Helminths of Small Mammals (Chiroptera, Insectivora, Lagomorpha) from Mongolia with a Description of a New Species of *Schizorchis* (Cestoda: Anoplocephalidae)

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Helminths of Small Mammals (Chiroptera, Insectivora, Lagomorpha) from Mongolia with a Description of a New Species of *Schizorchis* (Cestoda: Anoplocephalidae)

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ABSTRACT: Fifty-eight individuals belonging to 10 species of bats, insectivores, and pikas were examined for helminths from 4 collection sites in Mongolia in 1999. Two species of bats (*Vespertilio murinus* and *Eptesicus gobiensis*) were infected with a single species of trematode (*Plagiorchis vespertilionis*), which represents a new record for the country. One individual of *E. gobiensis* also harbored 1 unidentified filaroid nematode. The acanthocephalan *Moniliformis moniliformis* was found in the hedgehog *Hemiechinus auritus*. Cestodes in the genus *Catenotaenia* and the herein described *Schizorchis mongoliensis* n. sp. were recovered from pikas belonging to the species *Ochotona alpina*. *Schizorchis mongoliensis* n. sp. is distinguished from other members of the genus by shorter strobila length accompanied by earlier maturation of proglottids, as well as a distinct vaginal valve and secondary lateral seminal receptacle.

KEY WORDS: Mongolia, helminth, trematode, *Plagiorchis*, nematode, cestode, *Schizorchis*, *Catenotaenia*, bat, *Vespertilio*, *Eptesicus*, pika, *Ochotona*, hedgehog, *Hemiechinus*

In recent years, a concentrated effort has been made to understand the biology, distribution, population density, and behavior of species of mammals comprising the "charismatic megafauna" (particularly ungulates and large carnivores) of Mongolia (Reading, Amgalanbaatar, and Lhagvasuren 1999; Reading, Mix, et al., 1999), but comparative data are sorely lacking for the small mammals of the region (Tinnin et al., 2002). Although some baseline biodiversity survey data are available, little published information exists in the literature on the diminutive mammals of the region (Mallon, 1985; Tinnin et al., 2002). Even fewer published data are available that describe the diversity of parasites of small mammals, although a more extensive literature base, including more than 60 papers, has been generated on the plague bacillus [*Yersinia pestis* (Lehmann and Neumann, 1896)], the vector fleas, and reservoir rodents in Mongolia (Krasnov, personal communication). Despite this important work, few specimens of parasites or hosts were deposited as vouchers in accessible curated collections or museums. In our literature review, we documented 31 species of helminths, primarily cestodes and nematodes, that were reported from individuals representing 20 species of small mammals (Tenora and Murai, 1975; Danzan, 1978; Ganzorig et al., 1996; Ganzorig, 1998 unpublished thesis, Graduate School of Veterinary Medicine, Hokkaido University, Japan; Ganzorig et al., 1998; Suhbat and Ganzorig, 1998; Ganzorig, Tenora, et al., 1999; Ganzorig, Batssaikan, et al., 1999; Ganzorig et al., 2003). Fifty-three species of the small mammals that occur in Mongolia or in adjacent countries have never been reported as having been examined for endoparasites. For example, the parasite fauna of bats is unknown. There is only 1 report of a single individual of *Plecotus auritus* (Linnaeus, 1758) being examined for endoparasites, and this specimen was uninfected (Meszaros, 1974).

Because of this dearth of information on parasites of small mammals of Mongolia, and after we were invited to work with the Mongolians on a U.S. National Science Foundation international long-term ecological research program site visit, we concentrated on collecting mammals and their parasites from 9 July through 2 August 1999. This preliminary work resulted in broad scale baseline biodiversity collecting at 13 different sites and has now expanded into a survey of small mammal and parasite diversity in Mongolia (Tinnin et al., 2002). The results of the examination for helminths of 58 individual bats, shrews, hedgehogs, and pikas are presented in this study.

