammals, amphibians, reptiles and birds (Anderson, 2002). Shrews and moles are paratenic hosts in the life cycle of *Porrocaecum* spp., while adult parasites of raptors and earthworms serve as intermediate hosts (Anderson, 2002). *Spirocerca lupi* is a parasite of carnivores (Canoidea) (Segovia *et al.*, 2001) with larval stages in several species of invertebrates and mammals (Anderson, 2002). There is some confusion about the findings of *Trichinella spiralis* in moles. Several authors may have mistaken *T. spiralis* with larval stages of *Spirurata* encapsulated in muscles (Berezantsev, 1994) since at least two species of *Spirurata* larvae have been reported in *T. europaea* (Žasitytė & Griekienė, 2001).

Several species of the genus *Moniliformis* Travassos have been cited in rodents and carnivores in the Palaearctic Region (Petrochenko, 1958).

According to most recent taxonomic schemes, the order Lipotyphla includes three suborders, two of which have Palaearctic species: Erinaceomorpha with the family Erinaceidae (hedgehogs) and Soricomorpha with species in the families Soricidae (shrews) and Talpidae (moles, shrew-moles and desmans) (Mouchaty *et al.*, 2000). Most of the helminth species in *Talpa* spp. are typical of these hosts in Europe (Prokopic & Grulich, 1976; Casanova *et al.*, 1996; Shimalov & Shimalov, 2001; Žasitytė & Griekienė, 2001; Milazzo *et al.*, 2002; Ribas & Casanova, 2005). Several species have been reported in other Lipotyphla hosts, thereby supporting the hypothesis of a close phylogenetic relationship between moles and shrews (Prokopic, 1957). None of the adult helminth species reported in hedgehogs (Esteban *et al.*, 1987; Cordero del Campillo *et al.*, 1994; Feliu *et al.*, 2001; Poglayen *et al.*, 2003; Casanova & Ribas, 2004) have been detected in communities of European talpids (Prokopic & Grulich, 1976; Cordero del Campillo *et al.*, 1994; Casanova *et al.*, 1996; Shimalov & Shimalov, 2001; Žasitytė & Griekienė, 2001; Milazzo *et al.*, 2002; Ribas & Casanova, 2005).

Nevertheless, several genera with distinct species of helminths are present in the parasitic fauna of hedgehogs and talpids, and these include spirurid nematodes of the genus *Spirura*, *S. talpae*, *S. moldavica* Andreiko (parasites of moles in Europe) and *S. nipponensis* Ohbayashi, Masegi and Kubota (parasite of moles in Japan) (Esteban *et al.*, 1987). These species have undergone a low evolution and are more primitive than *S. rytipleurites* Chabaud, a parasite of erinaceids and carnivores. On the basis of helminthological findings reported in the literature, we support the notion of a close phylogenetic relationship between Talpidae and Soricidae, and to a lesser extent with Erinaceidae. This conclusion is consistent with molecular data that show the placement of the families Talpidae and Soricidae within Soricomorpha, and the ordinal-level classification of Soricomorpha and Erinaceomorpha (Mouchaty *et al.*, 2000).

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