

Review articles

Nematodes of rodents of Armenia

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ABSTRACT. This review summarizes known data on the species composition of nematodes in 24 species of rodents inhabiting the territory of Armenia (South of Lesser Caucasus). The studied rodents include members of some cosmopolitan species (*Mus musculus*, *Rattus norvegicus*, *Rattus rattus*), as well as endemic and narrow-areal species (*Meriones vinogradovi*, *Spermophilus xanthoprimum*, *Microtus schidlovskii*, *Mesocricetus brandti*, *Sciurus anomalus*). The taxonomical identity of the nematode species reported by previous authors is discussed with regard to present knowledge about helminth fauna of rodents. Our review concludes that 34 nematode species are present in rodents in Armenia, five of which are identified for the first time in rodents from the territory of Armenia, and three of which (*Trichinella spiralis*, *Trichostrongylus colubriformis*, *Trichostrongylus skrjabini*) are able to parasitize humans.

Key words: Armenia, Lesser Caucasus, rodents, parasitic nematodes

Introduction

The Republic of Armenia is located in the South of the Lesser Caucasus. It is a relatively small country, with a variety of reliefs and climatic conditions. The rodent fauna in Armenia is characterized by a significant diversity of species, some of which are endemic. Following the publication of the first study of the helminths parasitizing the rodents in Armenia in 1924 [1,2], a significant number of studies have been conducted in this field. However, most of their findings have not been published in the international scientific literature.

The aim of the present review is to synthesize data on the nematode fauna of rodents in Armenia in the light of current knowledge regarding their distribution and taxonomic changes.

Species composition of nematodes parasitizing rodents from Armenia

Data on the species composition of nematodes found in rodents from Armenia presented in Table 1. The species of rodents and nematodes are listed as their Linnaean names in alphabetical order. The taxonomic affiliation of the detected nematodes is discussed below. The taxonomy of rodents is given according to Wilson and Reeder [3].

The study examined a total of 24 species of rodents belonging to seven families: Cricetidae, Gliridae, Hystricidae, Muridae, Myocastoridae, Sciuridae and Spalacidae. Most of the studied species are from the families Cricetidae and Muridae. Three species of studied rodents are synanthropic: the house mouse, brown rat and roof rat. The highest number of nematodes species was observed in the herb field mouse, house mouse, grey dwarf hamster, common vole and brown rat. The

recorded nematodes belong to two classes: the Chromadorea and Enoplea, according to De Ley and Blaxter [18]. Within the Chromadorea, nematodes were reported from the following families of the order Rhabditida: Heligmosomidae (five species), Heligmonellidae (one species), Oxyuridae (eight species), Physalopteridae (one species), Rictulariidae (one species), Trichostrongylidae (two species), Spiruridae (one species), Spirocercidae (two species), Gongylonematidae (two species), Heterakidae (one species) and Ascarididae (one species).

The present study redefines some of the nematode species according to current knowledge of their host-specificity and synonymy, and on the basis of descriptions and drawings from original works. Thus, nematodes from meadow voles (*Microtus* spp.) named as *H. polygyrus* in original works [4,5] are considered herein as *H. laevis*, as *H. laevis* is known to be a specific parasite of meadow voles, and *H. polygyrus* a specific parasite of wood mice (*Apodemus* spp.) of the subgenus *Sylvaemus* [19,20]. For the same reasons, we also propose that the heligmosomoid nematodes identified in *Apodemus uralensis* reported in original works as *H. laevis* be regarded as *H. polygyrus*. In addition, we propose that the nematodes from voles, including those of the water vole (*Arvicola amphibius*), described in original papers as *H. halli* should be classified as *H. costellatum* on the basis of the synonymy of these species [21–23]. This is a common parasite of meadow voles [23] which is also found in water voles in Siberia [24]. Furthermore, the present study considers nematodes recorded as *H. costellatum* from *A. uralensis* to be members of *H. polygyrus*, as this is only known species of heligmosomid nematodes of the subgenus *Sylvaemus* found in wood mice (*Apodemus* spp.).