MATERIALS AND METHODS

Bats were collected from 2 localities in Mongolia in July 1999. The first site, Ulaan Tsutgaalan (46°47′13″N,

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101° 57′47″E, 1,850 m elevation) is located in the Khangai Mountains of Övörkhangay Aimag (province) in west central Mongolia. The surrounding area is mountain steppe habitat cut through by the Orkhon River. The river canyon (ca. 200 m wide by 50 m deep) is steep sharply cut rock with a mixed *Pinus*, *Populus*, and *Larix* forest along the riverbank. Bats were captured over a calm side channel of the river at the base of the canyon cliff during 2 nights of netting. At this site 2 *Eptesicus gobiensis* (Bobrinski, 1926), 5 *Myotis brandtii* (Eversmann, 1845), 6 *Myotis daubentoni* (Kuhl, 1817), and 16 *Vespertilio murinus* Linnaeus, 1758 were examined for parasites. The second site, Ulziyt Uul (44°41′09″N, 102°00′57″E, 1,640 m elevation) is a small barren rocky hill in the arid Gobi Steppe north of Arts Bogd Mountain. The area consists of sparse vegetation (*Allium*, *Stipa*, and *Artemesia*) and desert pavement. Bats were collected during 1 night by netting at the base of the hill as well as by shotgun as they circled camp. Six individuals of *E. gobiensis* were examined for parasites from this locality.

Insectivores were collected from 2 localities. One adult shrew (*Sorex caecutiens* Laxmann, 1788) was captured in Gorkhi-Terelj National Park (47°53′N, 107°23′E) in a Sherman live trap on a narrow mountaintop ridge (2,000 m) in *Pinus sibirica* forest. Five hedgehogs (*Hemiechinus auritus* (Gmelin, 1770)) were captured in Tomahawk live traps and by hand at Ulziyt Uul, and 1 was caught at the base of nearby Arts Bogd Mountain (44°39′32″N, 101°58′19″E).

Four species of pika were captured from 3 different localities. Two individuals of *Ochotona alpina* (Pallas, 1773) and 3 *Ochotona dauurica* (Pallas, 1776) from Ulaan Tsutgaalan, 2 *Ochotona hyperborea* (Pallas, 1811) from talus slopes at Gorkhi-Terelj, and 2 *Ochotona pallasi* (Gray, 1867) from Ulziyt Uul were examined.

Captured animals were processed immediately following standard protocols (Gardner, 1996). Each animal was brushed and examined for ectoparasites, a blood smear was made for later examination for microfilariae or hemoprotozoa, and fecal samples were collected for study of coccidia following the method of Vance and Duszynski (1985) and Gardner (1996). The complete gastrointestinal tract, liver, lungs, pleural cavity, and peritoneal cavity were examined separately for helminths. Gastrointestinal tracts of 3 individuals (2 *H. auritus*, 1 *O. hyperborea*) were preserved and stored in 70% ethanol (ETOH) until examined in the Harold W. Manter Laboratory of Parasitology (HWML). From complete field necropsies, specimens were preserved in 10% formalin or 70% ETOH for study by light microscopy. Trematode and cestode specimens were stained with carmine, cleared in xylene or terpineol, mounted in Damar gum, and observed with a microscope. Nematode specimens were preserved in 10% formalin, cleared in lactophenol, and observed with a microscope. Measurements are presented as range, with mean, standard variation, and sample size in parentheses. Specimens were deposited in the Harold W. Manter Laboratory of Parasitology (HWML).

RESULTS

Five taxa of helminths were collected from 4 of the 10 host species examined. Uninfected mammals included *S. caecutiens*, *M. brandtii*, *M. daubentoni*, *O. dauurica*, *O. hyperborea*, and *O. pallasi*. Host, parasite, locality, and infection parameters are outlined below for those mammals found to harbor parasites.

Chiroptera

Vespertilio murinus Linnaeus, 1758

Trematoda

Plagiorchis vespertilionis (Müller, 1780)

Collection locality: Ulaan Tsutgaalan.

Site of infection: Posterior 1/16 of intestine.

Prevalence and intensity: 2/16 (12.5%), 4.

Specimens deposited: HWML48487, HWML48488, HWML48490.

Additional hosts from Mongolia: This represents the first record from the country.

Type host and type locality: Plecotus auritus, Denmark; Neotype host designated by Tkach et al. (2000) as *M. daubentoni*, Kiev, Ukraine.

