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A NEW SPECIES OF *MOLINEMA* (NEMATODA: ONCHOCERCIDAE) IN BOLIVIAN RODENTS AND EMENDED DESCRIPTION OF *LITOMOSOIDES ESSLINGERI* BAIN, PETIT, AND DIAGNE, 1989

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ABSTRACT: We report the distribution of 2 species of filarioid nematodes occurring in different hosts in the central region of South America. *Molinema boliviensis* n. sp. was recorded as a parasite of sigmodontine and echymyid rodents in Bolivia, and *Litomosoides esslingeri* was recorded in sigmodontine and ctenomyid rodents from Bolivia and Argentina. *Molinema boliviensis* n. sp. shares several similarities with other species reported in spiny rats; however, it can be easily differentiated by the presence of a flat anterior end, gradually tapering lappets and a tubercle present in posterior end, a short, uniform buccal capsule, an oval-shaped vagina vera, and a ratio of spicules of 1:1.44. An account for the morphological variability of *L. esslingeri* is presented that allows the identification of the buccal capsule, the tail tip in females, and the shape of spicules as reliable diagnostic traits. A complete set of head papillae is also described. The finding of these parasites in phylogenetically unrelated hosts suggests that host capture may be a frequent phenomenon in these filarioids. Researchers should focus efforts in surveying mammals within the same ecological guild to understand the distribution and host specificity of these nematodes.

From 1984–2000, the American Museum of Natural History (AMNH), the Museum of Southwestern Biology (MSB), the Bolivian National Museum of Natural History in La Paz, and the Harold W. Manter Laboratory of Parasitology (HWML) mounted joint collecting expeditions throughout Bolivia to survey and inventory sylvatic mammals and their parasites.

Within the geopolitical boundaries of Bolivia, more than 327 species of mammals have been documented, with about 5% being endemic (Anderson, 1997). At the present time, around 140 species of rodents are known to occur in Bolivia, some of them only recently described (Salazar et al., 1994; Anderson, 1997; Anderson and Yates, 2000; Gardner et al., 2012). While the mammal fauna of the country is fairly well known, the data on the parasites are still lagging due to the paucity of workers in this area.

Members of *Molinema* Freitas and Lent, 1939 and *Litomosoides* Chandler, 1931 (Nemata: Onchocercinae) are known exclusively from the New World (Guerrero and Bain, 2001). Representatives of both genera have been reported from echimyid, ctenomyid (Hystricomorpha), and murid (Myomorpha) rodents in South America and from castorids in North America. At the present time, 12 species of *Molinema* are known and most of these parasites use mosquitoes as vectors (Bain, 1974); adults may be found in the body cavity of hystricognath rodents (11 species) and beavers (1 species) (Freitas and Lent, 1939; Anderson, 1953; Esslinger, 1974; Guerrero and Bain, 2001). To our knowledge, there is no record for any species of *Molinema* in Bolivia.

There are 41 species included in *Litomosoides*, all recorded from the thoracic and abdominal cavities of sigmodontine and ctenomyid rodents, bats, and marsupials (Caballero, 1947; Esslinger, 1973; Bain et al., 1989; Brant and Gardner, 1997; Notarnicola et al., 2000). Species of *Litomosoides* use mites as intermediate hosts (Bain et al., 1980). In Bolivia, they have been recorded in tuco-tucos (Hystricognathi: Ctenomyidae) and in phyllostomid and vepertilionid bats (Brant and Gardner, 1997; 2000; Notarnicola et al., 2010).

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As part of our investigations on Bolivian parasite biodiversity, we herein describe a new species of *Molinema* parasitizing sigmodontine and echymyid rodents (*Holochilus* and *Proechimys*, respectively) and record for the first time *Litomosoides esslingeri* Bain, Petit and Diagne, 1989 for Bolivia and Argentina. We also provide some additional data on the morphological variability of *L. esslingeri* based on observations of the type specimens and material from the present study.