The finding of *Heligmosomum pseudocostellatum* in *A. sylvaticus* in Central Europe [23] demands further investigations about the status of this species, its host specificity and its findings in wood mice. Furthermore, we regard specimens of *H. turgidus* observed in the common vole to in fact be *H. laevis*, because the former species parasitizes voles in the Nearctic [25]. In addition, nematodes from the family Heligmonellidae from the fat dormouse (*G. glis*), named in original works as *Longistriata elpatievskii*, have also been reassigned to *Paraheligmonina gracilis* on the basis of their synonymy [26,27]. This species has been found to be a common parasite of the fat dormouse in Europe

[26,27], and more recently in the North Caucasus [28]

We propose that nematodes classified as *S. obvelata* and *S. stroma* in the house mouse in fact belong to *S. obvelata*, a specific oxyurid nematode of the house mouse. Although some original reports indicate they are located in the caecum and in small intestine, this may occur in response to movement of intestinal contents after the death of the host. *S. obvelata* has also been reported in brown rats in Armenia, and we propose these specimens belong to *S. muris*, a specific *Syphacia* of rats. Also, we propose that nematodes previously recorded as *Syphacia obvelata* from the caecum and colon of the herb field mouse belong to *Syphacia frederici*, a parasite of the caecum and colon of wood mice (*Apodemus* spp.) of the subgenus *Sylvaemus* [21,29,30].

Nematodes currently recorded as *S. obvelata* from water voles apparently belong to *Syphacia arvicolae*, a specific parasite of this rodent [21,22]. It is also probable that *Syphacia* from *M. arvalis*, and perhaps from *M. schidlovskii*, in meadow voles in Europe which are currently reported as *S. obvelata* are in fact members of *Syphacia nigeriana* [21,29]. However *S. nigeriana* has been described from a few species of the Muridae in West Africa [31], and it is quite unlikely that they also parasitize the same species of meadow vole in the Palearctic.

Hence, it is possible that voles of the genus *Microtus* have their own species of *Syphacia*. *Syphacia montana* and *S. nigeriana* have been reported from the snow vole in Europe [29,32], it is also likely that the species obtained from the snow vole in Armenia, previously recorded as *S. obvelata*, belongs to the same *Syphacia* species identified in meadow voles in the Palearctic, or that it may represent a distinct undescribed species. Similarly, the *S. obvelata* identified in Vinogradov's jird may also represent an undescribed species of *Syphacia* specific for this genus, as no descriptions of oxyurid species from jirds, except reports about *S. obvelata* and *S. frederici* [21,33,34]. In addition, an oxyurid found in the Caucasian squirrel, recorded as *Syphacia thompsoni*, has been synonymized to *Syphabulea tjanshani* along with similar species identified in Eurasia, along with other scientific names [35]. Interestingly, *S. tjanshani* has previously been registered in China, Central Asia and Siberia [35], and its presence in Armenia represents the most western point of its known range.

