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A New Species of *Mathevotaenia* (Cestoda: Anoplocephalidae) from the Andean Tuco-Tuco, *Ctenomys opimus* (Rodentia: Ctenomyidae), on the Altiplano of Bolivia

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ABSTRACT: A new species of *Mathevotaenia* Akumyan, 1946 (Cestoda: Anoplocephalidae) is described from the Andean tuco-tuco, *Ctenomys opimus* Wagner 1848 (Rodentia: Ctenomyidae), collected in 1984 on the Altiplano of Bolivia. This is the second species of anoplocephalid cestode recorded from rodents of the genus *Ctenomys*, the first being *Monoecocestus torresi* Olsen 1976 from the Maule tuco-tuco, *Ctenomys maulinus* Philippi 1872, documented in southwestern Argentina. The new species of *Mathevotaenia* described here has more testes per segment than any other described species of the same genus from South America. The description of a new species from a decades-old specimen highlights the need for continuous examination of museum material as well as the need for collection of new specimens from rapidly disappearing biomes around the world.

KEY WORDS: *Mathevotaenia*, *Ctenomys*, Ctenomyidae, tuco-tuco, Bolivia, Cestoda, Rodentia, Anoplocephalidae.

Bolivia, along with much of the Andean part of the Neotropical region, remains a largely understudied area harboring a vast number of species that await discovery and formal description (Anderson, 1997). More than 5% of the mammals known from Bolivia are endemic to that country, and overall mammalian diversity is high, with more than 402 mammal species recorded (Drabik and Gardner, 2019). Unfortunately, the identification and description of species of helminths and other parasites from vertebrates in the country lag far behind the knowledge of the mammals themselves. The filarioid nematodes (Nemata: Filaroidea) of mammals collected from areas throughout Bolivia have been identified, described, and cataloged in the Harold W. Manter Laboratory (HWML) databases, but most other groups await focused work. For a summary of the status of knowledge of parasites from mammals of Bolivia, see Drabik and Gardner (2019).

As part of the effort to document parasite biodiversity of the region, from 1984 to 2000, specimens of *Ctenomys* and their parasites were collected from throughout the range of the Ctenomyidae in Bolivia. The individual tapeworm that was collected and described herein was obtained during the first survey expedition to the Altiplano led by Anderson and Yates to the area southwest of La Paz on 6 August 1984. An overall summary of the mammalian fauna and their parasites in Bolivia was given by Anderson (1997), and, more specifically, species of Ctenomyidae were described by Gardner et al. (2014), and the ancylostomatid nematode parasites of *Ctenomys* in the country were described by Drabik and Gardner (2019).

Anoplocephalid cestodes have a wide host range but have only been collected once before from tuco-tucos, which resulted in the description of *Monoecocestus torresi* Olsen 1976 from *Ctenomys maulinus* Philippi 1872 in southwestern Argentina (Haverkost and Gardner, 2009; 2010).

MATERIALS AND METHODS

Parasites were obtained from an individual of *Ctenomys opimus* Wagner, 1848, collected with a Victor Macabee™ gopher trap, which was placed in the burrow system of the rodents. The specimen was examined, and at necropsy, a single cestode was recovered from the anterior part of the duodenum of the small intestine. The cestode recovered was relaxed in freshwater before being killed and preserved in hot 10% formalin solution. The specimen was transported and stored in this solution until it was stained with Semichon's acetic carmine, dehydrated in an ethanol series, cleared with terpineol, transferred to xylene, and mounted on microscope slides in Canada balsam. Before mounting, the tegument and muscles were removed from the dorsal surface of several mature segments to facilitate observation. Measurements were made using a Zeiss Axiophot microscope with AxioVision 4.8.2 SP3 software. All figures were made using Adobe Photoshop CS5. All measurements were taken from the last three mature proglottids and are

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presented in micrometers unless otherwise noted. N is the number of structures measured or examined. The range is given followed by the mean and the standard deviation in parentheses.