Other reported hosts: In central Asia *Plagiorchis vespertilionis* has been reported from numerous bat species including *Eptesicus serotinus* (Schreber, 1774); *Myotis mystacinus* (Kuhl, 1817); *Myotis oxygnathus* Monticelli, 1885; *Nyctalus noctula* (Schreber, 1774); *Pipistrellus pipistrellus* (Schreber, 1774); *P. auritus*; *Eptesicus nilssoni* (Keyserling and Blasius, 1839) (see Spasski et al., 1952; Groschaft and Tenora, 1974; Tokobaev, 1976). Other reported hosts from across its range have included members of *Myotis* Kaup, 1829; *Pipistrellus* Kamp, 1829; *Plecotus* E. Geoffrey Saint-Hillare, 1818; *Nyctalus* Bowdich, 1825; *Nyctinomops* Miller, 1902; *Rhinolophus* Lacepede, 1799; *Tadarida* Rafinescque, 1820; and *Miniopterus* Bonaparte, 1837 (see Yamaguti, 1958); as well as *Barbastella barbastella* (Schreber, 1774) and possibly from paratenic rodent hosts (Tkach et al., 2000).

Geographic range: This species is known from across the Palearctic (Yamaguti, 1958; Tkach et al. 2000); although reported from the Nearctic, these reports may be erroneous (Tkach et al. 2000). In central Asia it has been reported from Kirgizia (Tokobaev, 1976); Yakutia, and Lake Baikal in Russia (Spasski et al., 1952); Afghanistan (Groschaft and Tenora, 1974); Tadjikistan (Spasski et al., 1952).

Remarks: The morphological variation seen in *P. vespertilionis* across its range and its presence in such a variety of bat hosts has made identification and taxonomic status of its synonyms problematic. Our specimens conform to those of the redescription by Tkach et al. (2000) of *P. vespertilionis* from the Ukraine, although there are a few discrepancies. Our specimens are very elongate; length 1.5–2.7 (2.3 ± 0.5, $n = 7$) mm; maximum width, usually at level of acetabulum, 302–503 (373 ± 71, $n = 7$) μm; length/width ratio 3.6–8.4:1 (6.4:1 ± 1.8, $n = 7$). Tegument covered with small spines, which reach to posterior margin of posterior testis, diminishing in number as they progress posteriad. Distance between middle of oral sucker and acetabulum 333–774 (560 ± 152, $n = 7$) μm. Vitelline fields end anterior to ovary, not reaching ventral sucker. Cirrus sac elongate, curving under the acetabulum, from medially to across the right margin. Oral sucker round to slightly oval 155–209 × 155–194 (187 ± 20 × 179 ± 16, $n = 7$) μm. Ventral sucker round or slightly oval, slightly smaller on average than oral sucker 124–178 × 116–155 (150 ± 18 × 133 ± 15, $n = 5$) μm. Sucker ratio 1:1.14–1.25 (1:1.25 ± 0.08, $n = 7$).

Eptesicus gobiensis (Bobrinski, 1926)

Trematoda

Plagiorchis vespertilionis (Müller, 1780)

Collection locality: Ulziyt Uul.

Site of infection: Posterior 1/16 of intestine, near rectum.

Prevalence and intensity: 1/6 (16.67%), 2.

Specimens deposited: HWML63032, HWML48489.

Remarks: See comments under *Vespertilio murinus*.

Nemata

Filaroidea gen. sp.

Collection locality: Ulziyt Uul.

Site of infection: Body cavity.

Prevalence and intensity: 1/6 (16.67%), 1.

Specimens deposited: HWML48491.

Remarks: One partial individual was recovered from the body cavity. Since *Litomosa* Yorke and Maplestone, 1926 is the only genus of filaroid nematode known from Old World bats, this individual likely represents a member of that genus.

Insectivora

Hemiechinus auritus (Gmelin, 1770)

Acanthocephala

Moniliformis moniliformis (Bremser in Rudolphi, 1811)

Collection locality: Ulziyt Uul.

Site of infection: Anterior end small intestine.

Prevalence and intensity: 1/6 (16.67%), 1.

Specimens deposited: HWML63026.