Table 1. Species composition of nematodes parasitizing in rodents of Armenia

Host species	Species of nematodes	Location	References
Herb field mouse <i>Apodemus uralensis</i> Pallas, 1811 (defined as <i>A. sylvaticus</i>)	<i>Aonchotheca murissylvatici</i> (Diesing, 1851)	SI	[4,5]
	<i>Gongylonema neoplasticum</i> (Fibiger et Ditlevsen, 1914)	E, S	[4]
	<i>Heligmosomoides polygyrus</i> (Dujardin, 1845) (also recorded as <i>Heligmosomoides laevis</i> and <i>Heligmosomum costellatum</i>)	SI	[4,5]
	<i>Mastophorus muris</i> (Gmelin, 1790)	S	[4]
	<i>Rictularia cristata</i> (Froelich, 1802) (recorded as <i>Rictularia amurensis</i>)	SI	[4]
	<i>Syphacia frederici</i> Roman, 1945 (recorded as <i>Syphacia obvelata</i>)	C, CL	[4,5]
	<i>Syphacia stroma</i> (Linstow, 1884)	SI	[4,5]
	<i>Trichinella spiralis</i> (Owen, 1835)	M	[6]
Water vole <i>Arvicola amphibius</i> L., 1758	<i>Heligmosomum costellatum</i> (Dujardin, 1845) (recorded as <i>Heligmosomum halli</i>)	S, SI	[4]
	<i>Syphacia arvicolae</i> Sharpilo, 1973 (recorded as <i>S. obvelata</i>)	C, CL	[4,5]
Snow vole <i>Chionomys nivalis</i> (Martins, 1842)	<i>Syphacia</i> sp.1 (recorded as <i>S. obvelata</i>)	C, CL	[4,5]
Gray dwarf hamster <i>Cricetulus migratorius</i> Pallas, 1773	<i>A. murissylvatici</i>	SI	[1,4,7]
	<i>Eucoleus gastricus</i> (Baylis, 1926)	S	[4,7]
	<i>Liniscus papillosus</i> (Polonio, 1860)	UB	[5,7]
	<i>M. muris</i>	S	[7]
	<i>S. mesocriceti</i> Quentin, 1971	C, CL	[5]
	<i>Trichuris</i> sp. (recorded as <i>Trichocephalus muris</i>)	C	[1,5]
Forest dormouse <i>Dryomys nitedula</i> Pallas, 1778	<i>E. gastricus</i>	S	[4,5]
	<i>R. cristata</i> (recorded as <i>R. amurensis</i>)	SI	[5]
Fat dormouse <i>Glis glis</i> L., 1766	<i>Paraheligionina gracilis</i> (Leuckart, 1842) (recorded as <i>Longistriata elpatievskii</i>)	SI	[4]
Indian crested porcupine <i>Hystrix indica</i> Kerr, 1792	<i>T. spiralis</i>	M	[6]
Persian jird <i>Meriones persicus</i> Blanford, 1875	<i>Physaloptera dogieli</i> Schachnasarova, 1949	S	[4,5]
Tristram's jird <i>Meriones tristrami</i> Thomas, 1892	<i>Ph. dogieli</i>	S	[4,5]
Vinogradov's jird <i>Meriones vinogradovi</i> Heptner, 1931	<i>E. gastricus</i>	S	[4,5]
	<i>Syphacia</i> sp.2 (recorded as <i>S. obvelata</i>)	C, CL	[4,5]
	<i>Trichuris rhombomidis</i> (Schulz et Landa, 1934)	C	[5]
Golden hamster <i>Mesocricetus auratus</i> Waterhouse, 1839	<i>Heligmosomoides juvenus</i> (Kirschenblatt, 1949)	SI	[4,8]
	<i>E. gastricus</i>	S	[4,5]
Brandt's hamster <i>Mesocricetus brandti</i> Nehring, 1898	<i>Heligmosomoides travassosi</i> Schulz, 1926	SI	[4]
	<i>S. mesocriceti</i>	C, CL	[5]