RESULTS

Mathevotaenia ctenomyos n. sp. (Figs. 1–4)

Description

One full specimen was studied for the following description. The specimen is rather robust: total length 163 mm, consisting of 79 craspedote proglottids. Maximum width 4.6 mm at 57th proglottid, counted from the scolex. Scolex unarmed, no rostellum evident, maximum width 378 μm, maximum length 252 μm. Suckers slightly oval, $n = 4$, 137–181, 162.25 (17) long by $n = 4$, 153–171, 162.25 (7) wide. Neck length 565 μm; 283 μm wide at narrowest region. Specimen, protandrous. Anlagen of genital organs visible at about 1,010 μm from base of scolex. Testes first visible in proglottid 11. Testes numbering 180, counted in one segment anteriad from where tegument was removed for detailed study, $n = 10$, 67–97, 77 (10) long by $n = 10$, 49–83, 66 (11) wide. Last mature segment appearing at segment number 39. Mature segments measured, $n = 3$, 1566–1781, 1685 (89) long by $n = 3$, 2008–2367, 2214 (151) wide. Position of genital pores alternating irregularly. Dorsal osmoregulatory canal mean width 12 μm; ventral canal mean width 23 μm. Genital ducts pass between osmoregulatory canals. Vagina entering genital pore posterio-dorsad. Vaginal canal reaching ovary, then entering the ootype; slight dilation arising as an expansion of distal female reproductive canal just before the region of the ootype expanded area with maximum width 49 μm, maximum length 107 μm. Cirrus sac contains a highly convoluted cirrus without a well-defined internal seminal vesicle. In mature segments, cirrus sac extends laterad toward the center of proglottids. Genital atrium communicating with lateral edge of proglottid; edge of proglottid distinctly distended where genital atrium exits. Genital atrium maximum width 36 μm, maximum depth 45 μm. Vitelline gland posterior to ovary, slightly overlapping ovary dorsally. Vitelline gland with maximum length 47 μm, maximum width 201 μm. Vitelline duct arising from dorsal surface of vitelline gland, entering posterior border of Mehlis' gland, fusing with fertilization canal, passing dorso-anteriad to ovary, and changing to uterine canal directed anteriad dorsally to ovary, extending to anterior part of segment. Uterus first appearing as a diffuse tube extending laterally from region of uterine canal dextrad in proglottid. Ovary ($n = 1$) grossly lobate with many small lobes, 518 μm in maximum length, 429 μm in maximum width. Eggs slightly ovoid, $n = 5$, 104–111, 106.4 (2.6) in diameter. Embryo $n = 6$, 40–48, 41.5 (5.7) in diameter with six hooks each $n = 5$, 13–15, 14 (0.75) long.

Taxonomic summary

Symbiotype host (see Frey et al., 1992): Ctenomys opimus Wagner, 1848, Museum of Southwestern Biology (MSB) catalog number MSB-55375. Mammal field collection number NK11567; personal field-prep collection number, parasitology, Scott L. Gardner, SLG-110-84; personal field-prep number, MSB mammalogy, Joseph A. Cook, JAC-1265.

Type locality: 3.5 km northeast of Huancaroma, Bolivia (lat. 17°39″S; long. 67°28″W), 3,720 m altitude.

Date of collection: 6 August 1984.