Additional hosts from Mongolia: Moniliformis moniliformis has been previously reported from *H. auritus*; *Mesechinus dauuricus* (Sundevall, 1842); *Spermophilus undulatus* (Pallas, 1778); *Spermophilus erythrogenus* Brandt, 1841; *Meriones meridianus* (Pallas, 1773); and *Microtus arvalis* (Pallas, 1778) (see Danzan, 1978; Ganzorig et al., 1988).

Other reported hosts and range: This species has been reported from a variety of insectivorous and carnivorous mammals across Eurasia, Africa, and Pacific Islands (Yamaguti, 1963; Tokobaev, 1976; Deveaux et al. 1988).

Remarks: A second species, *Moniliformis clarki* (Ward, 1917), has also been reported from *Phodopus sungorus* (Pallas, 1773); *Allocricetulus curtatus* (Allen, 1925); *Marmota sibirica* (Radde, 1862); and *S. undulatus* in Mongolia (Danzan 1978; Ganzorig, 1998). Some of the previous reports of *M. moniliformis* in *S. undulatus* may in fact represent *M. clarki* (see Ganzorig, 1998, unpublished thesis, Graduate School of Veterinary Medicine, Hokkaido University, Japan).

Lagomorpha

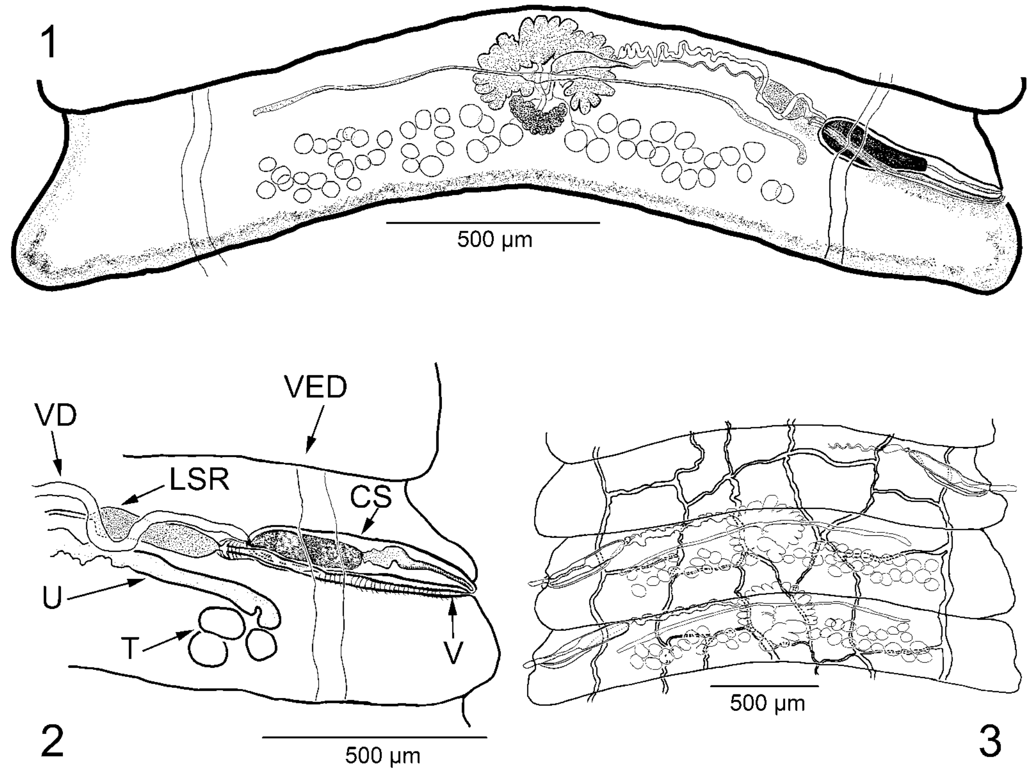
Ochotona alpina (Pallas, 1773)

Cestoda: Anoplocephalidae

Schizorchis mongoliensis n. sp. (Figs. 1–7)