MATERIALS AND METHODS

Rodents collected in the field were processed following the guidelines for the use of wild mammals in research of the American Society of Mammalogists (Sikes and Gannon, 2011). Nematodes were collected and preserved following Gardner (1996) and Gardner and Jiménez (2009). Filarioids were placed directly into either 70% ethanol, 95% ethanol, or 10% formalin; some were killed and straightened in glacial acetic acid and stored in 70% ethanol. All filarioids were transported in those solutions to the Harold W. Manter Laboratory (HWML), Lincoln, Nebraska, and stored until further examination. For study of morphological characters, specimens were cleared in lactophenol and examined using a Zeiss Ultraphot or Zeiss Axiophot digital microscope (Zeiss, Oberkochen, Germany). To examine the oral papillae, the apical portion was excised from a specimen and used to prepare an en face view. The lateral cuticular internal ridge was used to identify lateral fields and the Y-shaped section of the lumen of the esophagus was used to identify the dorsal side. The uterus of 1 female was dissected to extract microfilariae. Illustrations were made with the aid of a drawing tube. Measurements are presented as follows: holotype male; paratypes males, allotype female, and paratypes females. If more than 3 specimens were examined, mean values and standard deviations are presented with ranges in parentheses; measurements from 2 specimens are separated by semicolons. Measurements are given in micrometers unless otherwise stated. Prevalence and mean intensity of infection are also provided for each species.

Specimens were deposited in the HWML (Division of Parasitology, University of Nebraska State Museum). We choose the sigmodontine rodent *Holochilus sciureus* Wagner, 1842 as the type host for the description of the new species of *Molinema* because the material included 2 males and 1 female that were well preserved. One specimen of *Proechimys* contained a female and a male, but they were not well preserved; the remaining hosts contained either females or males. Specimens of *L. esslingeri* (originally identified as *Litomosoides carinii*) from *Melanomys caliginosus* (Tomes, 1860) from Yumbo, Valle del Cauca, Colombia, were requested from the United States National Museum, Parasite Collection (Beltsville, Maryland). Material examined included 3 males, 3 females (USNM 72391), and a slide with microfilaria from blood (USNM 72392). Other acronyms used throughout the text include: AMNH: American Museum of Natural History, New York, New York; CML: Colección Miguel Lillo, San Miguel de Tucumán, Argentina;

MACN: Museo Argentino de Ciencias Naturales "Bernardino Rivadavia," Buenos Aires, Argentina; MSB: Museum of Southwestern Biology, Albuquerque, New Mexico; NK: Cryovoucher number, field number of the host and parasites species; OMNH: Oklahoma Museum of Natural History, Norman, Oklahoma; ND: no data.

RESULTS

Mammals examined in Bolivia were infected by several species of filarioid nematodes, the results of which are reported elsewhere (Brant and Gardner, 1997, 2000; Notarnicola et al., 2007, 2010). Herein, we report on a new species of *Molinema* for Bolivia and emend the description of *L. esslingeri*, a species known only from Colombia, based on material collected from Bolivia and the northwest of Argentina and on the type specimens from Colombia. For details of the localities see the Appendix.

DESCRIPTION

Molinema boliviensis n. sp.

(Figs. 1–20; Table I)

General description (based on 4 males, 8 females): Males 1.4 to 1.6 times smaller. Anterior end flat. Rectangular cephalic shield expanded laterally, constricted in sagittal plane, wide and with rounded edges laterally (Figs. 2–5, 15–17). Oral opening minute and round. Buccal capsule wider than long, rhomboid-shaped (Figs. 4, 5). Esophagus divided, muscular and glandular parts of similar diameter; muscular esophagus observed in a single female. Deirids slightly asymmetrical, without salient point (Figs. 1, 13). Tail with 2 conical lappets terminating in narrow digitiform protuberances (Figs. 10, 20). Phasmids at base of lappets.

