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Endoparasites of Fat-Tailed Mouse Opossums (*Thylamys*: Didelphidae) from Northwestern Argentina and Southern Bolivia, with the Description of a New Species of Tapeworm

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ENDOPARASITES OF FAT-TAILED MOUSE OPOSSUMS (*THYLAMYS*: DIDELPHIDAE) FROM NORTHWESTERN ARGENTINA AND SOUTHERN BOLIVIA, WITH THE DESCRIPTION OF A NEW SPECIES OF TAPEWORM

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ABSTRACT: The parasite fauna of 2 species of fat-tailed mouse opossums from northwestern Argentina is herein presented. Five species of helminths were found, i.e., *Pterygodermatites kozeki*, *Hoineffia simplispicula*, *Oligacanthorhynchus* sp., and a new species of tapeworm, *Mathevotaenia sanmartini* n. sp. (Cyclophyllidea: Anoplocephalidae). The new species is characterized by a calyciform scolex, relatively few testes (32), and a long cirrus sac; it occurs in fat-tailed mouse opossums at localities above 4,000 m. Those characters make it different from 6 species known to occur in marsupials from the New World, and from other species occurring in armadillos and bats. *Didelphoxyuris thylamisis*, *H. simplicispicula*, and *Oligacanthorhynchus* sp. appear to occur in marmosas from the Yungas region. In contrast, both *P. kozeki* and *M. sanmartini* n. sp. appear to occur exclusively in the Puna.

The knowledge of the parasite fauna of marsupials (Didelphimorphia: Didelphidae) in the New World is biased towards both the largest and most common species of *Philander* and *Didelphis* (Wolfgang, 1951; Aldes, 1995; Vicente et al., 1997; Silva and Costa, 1999; Gomes et al., 2003). A search of the literature shows that most of the detailed studies have been focused on those species occurring in either the northern hemisphere or the eastern coast of South America, and that little knowledge exists about the parasite fauna of the fat-tailed mouse opossums (*Thylamys* spp.) in the central Andes. For the rest of the 15 genera and 77 species of didelphiomorphs in the Neotropics (Gardner, 2005), there are few helminthological records. For example, up to the present time, only 5 species of nematodes are known from fat-tailed mouse opossums in northern Argentina and Bolivia (Navone et al., 1990, 1991; Gardner and Hugot, 1995; Ramallo and Claps, 2007).

In the present work, we summarize the findings on the helminth fauna of 2 species of fat-tailed mouse opossums from Argentina and integrate some of the results of our previous expeditions to the highlands of Bolivia. Specimens of *Thylamys venustus* (Thomas, 1902) and *Thylamys pallidior* (Thomas, 1902) were collected from 8 localities in 3 provinces of Argentina, including Salta, Jujuy, and Catamarca, and 1 locality in the department of Cochabamba in Bolivia. Animals were collected from habitats corresponding to the Yungas forest, Prepuna, and Puna (Cabrera and Willink, 1973).

We report 5 species of metazoan endoparasites from the individuals necropsied in the field, including species of *Pterygodermatites* Wedl, 1861; *Didelphoxyuris* Gardner and Hugot, 1995; *Hoineffia* Diaw, 1976; *Oligacanthorhynchus* Travassos, 1915; and *Mathevotaenia* Akhuyman, 1946. The present study provides information on parasites from fat-tailed mouse opossums collected during our field expedition to northwestern Argentina in the Austral fall (March and April) of 2006.

MATERIALS AND METHODS

Fifteen individuals of *Thylamys pallidior* and 5 of *Thylamys venustus* were collected in 9 localities from habitats in the Yungas, Prepuna, and Puna in Argentina. Three individuals of *T. pallidior* were collected in the Puna of Bolivia. The list of localities is presented below, and for each species of marsupial collected the general locality is given first, followed by latitude, longitude, and altitude (m). Numbers of individuals examined for parasites are given in parentheses.

