

## Parasitic Nematodes and Acanthocephalan Obtained from Wild Murids and Dipodids Captured in Xinjiang-Uygur, China

Mitsuhiko Asakawa<sup>1\*</sup>, Katsuro Hagiwara<sup>2</sup>, Lifu Liao<sup>3</sup>, Wei Jiang<sup>3</sup>, Shunsheng Yan<sup>3</sup>,  
Junjie Chai<sup>3</sup>, Yuzaburo Oku<sup>4</sup> and Mamoru Ito<sup>5</sup>

<sup>1</sup> Department of Parasitology (Wildlife Zoology), School of Veterinary Medicine,  
Rakuno Gakuen University, Ebetsu, Hokkaido 069-8501, Japan

<sup>2</sup> Department of Veterinary Microbiology, School of Veterinary Medicine,  
Rakuno Gakuen University, Ebetsu, Hokkaido 069-8501, Japan

<sup>3</sup> Xinjiang Institute for Endemic Diseases Control and Research, Urumqi,  
Xinjiang 83002, People's Republic of China

<sup>4</sup> Graduate School of Veterinary Medicine, Hokkaido University,  
Sapporo, Hokkaido 060-0818, Japan

<sup>5</sup> Central Institute for Experimental Animals, Kawasaki 216-0001, Japan

**Abstract.** For the development of new animal models for human disease in the western part of China, helminthological surveys of murids and dipodids in and around both Mt Tian-Shan and Mt Altai, the Xinjiang-Uigur Autonomous region were carried out from 1998 to 1999. A total of 124 individuals belonging to 24 species were examined, and an acanthocephala and/or nematodes were obtained from the following 15 host species, i.e., *Dipus sagitta* [Ds] [Abbreviation of host name], *Euchoreutes naso* [En], *Allactaga sibirica* [Asi], *Meriones meridianus* [Mme], *M. tamariscinus* [Mt], *Rhombomys opimus* [Ro], *Cricetulus migratorius* [Cm], *C. eversmanni* [Cev], *Microtus oeconomus* [Mo], *Lagurus lagurus* [Lla], *L. luteus* [Llu], *Alticola argentatus* [Aa], *Clethrionomys rutilus* [Cr], *Microtus arvalis* [Ma], and *Apodemus uralensis* [Au]. To date, 1 acanthocephalan species, *Moniliformis* sp. [Cev] [abbreviation of infected animals], and at least 19 nematode species, i.e., *Eucoleus* sp. (*gastrica*?) [Au], *Eucoleus* sp. [Asi], *Aonchotheca murissylvatici* [Cr], *Calodium hepaticum* [Au], *Trichuris muris* [Llu], *Trichuris* sp. (*rhombomidis*?) [Mt], *Dentostonella translucida* [Mme], *Aspiculuris tetraptera* [Ds], *Syphacia petrusewicz* [Cr], *Syphacia* sp. (or spp.) [Mt, Cm, Cev, Lla and Ma], *Rhabditis* (*Pelodera*) *orbitalis* (3rd larvae) [Lla, Cr, Ma and Mo], *Heligmosomoides yorkei* [Cm], *H. polygyrus* [Au], *Heligmosomum* (*Paraheligmosomum*) *mixtum* [Cr and Ma], *Heligmosomum* (*Heligmosomum*) sp. [Aa and Mo], *Subulura citelli* [En], *Pterygodermatites* sp. [Cr], *Litomosa vite* [Ro], and spirurid unknown species [Cr] were obtained. Although most species have been reported from the former USSR or outer Mongolia, several species are first records in Xinjiang. Photographs of these nematodes are presented and helminthological studies of the parasitic nematodes obtained from the wild small mammals in Xinjiang are briefly reviewed.

**Key words:** China, helminths, Rodentia, Xinjiang-Uygur, parasitic nematodes.

---

\*Corresponding author:

Mitsuhiko Asakawa (e-mail: askam@rakuno.ac.jp)

## Introduction

For the development of new animal models for human disease in the western part of China supported by International Scientific Research Program No. 10041210 of the Ministry of Education, Science and Culture, Japan, epidemiological surveys of zoonosis on small mammals in Xinjiang were carried out from 1998 to 1999, and the study areas of the survey were located in and around both Mt Tian-Shan and Mt Altai in the Xinjiang-Uygur autonomous region (Asakawa *et al.*, 2001). After the collection, the preliminarily reports of the helminths obtained from the surveys were presented at the meetings of the Japanese Society of Wildlife and Zoo Medicine and the Japanese Society of Parasitology (Asakawa *et al.*, 1999, 2000), although some host names were misidentified and no figures for the helminths. Therefore, helminth data except for cestodes and trematodes obtained from the families Muridae and Dipodidae in the area together with the host names identified by Asakawa *et al.* (2001) are presented, and helminthological studies in this fields performed in Xinjiang are briefly reviewed in this paper.

## Materials and Methods

The host names in the both mountainous areas (*cf.* Asakawa *et al.*, 2001) and the number of individuals examined helminthologically in this study are shown below.

Mt Tian-Shan (Total No.=59): *Alactagulus pumilio* (1) (No. of individuals examined), *Dipus sagitta* (6) [Ds] [Abbreviation of host name shown in the results], *Meriones meridianus* (1) [Mme], *M. tamariscinus* (1), *Rhombomys opimus* (6) [Ro], *Cricetulus migratorius* (8) [Cm], *Microtus oeconomus* (1) [Mo], *M. socialis* (4), *Lagurus lagurus* (2) [Lla], *Ellobius talpinus* (3), *Alticola argentatus* (5) [Aa], *Apodemus uralensis* (12) [Au], *Mus musculus* (3), and *Rattus norvegicus* (2).

Mt Altai (Total No.=65): *Euchoreutes naso* (2) [En], *D. sagitta* (6), *Allactaga sibirica* (4) [Asi], *M. meridianus* (5), *M. tamariscinus* (3) [Mt], *C.*

*migratorius* (1), *C. longicaudatus* (1), *C. eversmanni* (10) [Cev], *Cricetus cricetus* (1), *Clethrionomys rutilus* (16) [Cr], *C. rufocanus* (1), *Microtus arvalis* (8) [Ma], *Lagurus luteus* (1) [Llu], and *A. uralensis* (16).