Male: Posterior region coiled. Area rugosa extends from coiled region to tail; with conspicuous transverse ridges (Figs. 9, 10). Spicules unequal in size and shape. Right spicule with strongly cuticularized proximal part and membranous wide distal end; rolled up and distal end with single columnelle (Fig. 11). Left spicule with well-cuticularized proximal handle; lamina membranous, supported by cuticular axis (Fig. 12). Four pairs of precloacal papillae; postcloacal pair 5 smaller and lateral relative to pair 6; 1 asymmetrical ventro-lateral papillae on posterior third of tail plus 1 symmetric terminal pair (Figs. 6–8). Lappets digitiform. Testis at level of esophago-intestinal junction.

Holotype: Length 41.4 mm; maximum width 193 at mid-body; width at nerve ring 130, at esophago-intestinal junction 171. Distance between cephalic papillae in median view 68, in lateral view 23; cephalic ratio 2.95; distance between labial papillae in median view 38 and 19 in lateral view. Buccal capsule 7 high and 10 wide. Esophagus 1,355 long; muscular portion 378. Nerve ring and deirids 200 and 342, respectively, from anterior extremity. Tail 260 long; width at cloaca 62; tail length-width ratio 4.19; lappets 11 long. Left spicule 230 long; handle 120 long, lamina 110 long. Right spicule 167; spicule ratio 1:1.37. Area rugosa 4,200 long; crests 2 in height, spaced 5–6.

Male paratypes (n = 3): Length 42.94 ± 9.4 (35.6–53) mm; maximum width 183.3 ± 20.8 (160–200) at mid-body; width at nerve ring 100, at esophago-intestinal junction 170. Buccal capsule 6 ± 1.4 (5–7) high and 12.5 ± 3.5 (10–15) wide. Esophagus 1,343.3 ± 102.1 (1,270–1,460) long; muscular portion 379.3 ± 80 (300–460). Nerve ring 231.6 ± 18.9 (210–245) from anterior extremity. Deirids in 1 male 380. Tail 257.3 ± 66.3 (200–330) long. Lappets 12 ± 1 (11–13) long. Left spicule 225 ± 35.3 (200–250) long; handle 125 ± 18 (110–145) long. Right spicule 155 ± 21.2 (140–170); spicule ratio 1:1.44 ± 0.02 (1.42–1.47). Area rugosa 3,736 ± 412 (3,410–4,200) long.

Female: Vulva at level of esophagus, slightly posterior to muscular-glandular division. Vagina with muscular walls, oval-shaped (Figs. 13, 14). Ovejector long and muscular. Tail rounded, finishing in a terminal tubercle and 2 digitiform lappets (Figs. 19, 20).

Allotype: Length 59.3 mm. Maximum width 400; width at nerve-ring 200; at vulva 250. Distance between cephalic papillae in median view 90, in lateral view 52; cephalic ratio 1.79; distance between labial papillae in median view 52 and 25 in lateral view. Buccal capsule 6 high and 10 wide. Nerve ring and deirids 260 and 420, respectively, from anterior end. Esophagus 1,260 long; muscular portion 430 long. Vulva 560 from anterior end. Vagina 200 long; ovejector 2,500 long. Tail 275 long; width at anus 130; tail ratio 2.11. Lappets 12 long.

Female paratypes (n = 6): Length 73.36 ± 12.2 (59.3–90.36) mm. Maximum width 344.6 ± 52.8 (260–400); width at nerve-ring 176 ± 5.7 (170–180), at vulva 195 ± 7 (190–200). Buccal capsule 9 ± 2.1 (6–11) high and 14.25 ± 4 (11–20) wide. Nerve ring and deirids 270 ± 56.8 (200–340) and 375 ± 91.9 (310–440), respectively, from anterior end. Esophagus 1,735 ± 299.2 (1,350–2,200) long; muscular portion 425 ± 150 (250–500) long. Vulva 615.7 ± 63.7 (490–700) from anterior end. Tail 262.1 ± 18.6 (225–280) long; width at anus 134.2 ± 13.9 (120–160); tail ratio 1.97 ± 0.2 (1.6–2.3). Lappets 11.8 ± 0.4 (11–12) long.