Collecting localities for *T. pallidior* include (Fig. 1): Argentina: Catamarca: Tinogasta, 34.6 km west of Fiambalá (by road) 27°42′15.5″S, 67°52′58.0″W, 2,395 ± 8.6 m (3); 57 km west of Fiambalá (by road), 27°47′40.5″S, 68°03′42.9″W, 3,053 ± 8 m (3). Jujuy: Susques, 8.2 km south of Sey (by road), 24°00′48.8″S, 66°30′52.8″W, 4,167 ± 10 m (6). Salta: La Poma, 16 km south, 1.8 km west of Barrancas, along Río de las Burras, 23°24′58.2″S, 66°12′23.0″W, 3,521 ± 8.6 m (3). Bolivia: Cochabamba: 5.7 km southeast of Rodeo, Curubamba, 17°40′31″S, 65°36′04″W, 4,000 m (3).

Individuals of *T. venustus* were collected from 4 localities, including (Fig. 1): Argentina: Jujuy: Dr. Manuel Belgrano, 5 km north of San Salvador de Jujuy (by road), 24°07′35.2″S, 65°17′47.6″W, 1,414 ± 8.5 m (1); Las Capillas, 24°05′29.0″S, 65°10′33.0″W, 1,173 ± 8.6 m (1); Santa Bárbara, 24.8 km east of Santa Clara (by road), 24°17′47.4″S, 64°29′05.6″W, 1321 ± 6.1 m (2); 5 km east of El Palmar, 24°06′08.8″S, 64°33′14.9″W, 794 ± 11.1 m (1).

All marsupials were collected with the use of Sherman™ live traps baited with a mixture of oatmeal, vanilla, tuna, and sardines, or snap traps baited with peanut butter. Traps were placed in suitable habitat each evening and checked at first daylight the following morning. Details of each mammal collected were recorded in a field-collection catalog book and in the trapping data book, which are maintained in the Department of Mammalogy, Sam Noble Oklahoma Museum of Natural History (OMNH), University of Oklahoma (Norman, Oklahoma), or for the Bolivian material, data are maintained in both the Museum of Southwestern Biology, the University of New Mexico (Albuquerque, New Mexico) and the Harold W. Manter Laboratory of Parasitology (HWML), University of Nebraska State Museum (Lincoln, Nebraska). Additional details of trapping localities can be found in field notes of the expedition that refer to specimens of mammals maintained at the OMNH, and specimens of parasites from those mammals in the HWML. Mammal voucher specimens are deposited in the following institutions: Department of Mammalogy, OMNH; Colección de Mamíferos Lillo, Universidad Nacional de Tucumán, Tucumán, Argentina (CML); and the Colección de Mamíferos, Museo de Ciencias Naturales ''Bernardino Rivadavia,'' Buenos Aires, Argentina (MACN).

Some complete digestive tracts were fixed in the field at the time of collection, stored in 10% formalin, and examined in the laboratory with a dissecting microscope. In the field, each organ of the digestive system was examined separately with an Optivisor™ (Donegan Optical Company, Lenexa, Kansas). Nematodes found were killed in concentrated glacial acetic acid (GAA), 70% ethanol (EtOH), or 10% formalin. Tapeworms were placed in distilled water until they relaxed and were killed and fixed in either 70% EtOH or 10% formalin. Acanthocephalans were relaxed in cold water overnight. All worms were stored in the same medium in which they were killed, except for those killed in GAA and water, which were then transferred for storage and transport into 70%