The whole bodies of the rodents were kept in 70% ethanol with a specimen label. Examination of the materials for internal parasites was performed using the body cavities and intestines in these examinations. The eyes were also investigated for the 3rd larva of the rhabditid nematodes. After macroscopic examination, the helminths were collected under a dissecting microscope. Nematodes and acanthocephalan were fixed and preserved in 70% ethanol, and examined microscopically with lacto-phenol solution. Measurement and drawings of the nematodes were achieved with the aid of a camera lucida, OLYMPUS Model BH2-DA. These helminthous specimens were identified using the taxonomical references, *i.e.*, Anderson *et al.* (1974-1983), Ryzhikov *et al.* (1979) and Skrjabin (1990), and they are deposited in the Department of Parasitology (Wildlife Zoology), School of Veterinary Medicine, Rakuno Gakuen University, Hokkaido, Japan.

## Result

To date, 1 acanthocephalan species, *Moniliformis* sp. (*clarki*?) (Moniliformidae) [Site, small intestine: Host abbreviation mentioned above, Cev: Occurrence of the mammals parasitized, 1] (Fig 1-1), and at least 19 nematode species, *i.e.*, *Eucoleus* sp. (*gastrica*?) (Capillaridae) [small intestine: Au: 1] (Fig 1-5), *Eucoleus* sp. [small intestine: Asi: 1] (Figs 1-6 and 1-7), *Aonchotheca murissylvatici* (Capillaridae) [small intestine: Cr: 2] (Fig 1-4), *Calodium hepaticum* (Capillaridae) [liver: Au: 1], *Trichuris muris* (Trichuridae) [large intestine: Llu: 1] (Figs 1-2 and 1-3), *Trichuris* sp. (*rhomboidis*?) [large intestine: Mt: 1], *Dentostonella translucida* (Heteroxyematidae) [large intestine: Mme: 2] (Fig 2-2), *Aspiculuris tetraptera* (Heteroxyematidae) [large intestine: Ds: 1] (Fig 2-3), *Syphacia petrusewiczii* (Oxyuridae) [large intestine: Cr: 6] (Fig 2-4), *Syphacia* sp. (or