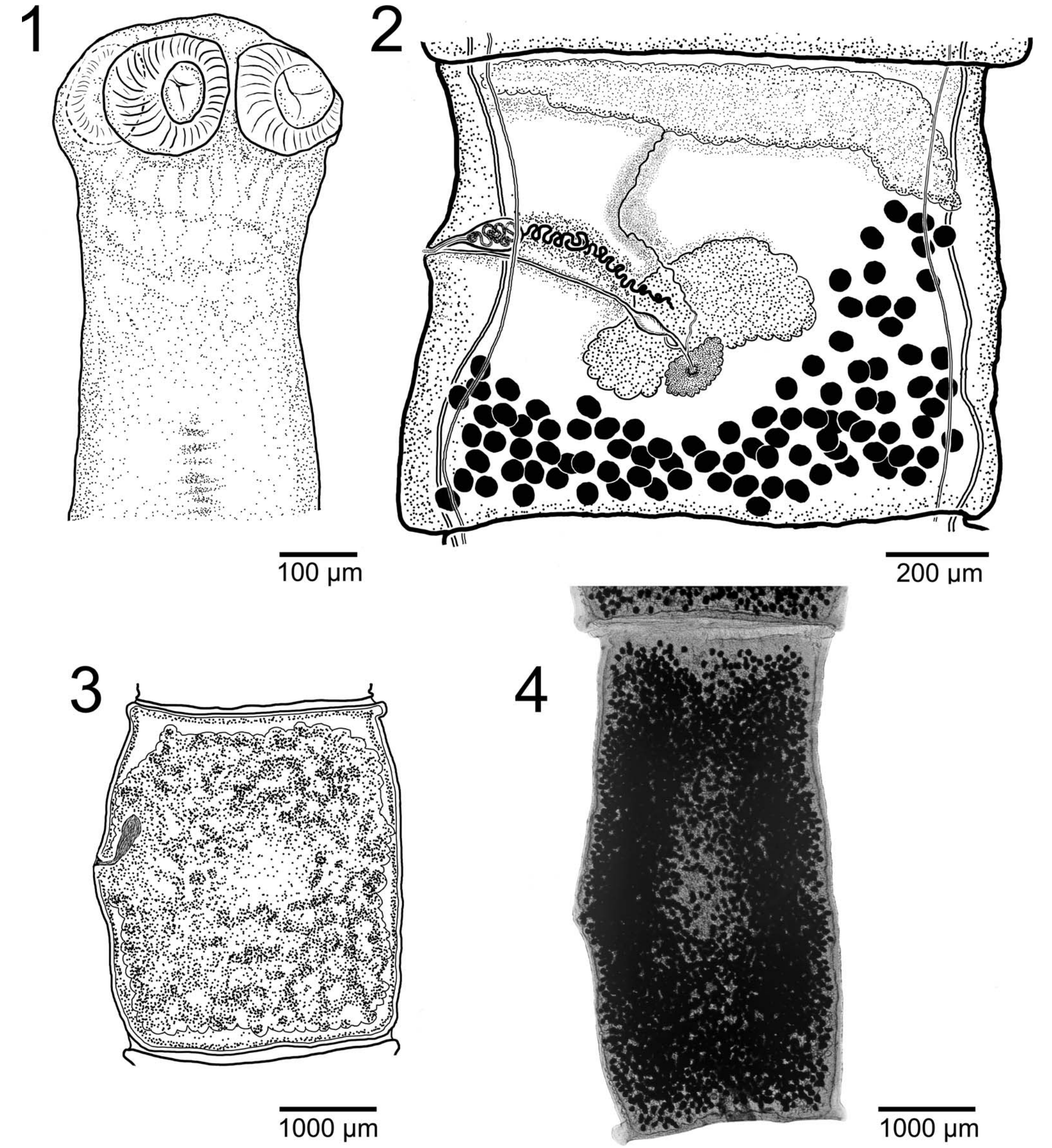
Prevalence and intensity: One individual rodent infected with 1 cestode.

Specimens deposited: 3 microscope slides labeled: HWML-216835A, HWML-216835B, HWML-216835C (holotype).

Etymology: The species name refers to the genus of the tuco-tuco (*Ctenomys*); -yos meaning "of *Ctenomys.*"

Differential diagnosis

Because rodents of the genus *Ctenomys* are found only in the Neotropics, with no evidence of extant Ctenomyidae anywhere but southern South America, we compared our new species of *Mathevotaenia* only to forms parasitic in mammals from the New World. *Mathevotaenia ctenomyos* n. sp. differs from *M. argentinensis* Campbell et al. (2003) by having a nonmuscular genital pore that is situated in the middle of the segment compared to the anteriorly located genital pore of *M. argentinensis*. The new species can be distinguished from *Mathevotaenia didelphidis* (Rudolphi, 1819) by having over 100 testes as compared to only 20 in *M. didelphidis*. From *Mathevotaenia pennsylvanica* (Chandler and Melvin, 1951) (later misspelled as *Mathevotaenia pennsylvania* [see Schmidt, 1986, p. 463]), *M. ctenomyos* differs by having many more testes per segment (180) versus 40–80 in *M. pennsylvanica*. Additionally, the gravid segments of *M. ctenomyos* are much longer than wide, rather than wider than long as in *M. pennsylvanica*. From those species of