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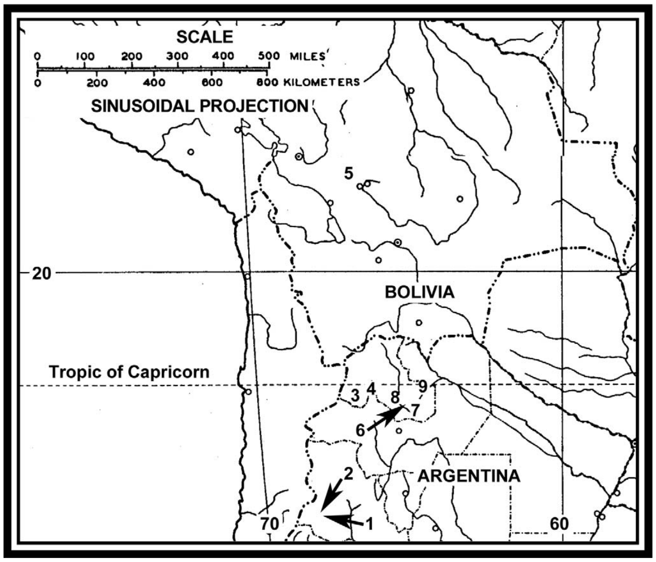


FIGURE 1. Collecting localities in Argentina and Bolivia. (**1**) 34.6 km west of Fiambalá (by road); (**2**) 57 km west of Fiambalá (by road); (**3**) 8.2 km south of Sey (by road); (**4**) 16 km south, 1.6 km west of Barrancas, along Río de las Burras; (**5**) 5.7 km southeast of Rodeo, Curubamba; (**6**) Las Capillas; (**7**) 24.8 km north of Santa Clara (by road); (**8**) 5 km north of San Salvador de Jujuy; (**9**) 5 km east of El Palmar.

aqueous v/v ethyl alcohol. Some specimens were preserved in vials filled with 95% aqueous v/v EtOH, or placed in cryotubes, frozen in liquid nitrogen, transported back to the laboratory in liquid nitrogen, and stored at −85 C in an ultralow freezer in the HWML. Abbreviations of museums from which specimens were borrowed or studied include the Colección Nacional de Helmintos (CNHE) of the Universidad Nacional Autónoma de México, México, the Harold W. Manter Laboratory of Parasitology (HWML), the Museo de Historia Natural, Departamento de Zoología de Invertebrados, Argentina (CHMLP), and the United States National Parasite Collection (USNPC). Specimens used for comparative purposes included *Didelphoxyuris thylamisis* Gardner and Hugot, 1995 (HWML39072, HWML39073, HWML63352–81), *Mathevotaenia argentinensis* Campbell, Gardner and Navone, 2003 (HWML17712), and *Mathevotaenia bivittata* (Janicki, 1904) (HWML17712).

Nematodes were cleared for study in lactophenol. Tapeworms were stained in Semichons' carmine and mounted on a microscope slide in Damar gum. Cross sections of the specimens were made with a stainless-steel razor blade. Drawings were made with a Wild microscope equipped with a drawing tube. Measurements were made with the use of a Zeiss Ultraphot™ microscope and digital measuring software (Jandel Sigma Scan Pro™, San Rafael, California; Albinger et al., 1995). Measurements are given in micrometers. For each character, the range is given first, followed by sample mean and coefficient of variation as a percentage (Sokal and Rohlf, 1995). If sample size for a character studied was different from number of specimens examined, this also is given.

RESULTS

Four species of parasites were found in the necropsied fat-tailed opossums. Here we present the description of a new species of tapeworm and the accounts for 4 species, 1 acanthocephalan and 3 nematodes. Among these *Pterygodermatites kozeki* (Chabaud and Bain, 1981) (Rictaluriidae) was found in the small intestine and duodenum of *Thylamys pallidior* (prevalence 83%, HWML63390–91 and CHMLP5730). The rest of the worms occurred in *Thylamys venustus*, including the nematodes *Didelphoxyuris thylamisis* Gardner and Hugot, 1995 (Oxyuridae) collected from the cecum (prevalence 100%, HWML63385 through HWML63388; CHMLP5729, and CNHE5985), and *Hoineffia simplicispicula* Navone, Suriano and Pujol, 1991 (Viannaiidae), found in the small intestine (prevalence 20%, HWML63395). Finally, *Oligacathorhynchus* sp. (Acanthocephala: Oligacanthorhynchidae) was collected from the small intestine (prevalence 20%, HWML70021).