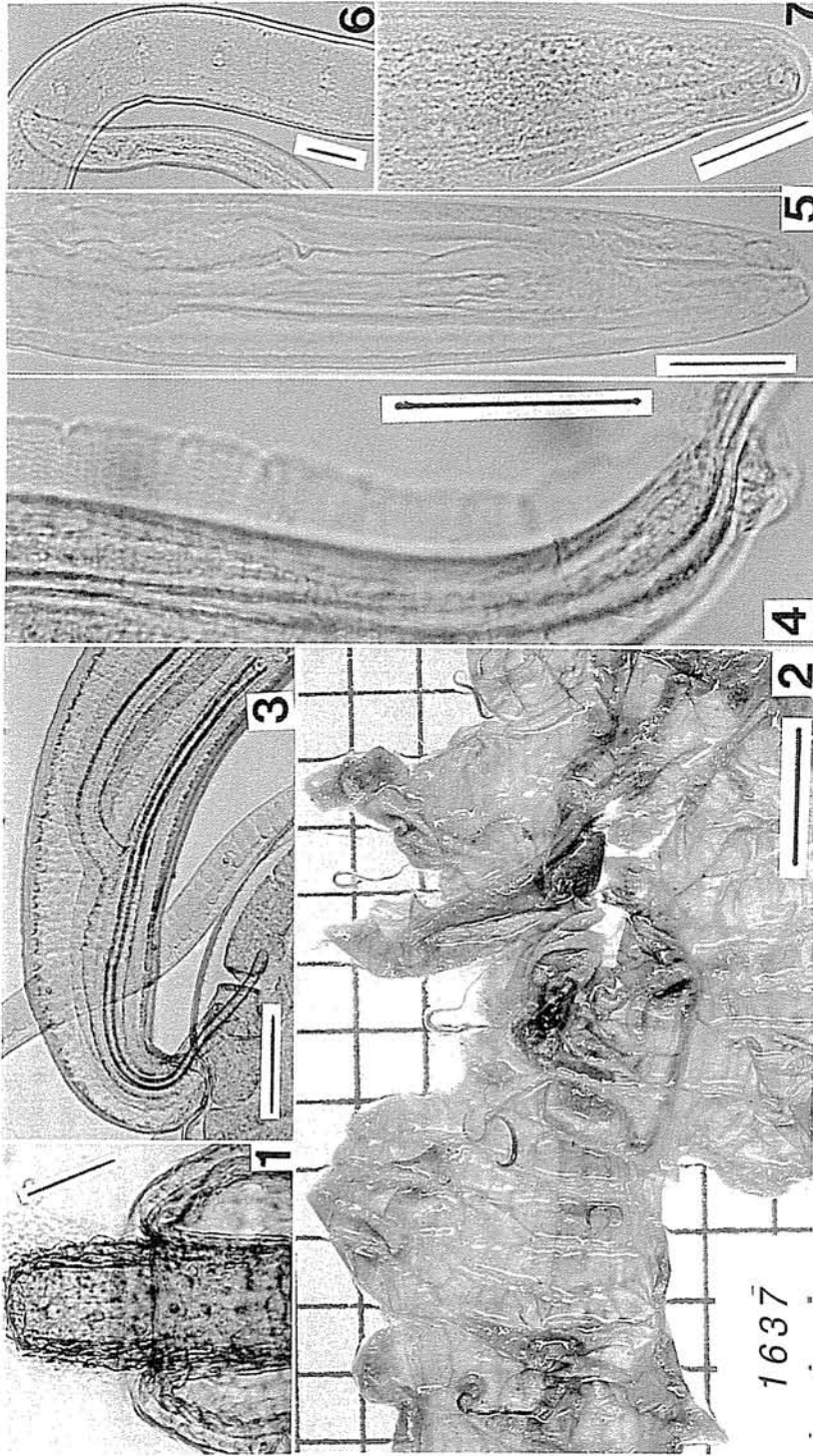


Fig. 1. Acanthocephalan helminth and aphasmid nematodes from wild murids and dipodids in Xinjiang. -1. *Moniliformis* sp. from *Cricetus* sp. *eversmanni*, lateral view of proboscis, anterior extremity of male (Bar=0.1 mm). -2 & 3. *Trichuris muris* from *Lagurus luteus*, site of host, anterior end of the body longer than posterior end (2: Bar=10 mm), and posterior extremity of male with spicular sheath and spicule (3: Bar=0.2 mm). -4. *Aonchotheca murissylvatici* from *Clethrionomys rutilus*, posterior extremity of male with well-developed caudal pseudobursa and without spine on the spicular sheath (Bar=0.2 mm). -5. *Eucoleus* sp. (*gastrica*?) from *Apodemus uralsensis*, posterior extremity of male without pseudobursa, and with rudimental spicule and spicular sheath with spines (Bar=0.05 mm). -6 & 7. *Eucoleus* sp. from *Allactaga sibirica*, anterior extremity with fine caphalic cavity (left) and esophageal cells (right) (6), and posterior extremity without pseudobursa, and with rudimental spicule and spicular sheath with spines (7) of male (Bar=0.05 mm).

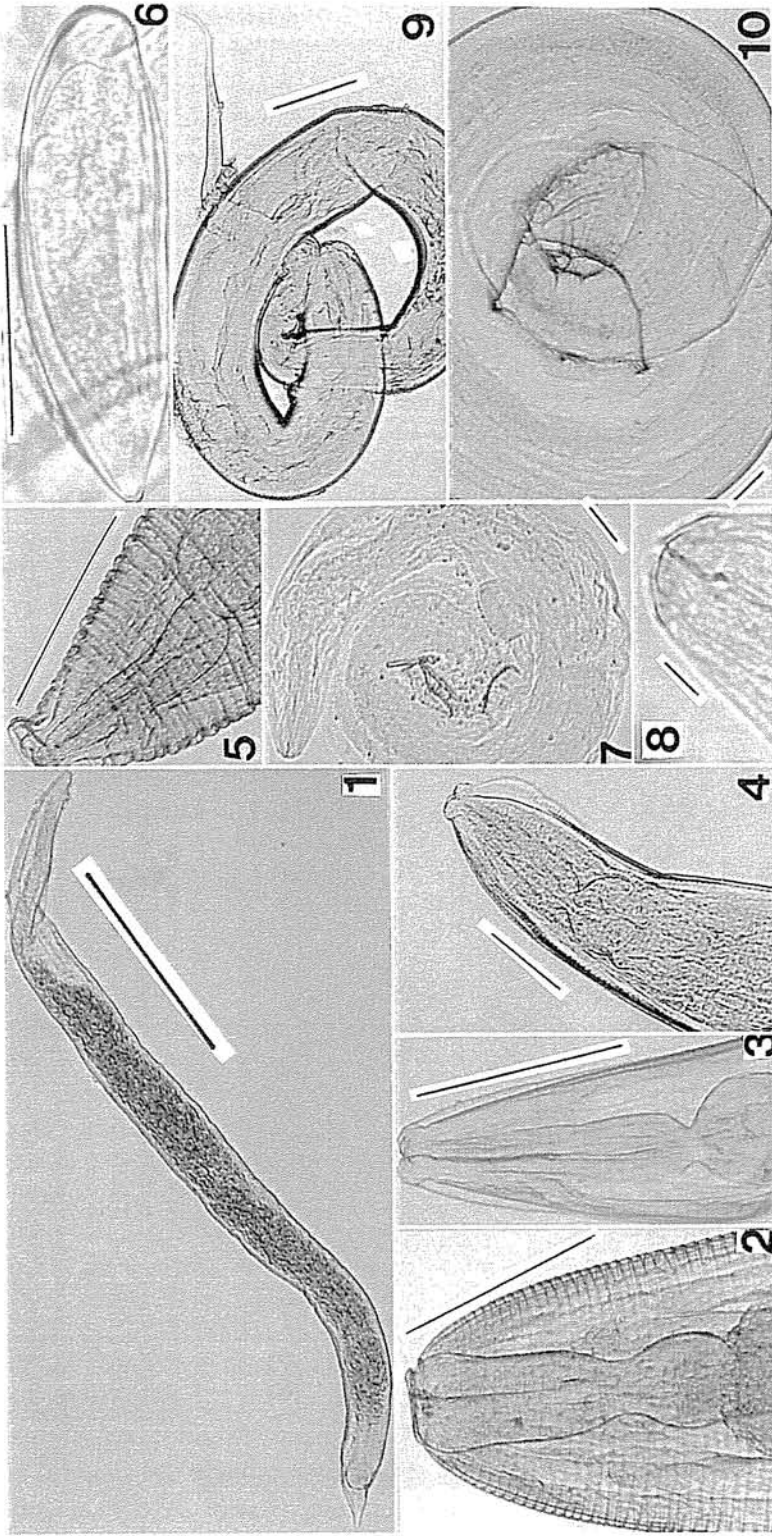


Fig 2. Rhabditid and oxyurid nematodes from wild murids and dipodids in Xinjiang. -1. *Rhabditis (Pelodera) orbitalis* from *Cricetulus migratorius*, whole body of the 3rd larval stage without genital organs (Bar=0.25 mm). -2. *Dentostonella translucida* from *Meriones meridianus*, anterior extremity of female with thick esophagus and posterior part of the esophagus (forming abulb) compressed by nerve ring (Bar=0.25 mm). -3. *Aspiculuris tetraptera* from *Dipus sagitta*, anterior extremity of female with esophagus encircled by nerve ring slightly anterior to middle part (Bar=0.25 mm). -4. *Syphacia petruszewiczi* from *Clethrionomys rutilus*, anterior extremity of female with prominent 3 lips and developed lateral alae (Bar=0.1 mm). -5, 6, 7, 8, 9 & 10. *Syphacia* spp. from *Lagurus lagurus* (5 & 6: esophagus with well-developed lips and bulb, and egg; Bars=0.25 mm in 5, 0.05 mm in 6), from *Cricetulus migratorius* (7 & 8: esophagus with rudimentary lips, and well-developed spicule and gubernaculum; Bars=0.05 mm in 7, 0.01 mm in 8), and from *C. eversmanni* (9 & 10: rudimentary lips and long tail of female, and non-developed genital organs of immature female; Bars=0.2 mm in 9 and 0.05 mm in 10).