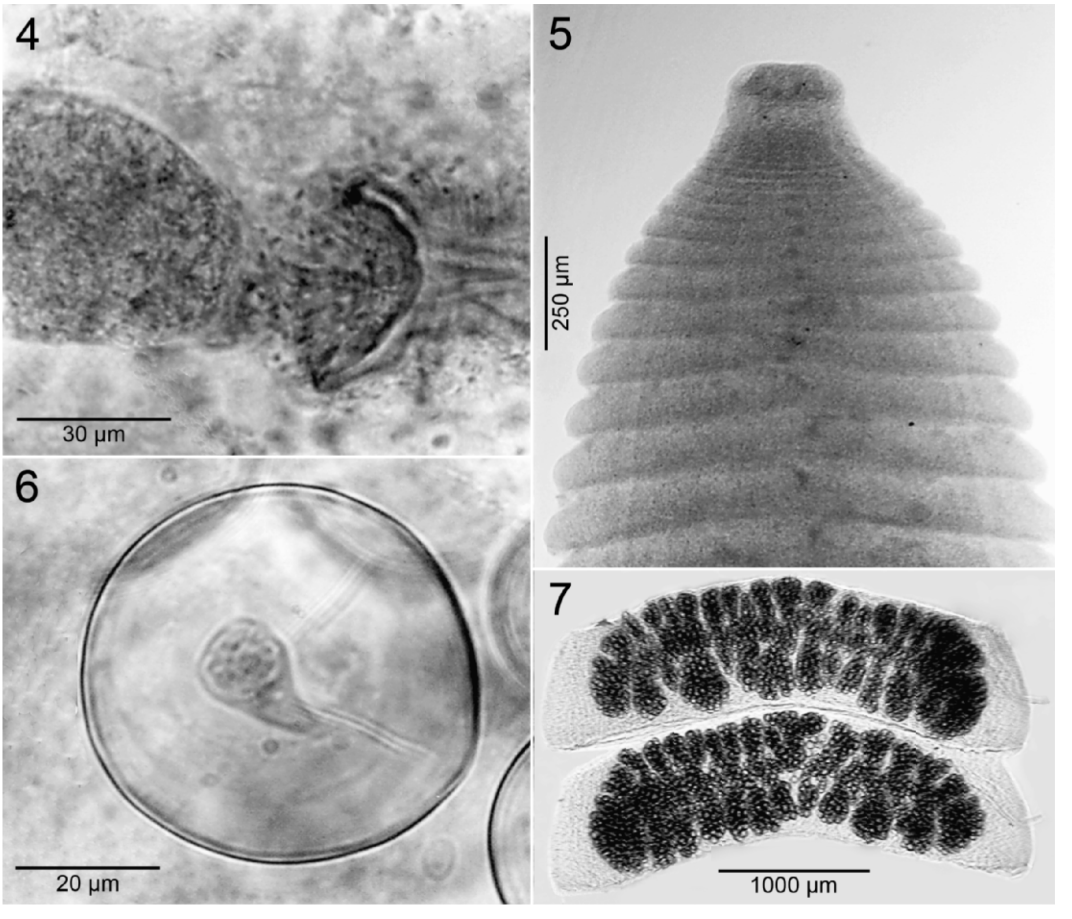
Description

Intact strobila ranging from 18.2 to 20.2 (19.5 ± 0.9, $n = 4$) mm long, with up to 68 proglottids. One individual cestode was found with additional loose segments (identifiable definitively as coming from that specimen); adding these would increase the overall length of this specimen to 30.1 mm. Maximum width of strobila 2.6–3.2 (2.8 ± 0.3, $n = 4$) mm attained in late gravid segments (Fig. 7). Strobila widens rapidly after scolex (Fig. 5). Strobila



Figures 1–3. Schizorchis mongoliensis n. sp. **1.** Mature proglottid, ventral view. **2.** Details of genital ducts showing lateral seminal receptacle and muscular vaginal valve. CS, cirrus sac; LSR, lateral seminal receptacle; VD, vas deferens; VED, ventral excretory duct; V, vagina; T, testes; U, Uterus. **3.** Mature proglottid detailing system of accessory excretory canals, dorsal view.