DESCRIPTION

***Mathevotaenia sanmartini* n. sp.**
(Figs. 2–6)

General (based on 7 whole mounts): Cyclophyllidea: Anoplocephalidae. Moderately long tapeworms 91–212 mm (n = 3) in total length with more than 200 segments or proglottids. Maximum width at gravid segments 1,123–2,427, 1,664 (24%, n = 35). Scolex unarmed, cup-shaped or calyciform, conspicuously wider than neck 843–1,246, 1,002 (19%) in length 824–1,415, 1,011 (22%) wide (Fig. 2). Suckers oval with heavy muscular walls 302–399, 341 (5%, n = 28) long by 236–336, 298 (9%, n = 28) wide, each sucker inside a pocket that opens externally at most anterior part of structure through a slit (Fig. 2). Neck 950–1,848, 1,316 (27%) long and 374–805, 646 (24%) wide. Primordia of reproductive organs (anlagen) visible at 58th proglottid (56th, 58th, 60th). Testes clearly formed at proglottid 31–48, 39 (19%, n = 7), and gravid proglottids first visible at 144th segment (111th, 158th, 168th). Mature proglottids 245–760, 459 (26%, n = 51) long and 805–1,721, 1,277 (20%, n = 51) wide; length–width ratio of 1:1.9–1:7. Gravid proglottids 469–1,662, 946 (33%, n = 35) long by 1,123–2,427, 1,664 (24%, n = 35) wide, length–width ratio 1:1.3–1:1.7. Terminal gravid proglottids 1,144–3,272, 2,049 (30%, n = 24) by 970–2,394, 1,512 (32%, n = 24), length–width ratio 1:0.3–1:1.9. Genital pores alternate irregularly. Genital ducts crossing excretory canals dorsally (Fig. 3).

Female reproductive system: Ovary in medial portion of proglottid, bilobed with up to 13 lateral lobules, never reaching excretory canals. Ovary 376–708, 551 (15%, n = 32) long and 166–331, 238 (18%, n = 32) wide, starts on segments 42–64, 55 (16%, n = 7). Oviduct connects ovarian isthmus to Mehlis' gland. Vitelline gland in posterior half of proglottid; few lobes projecting posteriad, connecting posteriorly to semispherical Mehlis' gland. Mehlis' gland connected to fertilization duct, which opens into thin vaginal duct. Vaginal duct surrounded by glands (Figs. 3, 4). Oviduct arising from ovarian isthmus. No seminal receptacle present; vagina anterior to cirrus pouch. Eggs in egg capsules (Fig. 5), clustered in parenchyma and occupying most of proglottid. Oncospheres 15–34, 23 (16%, n = 158) wide, 15–38, 28 (16%, n = 158) long, usually wrinkled as possible artifact of fixation and manipulation post mortem. Egg capsules 27–57, 39 (16%, n = 158) by 15–38, 28 (16%, n = 158). Embryonic hooks 9–15, 12 (9%, n = 65).

Male reproductive system: Testes from 26 to 41 in number, 32 (12%, n = 40 proglottids), arranged in 2 lateral fields between both ovary and vitelline gland and between lateral excretory canals. Testes first seen forming at segment 39 (31st–48th, n = 7), 54–96, 77 (14%, n = 151) long and 44–96, 71 (20%, n = 151) wide. Vas deferens starting slightly posterior and ventral to vitelline gland; directed anteriad running ventrally to ovary over midline, turning porally, becoming highly convoluted after passing ovary. Cirrus pouch 116–239, 175 (21%, n = 37) long by 62–96, 77 (9%, n = 37%) wide. Cirrus spinose, convoluted when invaginated (Fig. 6).