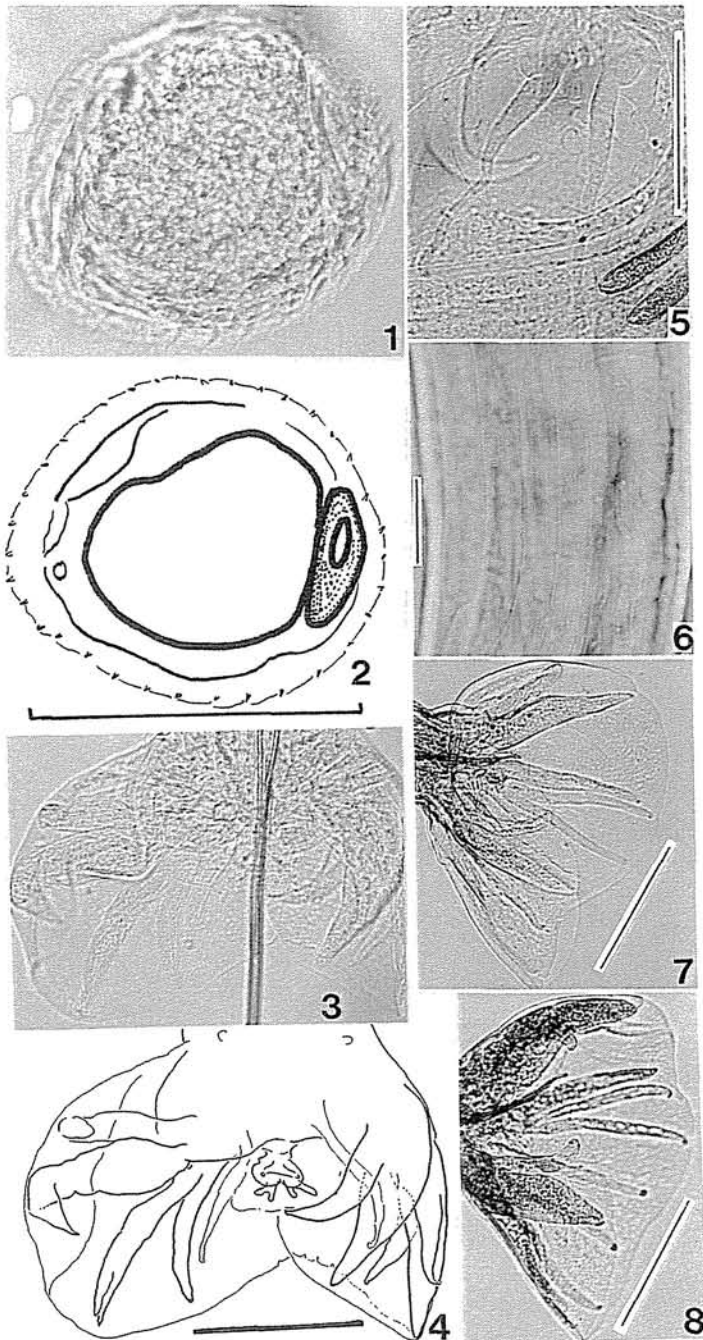


Fig 3. Heligmosomid nematodes from wild murids and dipodids in injiang. -1, 2, 3, & 4. *Heligmosomoides yorkei* from *Cricetulus migratorius*, cross-section of mid-body of female with rudimentary 35 ridges of the synlophe (1 & 2), and posterior extremity of male with symmetrical bursa (3 & 4) (Bar=0.1 mm). -5. *Heligmosomoides polygyrus* from *Apodemus uralensis*, externo-dorsal rays with swelling parts of the bases of male (Bar=0.1 mm). -6, 7 & 8. *Heligmosomum* (*Paraheligmosomum*) *mixtum*, anterior extremity with longitudinal ventral ridges (left) and oblique dorsal ridges (right) (6; Bar=0.05 mm), and posterior extremity of male with slightly asymmetrical bursa from *Microtus arvalis* (7; Bar=0.2 mm; longer and thinner ventral rays), and ditto from *Clethrionomys rutilus* (8; Bar=0.2 mm; shorter and thicker ventral rays).