Figures 1–4. *Mathevotaenia ctenomyos* n. sp. **1–3.** Line drawings. **1.** Scolex showing well-developed muscular suckers. **2.** Dorsal view, posterior half of mature segment showing distribution of testes, well-developed ovary, cirrus sac with coiled cirrus in posterior part, and the passage of the genital ducts between the osmoregulatory canals. **3.** Gravid segment showing arrangement of cirrus sac when filled with eggs. **4.** Photograph, last gravid segment.

Mathevotaenia from South America that have been described as possessing only 20–30 testes (*Mathevotaenia boliviana* Sawada and Harada, 1986, from bats in Santa Cruz department, Bolivia, and *Mathevotaenia paraguayae* Schmidt and Martin, 1978, from armadillos in Paraguay), *M. ctenomyos* n. sp. can be distinguished by having over 180 testes. *Mathevotaenia ctenomyos* n. sp. can be recognized as distinct from *Mathevotaenia bivittata* (Janicki, 1904), a parasite of marsupials of the New World, by having many more testes, a more pronounced and well-developed ovary, genital organs that occupy more of the mature proglottids, and osmoregulatory canals that are small and inconspicuous (Campbell et al., 2003).

DISCUSSION

Exploration of species allocated to the genus *Mathevotaenia* represents a rare opportunity for investigation of evolution, as these species are found in a wide taxonomic range of vertebrate hosts and a nearly cosmopolitan range of distribution. Most *Mathevotaenia* species infect rodents, marsupials, and carnivores in the Nearctic and Neotropical regions (Wallace, 1876), but there are undoubtedly many more species to be discovered in even more hosts (Beveridge, 2008). Further work determining the phylogeny and divergence times of species in this genus could help to illustrate biogeographical and evolutionary relationships of both hosts and parasites.

The subfamily Linstowiinae, to which *Mathevotaenia* belongs, has a long and torturous taxonomic history, and the current limits of the genera are poorly defined (Campbell et al., 2003; Beveridge, 2008). Many species in this group have outdated descriptions that lack illustrations or sufficient detail to properly assign placement in the correct genus, and the only solution to this problem will be a whole-sale reexamination of type specimens and additional collecting in the type localities, if they still exist; additional collections of specimens from this subfamily using modern methods of DNA studies combined with phylogenetic analysis will help to illustrate relationships among species and higher-level groups.

The fact that this cestode has only been collected a single time despite a concerted effort to obtain additional material from *C. opimus* over a 25 yr period shows the importance of expeditionary research to areas that are undercollected and little known. As development and obliteration of nature for agriculture, mining, and human settlements continue rapidly in many Neotropical areas, many species are being extirpated before they can ever be described, a problem that is exacerbated by irregular and infrequent field collecting. This problem is especially significant relative to parasites, which are rarely removed and preserved when their host species are collected by mammalogists or ecologists (Gardner and Jiménez-Ruiz, 2009; Galbreath et al., 2019).

Collections of parasites from *Ctenomys* in western Bolivia have only been made during the austral winter, and it is possible that cestodes such as *M. ctenomyos* cycle through the tuco-tuco populations during the austral spring and summer. Thus, collecting done only through a single season may bias the results of collecting in general and provide underestimates of actual biological diversity in any areas under investigation. One of the proposed methods to alleviate the problems of insufficient collecting over time would be the implementation of the document–assess–monitor–act (DAMA) protocol (Brooks et al., 2014; Hoberg et al., 2022). We encourage funding agencies and biologists interested in long-term studies to consider DAMA in their plans.

The fact that this specimen languished in a museum collection for decades before being described is far from unique, and this work highlights the importance of well-curated and actively researched museum collections. Specimens without proper collection information are of little value to science, and specimens that are never examined or cataloged cannot contribute to the efforts of researchers. While the continuous addition of modern specimens to museum collections is important, older specimens continue to remain vital to a proper understanding of the natural world and contain a wealth of unexplored information.

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