Taxonomic summary

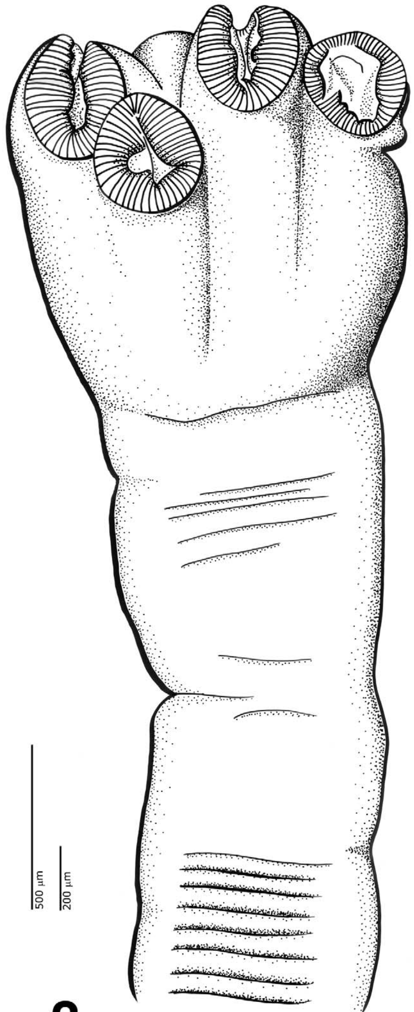
Symbiotype: Thylamys pallidior (Thomas, 1902) OMNH 34911.

Type locality: Argentina: Jujuy: Susques, 8.2 km south of Sey (by road), 24°00′48.8″S, 66°30′52.8″W, 4,167 ± 10 m (31 March and 1 April 2006). Prevalence 75%, n = 4 (Fig. 1).

Other localities: Bolivia: Cochabamba: Curubamba, 7.5 km southeast of Rodeo (by road), 17°40′31″S, 65°36′04″W, 4,000 m (24 and 26 July 1993). Prevalence 75%, n = 4.

Specimens deposited: Holotype CHLP5727, paratypes HWML70037–HWML70040, CHLP5728.

Habitat: Small intestine.



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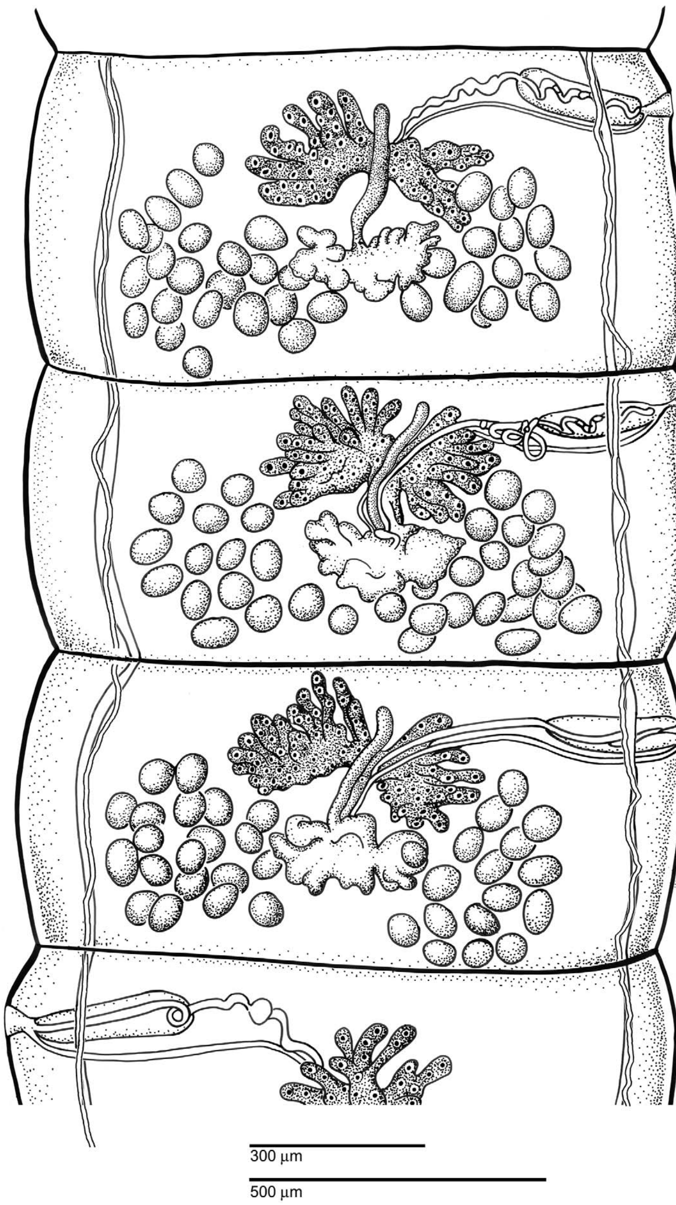