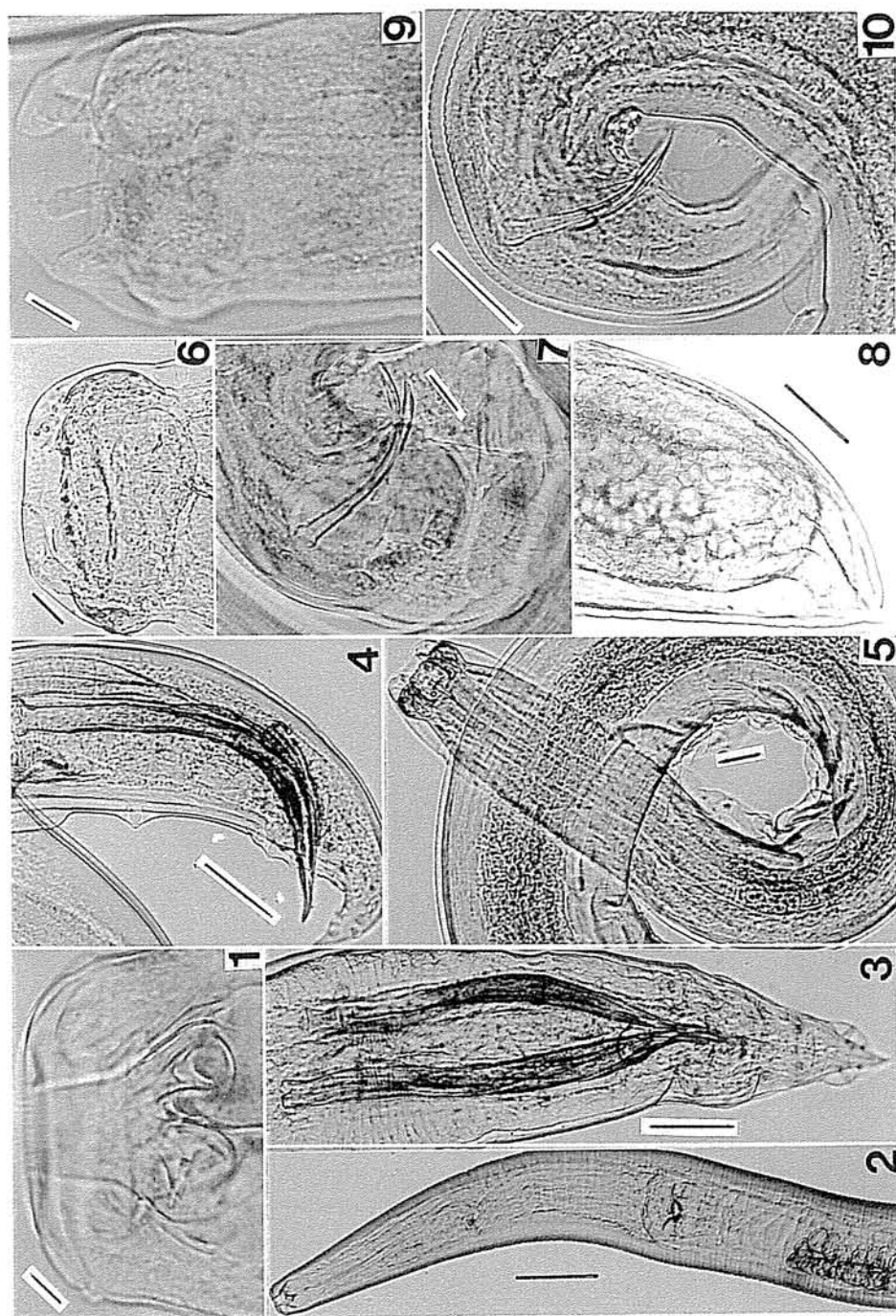


Fig 4. Subulurites and spirurid nematodes from wild murids and dipodids in Xinjiang. -1, 2, 3, & 4. *Subulurites nasoi* from *Euchoreutes naso*, anterior extremity with three large and highly chitinous teeth with sharp points located at base of buccal capsule, and with esophagus with well-developed bulb of female (Bars=0.01 mm in 1 and 0.2 mm in 2), and posterior extremity with preanal pseudosucker fusiform and rudimental caudal alae of male (Bars=0.1 mm in 3 and 4). -5, 6, 7 & 8. *Pterygodermatites* sp. from *Clethrionomys rutilus*, anterior extremity with oral aperture not shifted dorsally and encircled by ring of denticles of male (5) and female (6) (Bar=0.05 mm), posterior extremity of male with spicules (7; Bar=0.01 mm) and female with short tail (8; Bar=0.1 mm). -9 & 10. An anonymous spirurid species from *Clethrionomys rutilus*, anterior extremity with well-developed buccal cavity (9; Bar=0.01 mm) and posterior extremity with spicules and gubernaculum (10; Bar=0.05 mm) of male.