Microfilariae: Body fusiform, with salient cephalic hook. Tail attenuated, without nuclei at tip of tail (Fig. 18). Based on uterine microfilariae (n = 4): body length 236.5 ± 25.4 (210–270), width 4.

Taxonomic summary

Type host: Holochilus sciureus Wagner, 1842 (Cricetidae, Sigmodontinae), collected 12 August 1985 by T. I. Mercado, Deposited at MSB55987 (NK13055).

Type locality: Bolivia, Santa Cruz, 15°43′S, 63°09′W; 6 km W (by road), Ascensión, 240 m. See appendix for other localities.

Other hosts: Proechimys brevicauda and *Proechimys* sp. (Echimyidae). See appendix for details on deposited numbers.

Site of infection: Abdominal cavity; nematodes found among the intestines at necropsy.

Specimens deposited: Holotype (male) HWML 67122, allotype (female) HWML 67123, and 1 male paratype HWML 63461 at the Harold Manter Laboratory of Parasitology; other paratypes (6 females and 3 males) HWML60291; 61804; 63457; 63459; 63460; 63463.

Prevalence and intensity: From *H. sciureus* 1/7 (14.3%), 3 parasites; from *Proechimys* spp.: 7/57 (12.3%), mean intensity 1.5 (1–2).

Etymology: The specific name is derived from the name of the country Bolivia, meaning "of Bolivia."