craspedote. All segments wider than long with mature segments having a length/width ratio of 1:4.9–1:6.3 (1:5.8 ± 0.6, $n = 4$) and gravid segments 1:4.0–1:4.5 (1:4.2 ± 0.2, $n = 4$). When viewed from either dorsal or ventral aspect, all segments with characteristic arch shape, lateral edges more posterior relative to median part (Figs. 1, 3, 5, and 7). Scolex 215–250 (232 ± 18, $n = 3$) µm in width, suckers 78–92 (83 ± 5, $n = 12$) µm in diameter, neck 108–170 (149 ± 36, $n = 3$) µm in length. Anlagen of genitalia appears immediately following neck in first proglottids. Genital pores irregularly alternating and positioned slightly anterior to transverse midline of each segment. Ventral excretory canal 9–22 µm in diameter and undulating. Transverse canal crosses proglottid at approximately the level of the testes field. Accessory canals connecting transverse canals forming an irregular branching longitudinal network (Fig. 3). Dorsal excretory canal not clearly distinguishable. Testes 30–50 in number generally in discrete lateral groups somewhat more numerous antiporally. Testes ovoid to round, 51–91 (64 ± 9, $n = 38$) µm in diameter. Cirrus sac elongate, 433–596 (540 ± 37, $n = 30$) µm in diameter, approaching maximum size in mature proglottids, proximal end somewhat inflated, angled anteromedially, ending along the proglottid margin. Cirrus sac extends beyond the excretory canals; proximal end even with uterus and testes. Internal seminal vesicle well defined and elongate, 152–251 (208 ± 26, $n = 20$) × 45–96 (63 ± 10, $n = 20$) µm. Vas deferens tubular, not forming pronounced vesicular sac, tubular form slightly undulating, but not forming deep pronounced coils, extending mediad across anterior portion of proglottid before angling posteriad between ovary and seminal receptacle. Vagina thick walled 16–23 µm in diameter, positioned posterior and ventral to cirrus sac, curving anteriad and overlapping cirrus sac mediad, ending slightly proximal to cirrus sac, with a distinct muscular valve (Figs. 1, 2, and 4). Both vagina and cirrus sac lie dorsal to excretory canals. After muscular end of vagina, female genital duct immediately enlarging into a discrete sac



Figures 4–7. Schizorchis mongoliensis n. sp. **4.** Micrograph detailing vaginal valve and connection with lateral seminal receptacle. **5.** Micrograph showing anterior portion of specimen. **6.** Micrograph of egg. **7.** Micrograph of gravid proglottids.

136–225 (178 ± 1, $n = 15$) × 30–56 (41 ± 8, $n = 15$) μm (Figs. 1, 2, and 4), the lateral seminal receptacle. Genital duct then narrows to a small tube before reaching medial seminal receptacle, which lies dorsal to ovary. Ovary 176–254 (222 ± 5, $n = 12$) μm × 351–566 (432 ± 67, $n = 12$) μm with small lobes, situated medially, extending to anterior margin of proglottid and ventrally slightly past anterior edge of vitelline gland. Vitelline gland slightly lobed 90–125 (110 ± 12, $n = 12$) μm × 105–168 (145 ± 20, $n = 12$) μm. Uterus tubular and bilateral, extending to end of testes field and proximal end of cirrus sac (Figs. 1, 2). Eggs first appear at approximately the 44th proglottid, first as a mass in 1 distal end of the uterus, usually the antiporal side. Uterus forms anterior and posterior sacculations in gravid proglottids (Fig. 7). In gravid proglottids, uterus extending beyond end of cirrus sac, but not past the ventral excretory canal. Cirrus and vagina persist in gravid segments. Eggs round to slightly oval 46–75 (56 ± 7, $n = 40$) μm in diameter, egg membrane smooth and thin, less than 2 μm in thickness. Onchosphere with pyriform apparatus. Width of onchosphere 15–23 (20 ± 2, $n = 60$) μm (Fig. 6).

Taxonomic Summary

Type host: Ochotona alpina (Pallas, 1773) Symbiotype (see Frey, et al., 1992) deposited in the University of New Mexico, Museum of Southwestern Biology Mammal Division (MSB), MSB94337.