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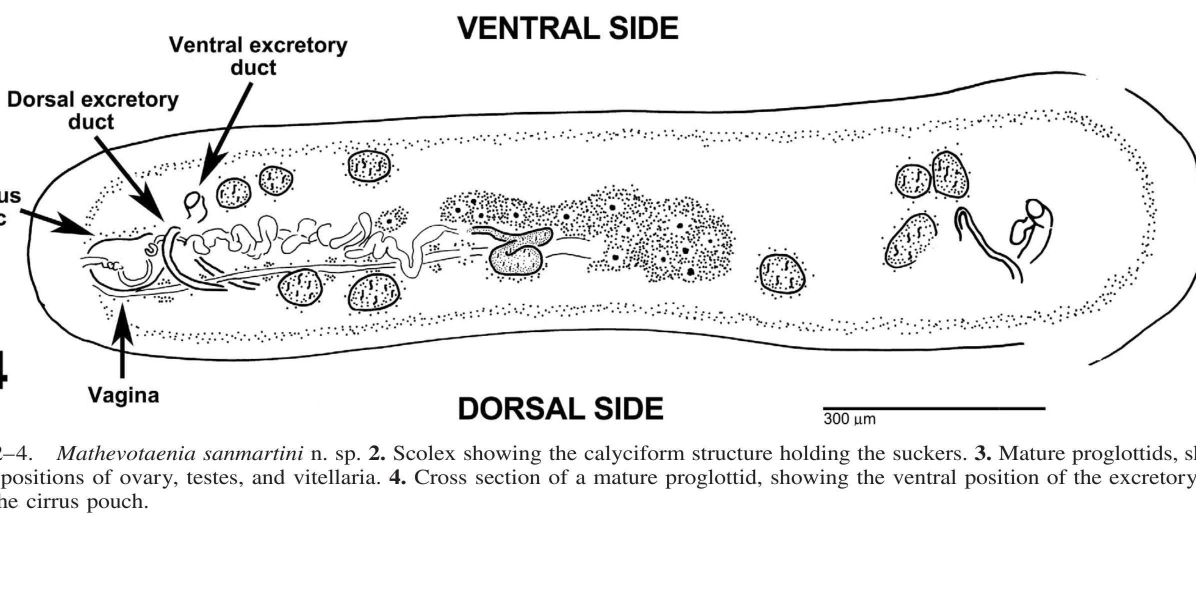