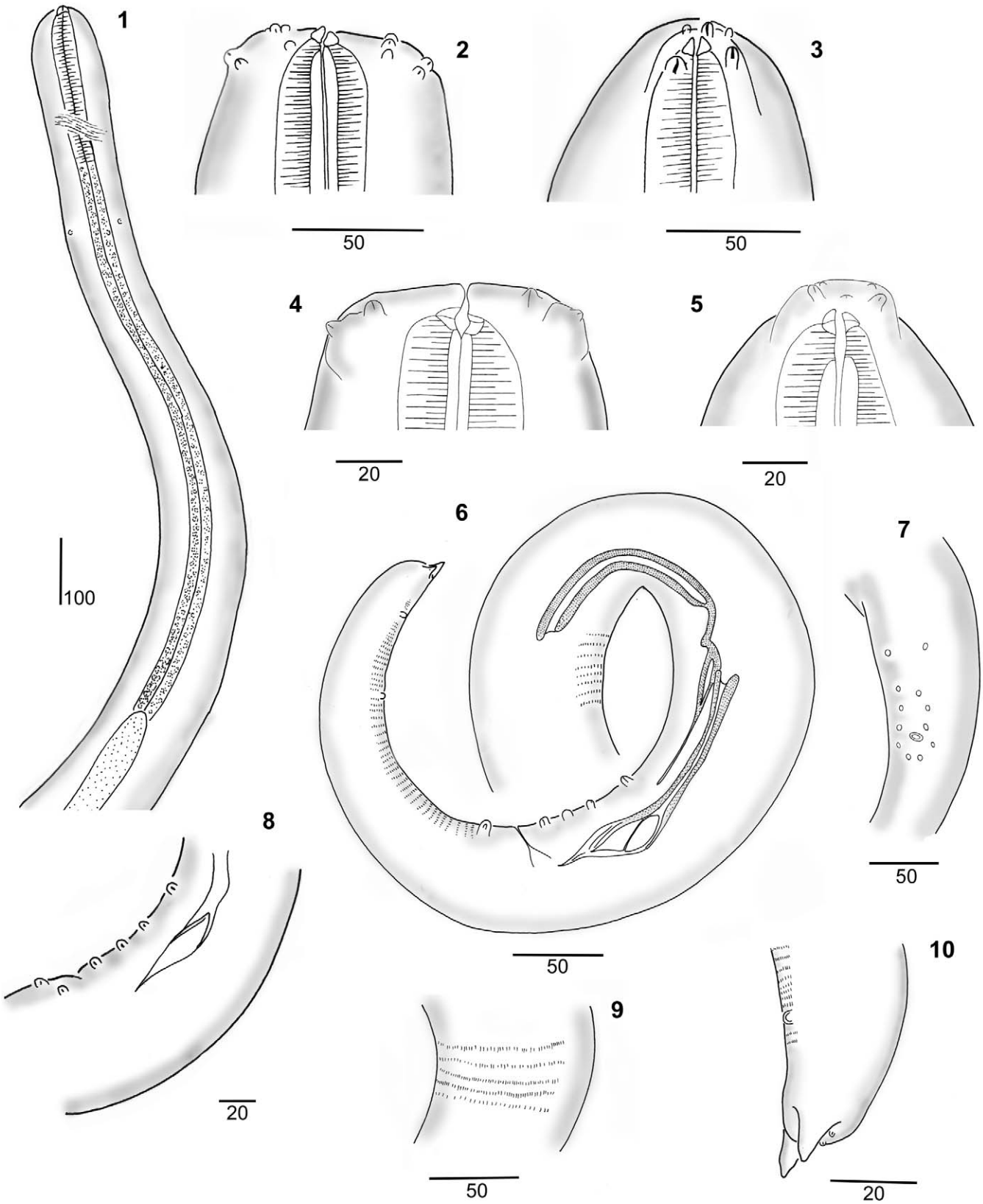
Remarks

From the 12 species of *Molinema* currently known, 8 have been recorded from species of Echimyidae, 2 in Erethizontidae, 1 in Castoridae, and 1 in Myocastoridae. The species we herein describe presents a unique combination of characters that includes the presence of a flat anterior end, gradually tapering lappets and a tubercle present in posterior end, a short uniform buccal capsule, an oval-shaped vagina vera, and a ratio of spicules of 1:1.44.