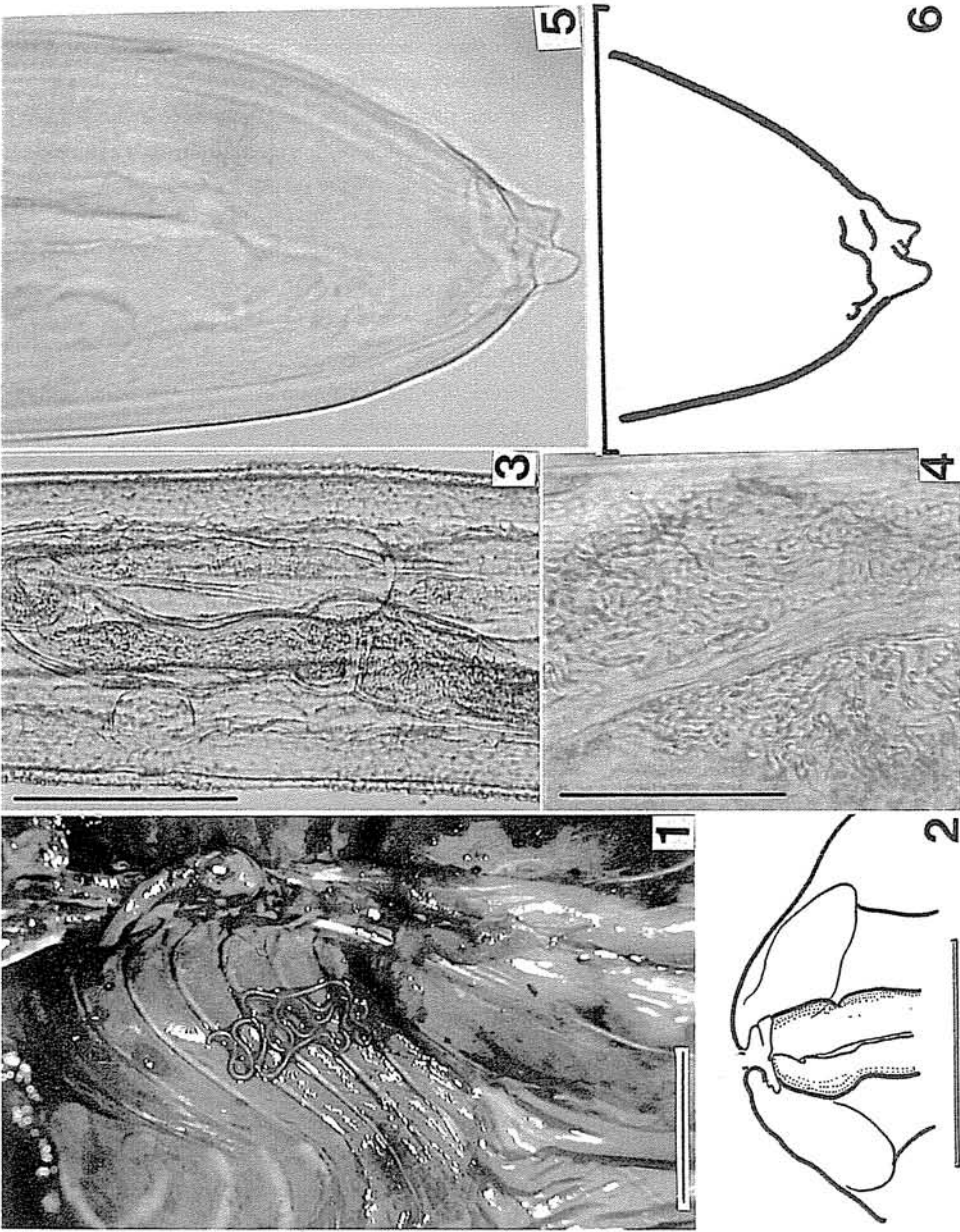


Fig 5. *Litomosa vite* of female from *Rhombomys opimus* in Xinjiang. -1. Site of host (Bar=10 mm). -2. Anterior extremity with rudimental buccal cavity (Bar=0.1 mm). -3. Vulva and uterus (Bar=0.25 mm). -4. Microfilariae in uterus (Bar=0.1 mm). -5 & 6. Posterior extremity with 3 papillae at the tail end (Bar=0.1 mm).

spp.) [large intestine: Mt, Cm, Cev, Lla and Ma: 1, 1, 1, 2 and 1, respectively] (Figs 2-5, 2-6, 2-7, 2-8, 2-9 and 2-10), *Rhabditis (Pelodera) orbitalis* (3rd larvae) (Rhabditidae) [eye: Lla, Cr, Ma and Mo: 2, 6, 1 and 1, respectively] (Fig 2I-1), *Heligmosomoides yorkei* (Heligmosomidae) [small intestine: Cm: 2] (Figs 3-1, 3-2, 3-3 and 3-4), *H. polygyrus* [small intestine: Au: 2] (Fig 3-5), *Heligmosomum (Paraheligmosomum) mixtum* (Heligmosomidae) [small intestine: Cr and Ma: 9 and 1] (Figs 3-6, 3-7 and 3-8), *Heligmosomum (Heligmosomum) sp.* [small intestine: Aa and Mo: 1 and 1], *Subulura citelli* (Subuluridae) [large intestine: En: 2] (Figs 4-1, 4-2, 4-3 and 4-4), *Pterygodermatites sp.* (Rictulariidae) [small intestine: Cr: 3] (Figs 4-5, 4-6, 4-7 and 4-8), *Litomosa vite* (Onchocercidae) [thoracic cavity: Ro: 1] (Figs 5-1, 5-2, 5-3, 5-4, 5-5 and 5-6), and spirurid unknown species [serous membrane of small intestine: Cr: 1] (Figs 4-9 and 4-10) were obtained.

However, no nematode or acanthocephala was obtained from *A. pumilio*, *M. socialis*, *E. talpinus*, *M. musculus*, *R. norvegicus*, *C. longicaudatus*, *C. cricetus*, *C. rufocanus* and *M. arvalis* in this survey.

## Discussion

Although most species have been reported in areas surrounding Xinjiang (Ryzhikov *et al.*, 1979; Ganzorig, 1998), these helminths except for *H. polygyrus* and the common nematodes with ones of the laboratory murids are first records in Xinjiang. The helminthological results for the parasitic nematodes in Xinjiang are shown below.

*Angiostrongylus cantnensis*, *Ganguleterakis spumosa*, *Mastophorus muris*, *Nippostrongylus braziliensis*, *Ollulanus tricuspis*, *Rictularia* spp., *Strongyloides* spp., *Syphacia* spp., *Trichocephalus muris*, and *Trichosomoides crassicauda* have been recorded from *Rattus* sp. and *Mus musculus* including the experimental animals in China (Xu, 1975). *Aspiculuris tetraptera*, *Syphacia obvelata*, and *S. muris* were recorded from experimental rodents in Xinjiang (Chen *et al.*, 1996).

There are a few reports on the parasitic nematodes

of the genus *Apodemus* in the eastern or southern parts of China (Yin, 1973; Asakawa *et al.*, 1990, 1993, 1994), but there is only one in Urumqi, Xinjiang, namely *H. polygyrus* obtained from *Apodemus microps* (Asakawa *et al.*, 1992). Therefore, it was confirmed that *H. polygyrus* is the parasitic nematode of *A. uralensis* occurring in the northwestern part of China. On the other hand, *H. neopolygyrus* was found from *A. peninsulae* and *A. agrarius* captured in the area around Akademgorodok in western Siberia, Russia (Asakawa *et al.*, 1995). A more detailed survey on the distribution of *H. polygyrus* and *H. neopolygyrus* in Mts Altai will be required in the future. In the nematode distribution, it is remarkable that the genus *Heligmonoides* (Fam. Heligmonellidae) was not obtained from *A. uralensis* although the genus had been reported from *Apodemus* spp. occurring in the eastern and southern part of China (Yin, 1973; Asakawa *et al.*, 1990).

In China, there are a few reports on the parasitic nematodes of the Microtinae, *i.e.*, *Longistriata (L.) dalrymplei* (Fam. Heligmonellidae) from *Eothenomys melanogaster* and *Labiobulura losea* (Fam. Subuluridae) from *E. olitor* in Yunnan (Yin, 1973, 1980) and *Eugenuris xizangensis* (Fam. Oxyuridae) and *Cephaluris jiachaehsis* (Fam. Heteroxyenematidae) from *Microtus* sp. in Tibet (Li *et al.*, 1991, 1992). In the northern part of Xinjiang, *Capillaria hepatica* was obtained from *Lagurus luteus*, *Microtus arvalis*, and *Ellobius tapinus* (Chen *et al.*, 1993).

There has been no report on the parasitic nematodes from the genera *Cricetulus*, *Meriones* and *Rhombomys* in Xinjiang. However, 2 heligmonellid species, *Orientostrongylus chinensis* and *Morganiella cricetuli*, and the 3rd larvae of *Rhabditis (Pelodera)* sp. were recorded from *Cricetulus barabensis* and *C. triton* in Beijing and Shenyang of the eastern part of China (Durette-Desset, 1970; Yin and Zhang, 1981; Asakawa *et al.*, 1990). Furthermore, the genera *Longistriata*, *Aspiculuris*, *Dentostomella*, *Syphacia*, *Mastophorus*, *Gongylonema*, *Rictularia*, *Physaloptera*, *Litomosa*, *Capillaria* and *Trichuris* were recorded from the gerbillins captured in the former USSR and Mongolia, *Heligmonoides afghanus* was recorded



from *Meriones libycus*, and *Heterakis yamagutii* was recorded from *M. hurrianae* (Tenora, 1969; Ganzorig, 1998; Gupta and Trivedi, 1984; Ryzhikov *et al.*, 1979).