Host species	Species of nematodes	Location	References
Common vole <i>Microtus arvalis</i> Pallas, 1778	<i>A. murissylvatici</i>	SI	[4,5]
	<i>E. gastricus</i>	S	[4,5]
	<i>Heligmosomoides laevis</i> (Dujardin, 1845) (recorded also as <i>H. polygyrus</i> and <i>H. turgidus</i>)	SI	[4,5]
	<i>H. costellatum</i> (recorded also as <i>H. halli</i>)	S, SI	[4,5]
	<i>Syphacia</i> sp.3 (recorded as <i>S. obvelata</i>)	C, CL	[4,5]
	<i>T. spiralis</i>	M	[6]
Guenther's vole <i>Microtus guentheri</i> Danford et Alston, 1880	<i>H. laevis</i> (recorded as <i>H. polygyrus</i>)	SI	[4,5]
Major's pine vole <i>Microtus majori</i> Thomas, 1906	<i>G. neoplasticum</i>	E, S	[4]
	<i>H. laevis</i> (recorded as <i>H. polygyrus</i>)	SI	[4,5]
	<i>T. spiralis</i>	M	[6]
Schidlovsky's vole <i>Microtus schidlovskii</i> Argyropulo, 1933	<i>E. gastricus</i>	S	[4,5]
	<i>H. costellatum</i> (recorded as <i>H. halli</i>)	SI	[4]
	<i>Syphacia</i> sp.4 (recorded as <i>S. obvelata</i>)	C, CL	[4,5]
Social vole <i>Microtus socialis</i> Pallas, 1773	<i>E. gastricus</i>	S	[4,5]
	<i>H. laevis</i> (recorded also as <i>H. polygyrus</i>)	SI	[4,5]
	<i>H. costellatum</i> (recorded as <i>H. halli</i>)	SI	[4]
	<i>T. spiralis</i>	M	[6]
House mouse <i>Mus musculus</i> L., 1758	<i>A. murissylvatici</i>	SI	[5,9]
	<i>G. neoplasticum</i>	S	[9]
	<i>M. muris</i>	S	[9]
	<i>Protospirura armeniana</i> Alojjan, 1951	S	[10]
	<i>Syphacia obvelata</i> (Rudolphi, 1802) (recorded also as <i>S. stroma</i>)	SI, C, CL	[2,5,9]
	<i>Trichuris muris</i>	C	[1,5]
	<i>T. spiralis</i>	M	[6]
	<i>Trichostrongylus colubriformis</i> (Giles, 1892)	SI	[11]
Coypu <i>Myocastor coypus</i> Molina, 1782	<i>Trichuris myocastoris</i> Enigk, 1933	C	[12]
	<i>Ascaris spalacis</i> Schulz et Alojjan, 1950 (initially recorded as <i>Ascaris</i> sp.)	SI	[13,14]
Brown rat <i>Rattus norvegicus</i> Berkenhout, 1769	<i>Heterakis spumosa</i> Schneider, 1866	C, CL	[4,15]
	<i>L. papillosus</i>	UB	[4,5]
	<i>M. muris</i>	S	[4]
	<i>Syphacia muris</i> (Yamaguti, 1935) (recorded as <i>S. obvelata</i>)	C, CL	[4,5]
	<i>T. spiralis</i>	M	[6]
Roof rat <i>Rattus rattus</i> L., 1758	<i>L. papillosus</i>	UB	[4,5]
Caucasian squirrel <i>Sciurus anomalus</i> (Gmelin, 1778)	<i>Syphabulea tjanshani</i> (Ablasov, 1962) (recorded as <i>Syphacia thompsoni</i>)	C, CL	[4,5]
Asia minor ground squirrel <i>Spermophilus xanthoprymnus</i> (Bennet, 1835) (defined also as <i>S. citellus</i>)	<i>Aonchotheca armenica</i> (Kirschenblat, 1939)	SI	[4,16]
	<i>Gongylonema longispiculum</i> Schulz, 1927	S	[4]
	<i>Streptopharagus kutassi</i> (Schulz, 1927)	S	[5,17]
	<i>Trichostrongylus skrjabini</i> Kalantarian, 1928	SI	[4,17]

Explanations: E – esophagus, S – stomach, SI – small intestine, C – caecum, CL – colon, M – muscles, UB – urinary bladder

From the Spirocercidae, *Mastophorus muris* and *Streptopharagus kutassi* have been reported, the former being a widespread host-generalist parasite of rodents. From the Spiruridae, *Protospirura armeniana* was described in a house mouse. *Rictularia amurensis* of the family Rictulariidae, identified in the herb field mouse and forest dormouse, was made a junior synonym of *R. cristata* [36]. Formerly *R. cristata* was found in Georgia, the northern neighbor of Armenia [21]. *Physaloptera dogieli* from the family Physalopteridae was recorded from Persian and Tristram's jirds, this parasite has also been reported in jirds from Central Asia [21]. Two species of the family Gongylonematidae were found: *G. neoplacticum* in the herb field mouse and house mouse, and *G. longispiculum* in Asia minor ground squirrel. The former one seems to be host-generalist species while the latter has been reported in ground squirrels and blind mole rats [21]. Two species of Trichostrongylidae were registered: *T. colubriformis* in coypu and *T. skrjabini* in the Asia minor ground squirrel. *Ascaris spalacis* was described in *Nannospalax nehringi* (defined as *Spalax leucodon*) [14]; this species was originally reported by Kirschenblat, 1947 as *Ascaris* sp. following the discovery of a small number of females and immature males [13]. *A. spalacis* is a specific parasite of *N. nehringi*, also found in Georgia [21]. *Heterakis spumosa*, identified in the brown rat, is a widespread parasite of rats and mice [21].