Type locality: Ulaan Tsutgaalan, Ovorkhangay Aimag, Mongolia, 46°47′13″N, 101°57′47″E, 1850 m elevation.

Site of infection: Small intestine.

Type specimen: Holotype, mounted on slide, collected 17 July 1999, HWML48485A, paratypes, from same host symbiotype, mounted on slides, HWML 48485B-D; and 1 vial, HWML62980.

Prevalence and intensity: 1/2 (50%), 6 (4 fully developed, 2 immature).

Etymology: The specific epithet refers to Mongolia, the country from which this new species was collected.

Differential Diagnosis

Schizorchis mongoliensis n. sp. is most similar to *Schizorchis altaica* Gvozdev, 1951 and *Schizorchis ryzhikovi* Rausch and Smirnova, 1984. It is distinguished from *S. altaica* in general size characters being significantly shorter, up to 20.2 mm, in intact strobila, versus up to 150 mm total length in *S. altaica* (measured by Gvozdev 1951) or 68 mm in specimens examined from *Ochotona rutilla* (Severtzov, 1873) in Kazakhstan by Rausch and Smirnova (1984). The maximum number of segments found in *S. mongoliensis* was 68 versus 188 reported by Rausch and Smirnova (1984) from *S. altaica*, while the last mature proglottid of *S. mongoliensis* was found to be segment 44 versus 76 in *S. altaica*. Testes number in *S. mongoliensis* are fewer (30–50) relative to *S. altaica* (50–60), and the eggs in *S. mongoliensis* are slightly smaller, 46–75 μm versus 46–85 μm, and they are smooth with a thin egg membrane, while those of *S. altaica* are covered in fine projections and thick skinned, >2 μm (Rausch and Smirnova, 1984). However, Spasski and Rhizhikov (1951) provided counts of the testes (40–50) and diameter of the eggs (47–60 μm) from specimens they ascribed to *S. altaica* that were collected from a different locality (near Lake Baikal) than that of the type locality for *S. altaica* in Kazakhstan as recorded by Gvosdev (1951). The specimens collected from near Lake Baikal show some overlap in these 2 measurements with *S. mongoliensis*.

Although strobila length is approximately equal between *S. mongoliensis* and *S. ryzhikovi* (20–36 mm), *S. mongoliensis* contains only 68 segments, while *S. ryzhikovi* contains up to 131 proglottids with the last mature proglottid in *S. mongoliensis* at number 44 versus 56–65 in *S. ryzhikovi*. The ovary of *S. mongoliensis* is less distinctly lobed than in *S. ryzhikovi*. The eggs of *S. mongoliensis* are much smaller than those of *S. ryzhikovi* (66–90 μm). Finally, the occurrence of a distinct muscular valve at the end of the vagina (Figs. 2, 3) in addition to the pronounced lateral seminal receptacle (Figs. 1, 2, 3) in the female reproductive tract clearly distinguishes *S. mongoliensis* from both *S. altaica* and *S. ryzhikovi*, which have neither.

The muscular vaginal valve and lateral seminal receptacle, as well as length of strobila (maximum 20 mm), number of segments (maximum 68), and last mature proglottid (44), serve to distinguish *S. mongoliensis* from the other species in the genus, all of which have measurements exceeding these. For a complete summary of species in the genus *Schizorchis*, with a table of comparative data, see Rausch and Smirnova (1984).

Remarks

Cestodes of the genus *Schizorchis* (Hansen, 1948) have been reported from pikas from both Asia and North America (Hansen, 1948; Gvozdev, 1951; Rausch, 1960; Rausch, 1963; Rausch and Smirnova 1984). At the present time 7 species are known, only from ochotonids, but Rausch and Smirnova (1984) indicated that a relatively large amount of morphological variation is shown by some of these species and additional work may reveal undescribed forms within this complex.