Although the genera *Aspiculuris*, *Graphidioides*, *Rictularia*, *Mastophorus*, and *Cyathospirura* were recorded from the genera *Allactaga* and *Dipus* in the former USSR and Mongolia (Ganzorig, 1998; Ryzhikov *et al.*, 1979), there have been no report on the parasitic nematodes from the genera *Alacutalagus* and *Euchoreutes*. Therefore, *Subulura citelli* from the genus *Euchoreutes* and *Eucoleus* sp. from the genus *Allactaga* are first records.

The mammal species belonging to the family Heteromyidae are highly desert-adapted species from an ecological point of view, and their body forms are remarkably convergent with the Chinese mammalian species (Mares, 1993). However, the helminth faunas are different in the two different group. For example, there are no records of acanthocephalans from the heteromyids (Whitaker *et al.*, 1993). Nevertheless, in the present survey, *Moniliformis* sp. was obtained from *Cricetulus eversmanni*, and this is the first recorded incidence of this parasite in this species and this locality.

As most of the present helminths obtained were recorded for the first time in this locality and in these hosts, the pictures of the helminths are presented here in order to aid a future survey in Xingjiang. Among the helminths, some nematodes could not be identified to the species level, but were allocated to the genera *Moniliformis*, *Syphacia* and *Pterygodermatites*. The spirurid from *C. rutilus* has also not been named at the time of writing the present paper. There has been controversy from a taxonomical point of view, regarding the genera *Heligmosomoides* and *Heligmosomum* and the family Capillaridae (cf. Asakawa, 1995; Asakawa *et al.*, 1988; N'zobadila *et al.*, 1996). Hence, the characteristic structures of the helminths are also given for provoking future taxonomical studies. These comprise the following structures; viz., the proboscis with row of hooks (Fig 1-1), the esophagus including bulb and/or the head end including lips, lateral alae or buccal capsule (Figs

1-6, 2-2 to -8, 4-1, -2, -5 to -7 and -9, 5-2), the male genital organs including spicules and/or spicular sheath, gubernaculum, preanal pseudosucker, caudal-pseudobursa, bursa, caudal alae (Figs 1-3 to -5, 2-7, 3-3 to -5, 3-7 and -8, 4-3, -4, -7 and -10), the female genital organs including eggs or larvae in the uterus and vulva, or tail including anus or papillae at the tail end (Figs 2-6, -9, 4-8, 5-3 to -6), the ridges of the synlophe (cf. Durette-Desset, 1970; Asakawa, 1995; N'zobadila *et al.*, 1996) (Figs 3-1, -2, -6).

### Acknowledgements

The authors wish to thank Dr Chen, X.-R., Xinjiang Institute for Endemic Diseases Control and Research, Urumqi, for the donation of the studies of the helminths of small mammals in Xinjiang, and Mr Iwashita, Y., Rakuno Gakuen University, and Mr Kobayashi, K., Central Institute for Experimental Animals, for cooperation of the dissection of the animals. Furthermore, the authors are grateful to Dr. Couper, D., the MSc of Wild Animal Health, the Royal Veterinary College, for reading and commenting a part of this manuscript. This paper was published by the Kanto-Giken Publishment Aid, Yamanashi Pref, Japan.

### References

- Anderson, R. C., Chabaud, A. G. & Willmott, S. (Eds). 1974-1983. Key to the Nematodes of Vertebrates. Nos 1-10. Commonwealth Institute of Helminthology, Farnham Royal, CAB, UK.
- Asakawa, M. 1995. A biogeographical study on the parasitic nematodes of Japanese Microtinae and Murinae with systematic and phylogenetic studies of the genera *Heligmosomoides* and *Heligmosomum* (Nematoda: Heligmosomidae). J. Rakuno Gakuen Univ., Nat. Sci., 19: 285-379. (In Japanese with English summary.)
- Asakawa, M., Guo, A.-H., Yang, X.-Y., Liu Z.-L., Li, J.-F., Koyasu, K., Tsuchiya, K., Miyashita, N., Wang, F.-S. & Moriwaki, K. 1993. A further survey on the distribution of *Heligmosomoides*