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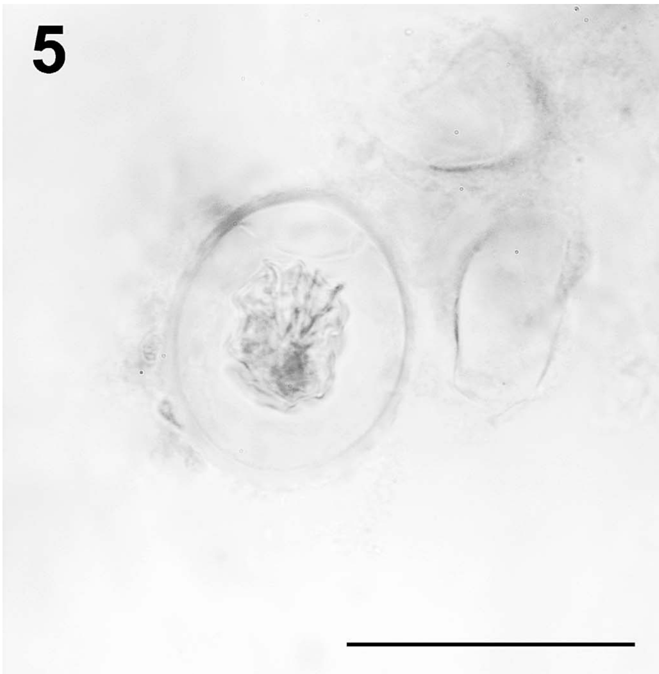
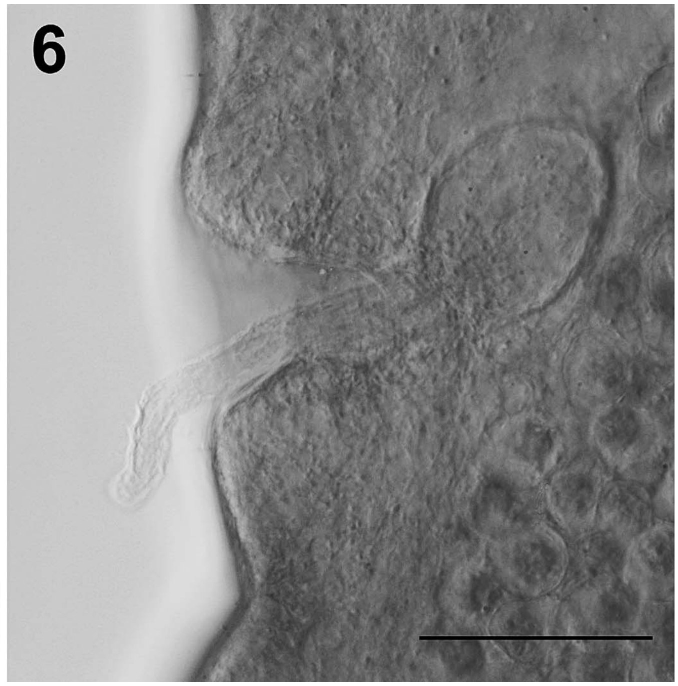
FIGURES 2–4. *Mathevotaenia sanmartini* n. sp. **2.** Scolex showing the calyciform structure holding the suckers. **3.** Mature proglottids, showing the relative positions of ovary, testes, and vitellaria. **4.** Cross section of a mature proglottid, showing the ventral position of the excretory canals relative to the cirrus pouch.





FIGURES 5 AND 6. Micrographs of *Mathevotaenia sanmartini* n. sp. **5.** Egg showing oncosphere and envelope. Scale bar = 50 μm. **6.** Poral side of a gravid proglottid, showing cirrus pouch and everted cirrus. Scale bar = 100 μm.

Etymology: The species is named after General José de San Martín, ''El Libertador''.

Remarks

Mathevotaenia sanmartini n. sp. is unique in having a calyciform scolex, an average of 32 testes per segment, and a relatively long cirrus pouch, which crosses the excretory canals. *Mathevotaenia sanmartini* can be recognized as distinct from both *M. bivittata* and *Mathevotaenia didelphidis* (Rudolphi, 1819) in having a much longer cirrus sac and an average of 32 testes per segment versus 13 and 20 per segment, respectively. *Mathevotaenia sanmartini* can be recognized as distinct from *M. argentinensis* in having a much longer cirrus sac and total length of the strobila. Interestingly, *M. sanmartini* has a cirrus sac that is relatively much longer than all other species of the genus in the Neotropics, thus allowing the cirrus sac to cross the excretory canals. In other species, including *M. argentinensis*, the cirrus sac is short and never crosses the excretory canals. In this respect, *M. sanmartini* is more similar to other anoplocephalids present in Australian marsupials.