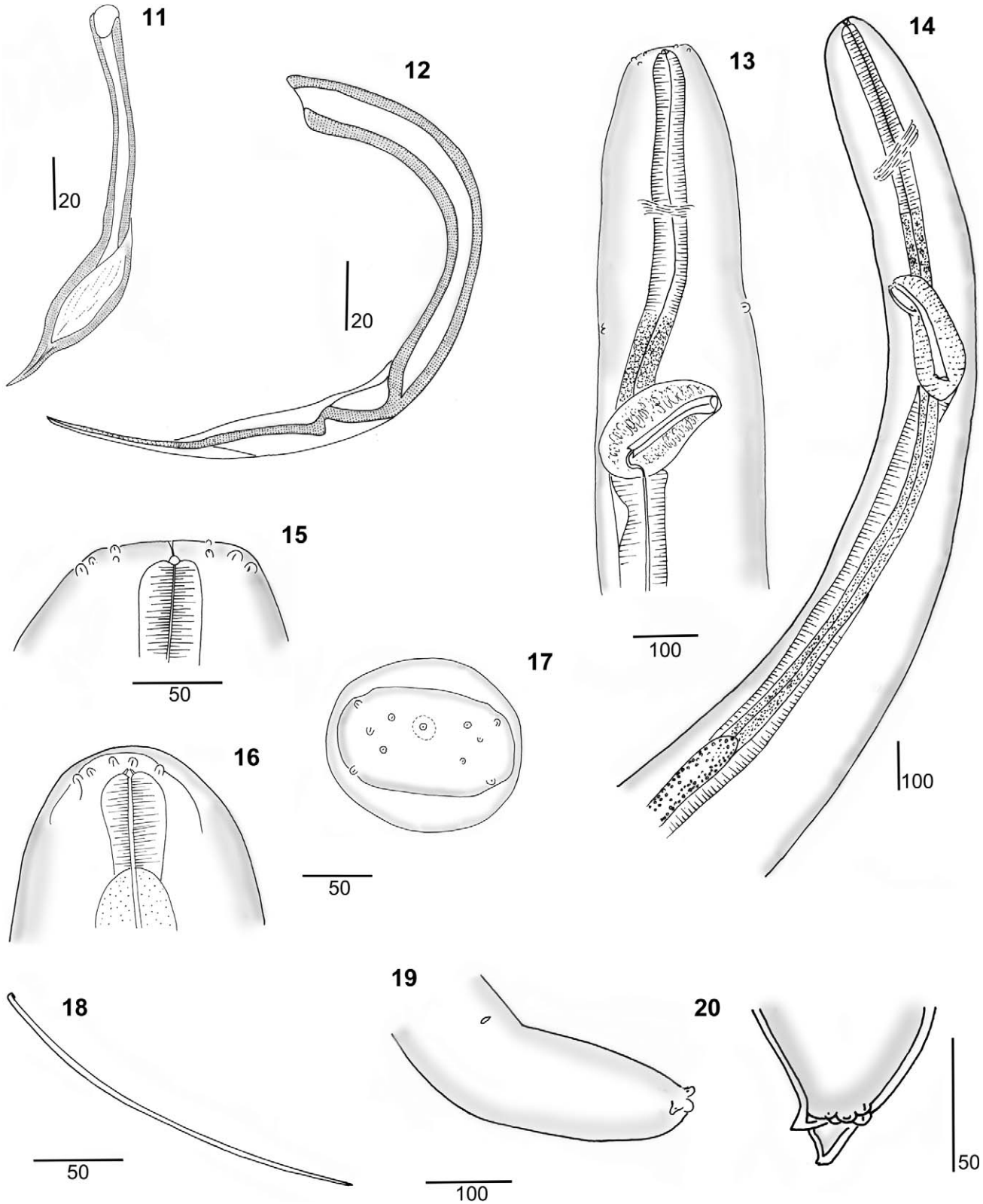
Molinema boliviensis n. sp. has a flat anterior end, which differs from the concave anterior end in *Molinema diacantha* (Molin, 1858), *Molinema bifida* (Molin, 1858), *Molinema travassosi* (Artigas and Pacheco, 1933), *Molinema proechimyis* (Esslinger, 1974), and *Molinema barbarae* Guerrero and Bain, 2001. Moreover, the new species possesses a shorter esophagus compared with *M. diacantha* (mean of 1,735 in females and 1,343 in males vs. 4,895 and 4,200–4,700, respectively) and has a terminal tubercle in the tail, absent in *M. bifida*. The vulva in *M. boliviensis* n. sp. is closer to the anterior end compared with *M. travassosi*, and males have a shorter tail (mean of 257.3 vs. 330–400, respectively) (Artigas and Pacheco, 1933; Freitas, 1964; Esslinger, 1974; Guerrero and Bain, 2001). In addition, the new species differs from *M. proechimyis* in having males with a smaller spicule ratio (1.4 vs. 1.8), shorter tails, and larger microfilariae (mean of 236.5 vs. 192) (Esslinger, 1974). The females of *M. bifida*, *M. travassosi*, *M. proechimyis*, and *M. barbarae* are larger when compared with those of the new species (body length of more than 104 mm vs. a mean of 73.36 mm in our specimens). Moreover, there are another 3 differences between *M. boliviensis* n. sp. and *M. barbarae*: first, the left spicule of the new species is shorter than that in *M. barbarae*; second, microfilariae are longer (236.5 vs. 172, respectively), and third, males lack 1 precloacal papilla (Guerrero and Bain, 2001).

Molinema boliviensis n. sp. also is different from *Molinema arbuta* (Highby, 1943), a parasite of *Erethizon dorsatum*, in having a longer and different shape of the spicules; the tip of the tail of females possesses a tubercle and lappets, absent in *M. arbuta*, and the vagina is oval-shaped with a markedly muscular duct whereas this structure is elongated and muscular in *M. arbuta* (Highby, 1943).