Two other species of *Schizorchis* have been reported from Mongolian *Ochotona: S. altaica* has been reported from *O. dauurica* in the southern Mongolian Altai Mountains region and *O. hyperborea* from the northern part of the country (Danzan, 1978; Ganzorig, 1998, unpublished thesis, Graduate School of Veterinary Medicine, Hokkaido University, Japan). *Schizorchis ryzhikovi* has also been reported from *O. pallasi* in the Mongolian Altai (Ganzorig, 1998, unpublished thesis, Graduate School of Veterinary Medicine, Hokkaido University, Japan). One of us (S.G.) collected 2 incomplete specimens, lacking gravid proglottids, from the type locality of *S. mongoliensis* in 1996. They were morphologically similar (including the muscular vaginal valve), and we determined that they represent the same species. Additional collections need to be done in this area to confirm the species range.

Cestoda: Catenotaeniidae

Catenotaenia sp.

Collection locality: Ulaan Tsutgaalan.

Site of infection: Small intestine.

Prevalence and intensity: 1/2 (50%), 1.

Specimens deposited: HWML48486.

Remarks: One partial specimen was recovered, which conforms with *Catenotaenia* Janicki, 1904.

Scolex 387 μm in width, suckers pouched 172–178 μm in diameter. Strobila consisting of 15 immature proglottids length 5.5 mm, proglottids longer than wide 521 × 347 μm. Currently 3 species of *Catenotaenia* are known from Mongolian rodents, *Catenotaenia dendritica* (Goetze, 1782); *Catenotaenia asiatica* Tenora and Murai, 1975; and *Catenotaenia afghana* Tenora, 1977 (see Ganzorig, Tenora, et al., 1999). Since members of the genus *Catenotaenia* are primarily known to infect rodent hosts, this could be an accidental infection.

DISCUSSION

Approximately twice the size of Texas, Mongolia is situated at the center of central Asia's biodiversity. Because of the unique geographic location of the country, several major biomes and ecosystems converge in this area, including alpine, taiga, forest steppe, steppe, desert steppe, and desert (Tinnin et al., 2002; Jargal, 2003). Elevations range from a minimum of 560 m in the eastern steppe/desert to a maximum of 4,374 m at Khuiten peak in the western most Altai mountains. In montane regions of Mongolia the geographic relief creates many intermountain pockets of isolated and fragmented habitats. Even though these areas may harbor hidden or undiscovered biological diversity, modern extensive biodiversity surveys in Mongolia are sorely lacking, particularly in regard to the sylvatic mammal/endoparasite fauna.

Data obtained and analyzed on both mammals and their parasites provides detailed habitat information that could not be collected in any other way (Manter, 1966; Gardner and Campbell, 1992; Brooks and Hoberg, 2000; Hoberg et al., 2003). The presence, in mammals and other vertebrates, of parasites that have complex life cycles provides a clear window on otherwise "cryptic information" relative to ecological habits, trophic interactions, home range size, historical ecology, phylogenetic relationships, and biogeography of the mammal species under investigation. Complete knowledge of a fauna in a region will also reveal the presence of any actual or potential zoonoses that might exist there (Brooks and Hoberg, 2000; Hoberg, et al., 2003). In addition, we have shown that data on parasites with complex life cycles, when combined with knowledge of the phylogenetic relationships of both host and parasite, can be used as probes for areas of great biological diversity (Gardner and Campbell, 1992; Brooks and Hoberg, 2000).

Of the approximately 100 species of rodents, lagomorphs, bats, and insectivores that are currently known from Mongolia, only 20 have been examined for helminths. Of those species, only half have had more than 10 individuals in total examined. Eighty percent of all specimens investigated were from 2 species *Lasiopodomys brandti* (Radde, 1861), 61%, and *S. undulatus*, 19%. The results of this study increased the number of known helminths to 33. However, we estimate that between 320 and 420 species of helminths (Cestoda, Nemata, Trematoda, and Acanthocephala) occur in the small mammals of the country (Brooks and Hoberg, 2000; Gardner, 2000; Brooks and McLennan, 2002). This rough estimate is based on extensive faunal surveys of Kirgizia, Tadjikistan, Kazakhstan, Uzbekistan, and Turkmenistan (Tokobaev, 1976). This in fact may be a conservative estimate due to the large number of isolated habitats and potentially undescribed endemic mammals present in Mongolia. Based on our initial analyses, it appears that a gap of biodiversity knowledge exists in the country (Tinnin et al., 2002; Tinnin and Gardner, unpublished data).

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