At the present time, only 5 species of *Mathevotaenia* have been recorded from didelphid marsupials in South America. In Argentina, the cestodes *M. argentinensis* and *M. bivittata* were collected from both *Didelphis albiventris* Lund, 1840 and *Micoureus cinereus* Temminck, 1824, respectively (Campbell et al., 2003). Those specimens, as well as most other species of *Mathevotaenia* in the Neotropics, were collected from localities at relatively low altitudes.

DISCUSSION

Mathevotaenia sanmartini occurs in marsupials inhabiting only high-altitude habitats of the Altiplano and Puna, having been collected from 2 sites at over 4,000 m more than 700 km apart. Interestingly, the other species in the genus that occur in marsupials are known only from low-altitude habitats, with the most widespread (*M. bivittata*) ranging from Panamá to Argentina (Campbell et al., 2003). Whether this is a reflection of the effort of field biologists collecting mammals from these habitats or is an actual biological characteristic of this cestode/host association remains to be tested with additional sampling in these and other areas, particularly as the host species, *T. pallidior*, exhibits the broadest geographic and elevational range in the genus. The known collection records for *T. pallidior* show this species ranges from southern Peru to Chubut Province, Argentina, where it occupies many diverse habitats, including the Altiplano, Puna, Monte Desert, Southern Andean Steppe, and Patagonia Steppe from sea level to more than 4,000 m. This cestode–host–habitat association is similar on a biological sense to that reported by Gardner and Campbell (1992) for the restricted distribution in the Yungas of Bolivia for species of *Linstowia* Zschokke, 1988 in marsupial species of *Thylamys* and *Monodelphis*. Additionally, the possible synapomorphy of the relative length of the cirrus sac in *M. sanmartini* and the Australian fauna deserves more attention (for example, see linstowiid discussion by Gardner and Campbell, 1992).

The records for the nematodes *Pterygodermatites kozeki*, *D. thylamisis*, *Hoineffia simplicispicula*, and the unidentified species of *Oligacanthorhynchus* may represent range extensions. *Pterygodermatites kozeki* presents a distribution pattern similar to that of *M. sanmartini* in that it has been found in localities along the Puna, ranging from Colombia to Mendoza Province, central Argentina. Nevertheless, Ramallo and Claps (2007) recently reported finding this species at lower altitudes. The locality of the record from Argentina reported herein from Catamarca Province is geographically located between the 2 extremes for the distribution of this species. Finally, it appears that *Oligachanthorhynchus* sp., *H. simplicispicula*, and *D. thylamisis* may be associated more with tropical or subtropical localities, such as the Yungas, which extends from a southern limit in Argentina north through Bolivia and into Peru. *Didelphoxyuris thylamisis* was previously recorded from the Yungas of Bolivia, and there are several records of acanthocephalans infecting marsupials in the forests and savannahs of South America.

The parasite fauna of fat-tailed mouse opossums appears to be depauperate relative to that of opossums examined from localities in tropical habitats, thus far consisting of 7 species from which only *M. sanmartini* appears to be specific. Two species of helminths occur in *T. pallidior* (*M. sanmartini* and *P. kozeki*), and 3 infect *T. venustus* (*D. thylamisis*, *H. simplicispicula*, and *Oligacanthorhynchus* sp.). In our survey, we found no parasites being shared between these 2 species of fat-tailed opossums. Size, extent of range of host, and suitability of intermediate hosts in high-altitude habitats in South America may account for the poor diversity in helminths that we documented in these mammals; however, much more work is needed to verify these observations.

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