Of the specimens from class Enoplea, only three families were identified, all from the order Trichinellida: Trichinellidae (one species), Capillariidae (four species) and Trichuridae (four species). One species, *Trichinella spiralis*, was reported from seven species of rodents: the herb field mouse, house mouse, brown rat, Indian crested porcupine, common vole, Major's pine vole and social vole.

We propose reclassifying some species from the family Trichuridae (whipworms) based on their known host specificity. Whipworms have been identified in four host species: grey dwarf hamster, house mouse, coypu and Vinogradov's jird. The *Trichuris* obtained from the grey dwarf hamster does not appear to be *T. muris*, as previously reported, because *T. muris* is a parasite of the Muridae [37,38], and the whipworm identified in *C. migratorius* is specific to that species of hamster [39]. Other rodent species also have their own specific species of whipworms: *T. muris* in house

mouse, *T. myocastoris* in coypu and *T. rhomboidis* in Vinogradov's jird.

Four species of Capillariidae were recorded in 11 species of rodents in Armenia; their generic names are presented according to Moravec [40]. *Aonchoteca murissylvatici* was recorded in three species of rodents in Armenia: *Apodemus uralensis*, *C. migratorius* and *M. musculus*. Nematodes of the genus *Aonchoteca* have host specificity [41], and among all described species, only *A. murissylvatici* was recorded in both murids and voles [41,42]. Another species of nematode, *A. armenica*, specific to the minor ground squirrel, a genus specific to Asia, and perhaps other ground squirrels, was described within the territory of Armenia. The stomach parasite *Eucoleus gastricus* was reported in six species and the urinary bladder parasite *Liniscus papillosus* was observed in grey dwarf hamsters and two species of rat.

All discovered species of nematodes, except *T. spiralis*, were found in rodents in adult stage. Five of the species listed in the review (*A. armenica*, *A. spalacis*, *H. juvenus*, *T. skrjabini*, *P. armeniana*) were first identified in Armenia [8,10,13,16,43]. Following this, two of the species were found to have a narrow areal: *A. spalacis* has only been registered in Armenia and Georgia, and *H. juvenus* has not been recorded outside Armenia [21]. We therefore recommend that *H. juvenus* be reclassified in the light of more modern data concerning the taxonomy of the Heligmosomidae. Otherwise, *A. armenica* has been found in Kyrgyzstan and Uzbekistan, and *P. armeniana* in Volgograd (Russia) and Uzbekistan [21]. Finally, while *T. skrjabini* is typical of ruminants, it has also been recorded in rodents and humans in several countries [44,45]. In total, three species of nematodes able to infect humans were detected in rodents in Armenia: *T. spiralis*, *T. colubriformis* and *T. skrjabini*.

Of the helminths parasitizing rodents in Armenia, most numerous group appears to be the nematodes, while the flatworms are represented by 13 species of trematodes and 23 species of cestodes [46,47]. A significant proportion of rodents presented in this review is endemic or has a narrow areal (*M. vinogradovi*, *S. xanthoprymnus*, *M. schidlovskii*, *M. brandti*, *S. anomalus*). In this regard, the data on nematode fauna of these rodents could be play an important role in conservation efforts.

Finally, the taxonomic diversity of helminths parasitizing the rodents in the Caucasus remains poorly studied, which can be attributed by the wide

species diversity of the rodents and the climatic variety of this region. Further studies are therefore required to determine the true species diversity of nematodes and other parasites of rodents in this area.

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