- neopolygyrus* Asakawa et Ohbayashi, 1986 (Nematoda: Trichostrongyloidea: Heligmosomidae) in eastern part of China. Bull. biogeogr. Soc. Japan, 48: 49-52. (In Japanese with English summary.)
- Asakawa, M., Hagiwara, K., Liao L.-F., Jiang, W., Yan, S.-S., Chai, J.-J., Oku, Y. & Ito, M. 2000. Parasitic helminths of rodents collected in the northern part of Xinjiang, China. Parasit. int, 49 (Suppl.): 90-91.
- Asakawa, M., Hagiwara, K., Liao, L.-F., Jiang, W., Yan, S.-S., Chai, J.-J., Oku, Y., Kobayashi, K. & Ito, M. 2001. Collection record of small mammals in Xinjiang-Uygur, 1998 and 1999 with brief review of its mammalian fauna. Biogeography, 3: in press.
- Asakawa, M., Iwashita, Y., Liao, L.-F., Jiang, W., Junjie Chai, J.-J., Oku, Y., Kobayashi, K. & Ito, M. 1999. Preliminary report on the parasitic nematodes of the rodents collected on Xinjiang, China. In The Program and Abstracts of the 5th Meeting of the Japanese Society of Zoo and Wildlife Medicine in July 2-4, 1999, Osaka Prefecture University: 45. (in Japanese.)
- Asakawa, M., Kamiya, H. & Ohbayashi, M. 1988. Studies on the parasite fauna of Insectivora. II. Four new capillariid nematodes from the Japanese shrews, genera *Sorex* and *Crocidura*. J. Coll. Dairying, Nat. Sci., 12: 335-347.
- Asakawa, M., Li, J.-F., Guo, A.-I., Yang, X.-Y., Huhebateer, Liu, Z.-L., Liu, Y., Cao X.-M. & Chen, K.-Y. 1994. A new and locality record for *Toxocara apodemi* (Olsen, 1957) (Nematoda: Ascarididae) from striped field mice, *Apodemus agrarius* (Pallas) (Rodentia: Murinae) in Changsha, China. J. Rakuno Gakuen Univ., Nat. Sci., 19: 193-196.
- Asakawa, M., Oda, S.-i., Harada, M., Narita, Y., Koyasu, K., Chechulin, A. I., Dobrotvorsky, A. K., Panov, V. V. Borodin, P. M. & Fedorov, K. P. 1995. Heligmosomoid nematodes from the small mammals captured in the adjacent areas of Akademgorodok City, Southern Part of West Siberia, Russia. Bull. biogeogr. Soc. Japan, 50(1) or (2): 11-14.
- Asakawa, M., Tenora, F., Hasegawa, H., Jin, M.-L., He, X.-Q., Wu, X.-M., Tsuchiya, K., Miyashita, N., Moriwaki, K., Fukumoto, S.-I. & Ohbayashi, M. 1992. *Heligmosomoides polygyrus* (Dujardin, 1845) (Nematoda: Trichostrongyloidea: Heligmosomidae) from *Apodemus microps* (Rodentia: Muridae) in Ulumuchi, China. Bull. biogeogr. Soc. Japan, 47: 69-71.
- Asakawa, M., Ying, W.-Z., Zhu, J.-H., Chen, G.-Q., Takahashi, K., Hasegawa, H., Sawada, I., Matsukawa, K. & Ohbayashi, M. 1990. A preliminary report on the helminth fauna of small mammals in Shenyang, China. J. Rakuno Gakuen Univ., Nat. Sci., 14: 135-146. (In Japanese with English and Chinese summary.)
- Chen, X.-R. Yan, S.-S. & Li, W. 1996. A preliminary investigation on internal parasites of laboratory animals in Xinjiang, China. Endemic Dis. Bull., 11(4): 81-83. (in Chinese with English summary.)
- Chen, X.-R., Ye, R.-Y., Dou, Z.-H., Yu, X. & Zhang, Z.-J. 1993. An investigation on rodent infected with *Capillaria hepatica*. in Xinjiang. Acta Zool. Arid Inland, (1): 197- 198. (In Chinese with English summary.)
- Durette-Desset, M.-C. 1970. Caracteres primitifs de nematodes heligmosomes, parasites de murides et cricetides orientaux. Definition d'*Orientostrongylus* n. gen. Annls. Parasit. hum. comp. Paris, 45: 829-837.
- Ganzorig, S. 1998. Biodiversity of helminth parasites in Mogolia. PhD thesis of Hokkaido University: 182 pp.
- Gupta, S. P. & Trivedi, K. K. 1984. Nematode parasites of vertebrates. VII. On two new species of the genus *Heterakis* Dujardin, 1845 (Heterakidae Railliet & Henry, 1914), from mammals of Udaipur, Rajasthan, India. Ind. J. Helminthol., 34: 29-35.
- Li, J.-F., Liu, Y. & Tian, W.-Z. 1991. [A new species of *Eugenuris* (Nematoda: Oxyuridae)]. Acta Vet. zootech. sin., 22: 268-272. (In Chinese with English summary.)
- Li, J.-F., Liu, Y. & Tian, W.-Z. 1992. [A new species

- of *Cephaluris* (Oxyurata: Hetroxynematidae)]. *Acta zootaxon. sin.*, 17: 156-159. (In Chinese with English summary.)
- Mares, M. A. 1993. Heteromyids and their ecological counterparts: a pandesertic view of rodent ecology and evolution. In Genoways, H. H. (Ed), *Biology of the Heteromyidae*, Special Publication No. 10: 652-715. The American Society of Mammalogists, USA.
- N'Zobadila, G., Boyer, J. & Durette-Desset, M.-C. 1996. Morphogenèse d'*Heligmosomoides polygyrus polygyrus* (Dujardin, 1845) (Trichostrongylina, Heligmosomoidea) chez *Apodemus flavicollis* en France. Comparaison avec les espèces proches: *Heligmosomoides laevis* (Dujardin, 1845) et *Heligmosomum mixtum* Schulz, 1954, parasites d'Arvicolidae. *Bull. Mus. natn Hist. nat., Paris*, 4<sup>e</sup> sér., 18, Sec. A: 367-385.
- Ryzhikov, K. M., Gvozdev, E. V., Tokobaev, M. M., Shaldybin, L. S., Matsaberidze, G. V., Merkusheva, I. V., Nadtochin, E. V., Hohlova, I. G. & Sharpilo, L. D. 1979. [A Handbook of Helminths of the rodent Fauna of the USSR. I. Nematoda and Acanthocephala.], Nauka, Moscow: pp. 271. (In Russian.)
- Skryabin, K. I. (Ed). 1990. Key to parasitic Nematodes, Vols 1-4, E. J. Brill, Leiden.
- Tenora, F. 1969. Parasitic nematodes of certain rodents from Afghanistan. *Acta Soc. zool. Bohem*, 33: 174-192.
- Whitaker, J. O. Jr, Wrenn, W. J. & Lewis, R. E. 1993. Parasites. In Genoways, H. H. (Ed), *Biology of the Heteromyidae*, Special Publication No. 10: 386-478. The American Society of Mammalogists, USA.
- Xu, N. (Ed.) 1975. *Animal parasitic Nematology*, Science Publ. Camp., Beijing : pp. 380. (In Chinese.)
- Yin, W.-Z. 1973. [Helminths of birds and wild animals from Lin-Tsan Prefecture, Yunnan Province, China. II. Parasitic nematodes of mammals]. *Acta zool. sin.*, 19: 354-364. (In Chinese with English summary.)
- Yin, W.-Z. 1980. [On the nematodes of mammals from the Dehong Area, Yunnan, China. *Acta zootaxon. sin.*, 5: 22-29. (In Chinese with English summary.)
- Yin, W.-Z. & Zhang, N.-X. 1981. On some parasitic nematodes from rodents and insectivora in Peking, China]. *Acta zootaxon. sin.*, 6: 16-21. (In Chinese with English summary.)

(Accepted April 16, 2001)