The new species differs from *Molinema sprenti* (Anderson, 1953), a parasite of *Castor canadensis* Kuhl, in having a shorter esophagus, a vulva opening near the anterior end, tail with a smaller ratio in both sexes (2.11 in



FIGURES 1–10. *Molinema boliviensis* n. sp. Male. (**1**) Anterior region. (**2–3**) Anterior end, median and lateral views. (**4–5**) Detail of buccal capsule, median and lateral views. (**6**) Posterior region, lateral view. (**7–8**) Cloacal region, ventral and lateral views. (**9**) Area rugosa at mid-length. (**10**) Tail tip, lateral view.



FIGURES 11–20. *Molinema boliviensis* n. sp. male (**11–12**) and female (**13–20**). (11) Right spicule, lateral view. (12) Left spicule, lateral view. (**13**) Anterior region showing the vulva, ventral view. (14) Anterior region showing the esophago-intestinal junction. (15–17) Anterior end, median, lateral, and apical views. (18) Uterine microfilaria. (19) Tail, lateral view. (20) Tip tail.

TABLE I. List of species and number of rodents trapped from 4 Departments in Bolivia. Symbols indicate the positive hosts for filarioid species as follow: **Molinema boliviensis* n. sp. and †*Litomosoides esslingeri*.

		Departments and localities								
		Santa Cruz	La Paz	Beni				Oruro		
Host taxon	Host species	Ascensión	Rio Beni	Totaizal	Yucumo	Rio Tijamuchi	San Pablo	Huancaroma	3.5 km NE Toledo	Rio Barros
Echimyidae	*Proechimys brevicauda*	12*	6	8*	10*	—	—	—	—	—
	Proechimys sp.	—	3*	2*	6*	—	10	—	—	—
Ctenomidae	*Ctenomys opimus*	—	—	—	—	—	—	—	—	8†
Cricetidae	*Akodon* sp.	6	5	—	—	—	1	—	—	—
	Akodon albiventer	—	—	—	—	—	—	18	9	—
	Akodon boliviensis	—	—	—	—	—	—	6	3	—
	Akodon dayi	3	—	—	—	—	—	—	—	—
	Calomys callosus	1	—	—	—	—	—	—	—	—
	Calomys lepidus	—	—	—	—	—	—	33	1†	1
	Eligmodontia puerulus	—	—	—	—	—	—	2†	7†	5
	Galenomys garleppi	—	—	—	—	—	—	1	—	—
	Holochilus sciureus	3*	—	1	—	3†	—	—	—	—
	Neacomys spinosus	—	3	—	1	—	—	—	—	—
	Necromys lasiurus	9	—	—	—	—	12	—	—	—
	Necromys lenguarum	1	—	—	—	—	—	—	—	—
	Nectomys squamipes	—	—	—	3	—	—	—	—	—
	Oecomys bicolor	—	—	—	1	—	—	—	—	—
	Oecomys mamorae	—	—	—	3	1†	1	—	—	—
	Oligoryzomys microtis	19	27	29	30	23†	—	3	—	—
	Oligoryzomys subflavus	1	—	—	2	—	—	—	—	—
	Oligoryzomys sp.	—	9	—	—	—	18†	—	—	—
	Oryzomys nitidus	3	9	11	26	—	4	—	—	—
	Oxymycterus inca	1	—	—	—	—		—	—	—
	Phyllotis xantopygus	—	—	—	—	—	—	6	—	—
	Pseudoryzomys simplex	—	—	2	—	—		—	—	—

females and 4.19 in males vs. 4.36 and 5.88 respectively), and shorter microfilariae (Anderson, 1953). From *Molinema nattereri* Guerrero and Bain, 2001 it differs in having a more-posterior vulva opening, a smaller tail ratio, a left spicule with a longer handle (mean of 125 vs. 90), and a smaller spicule ratio (1.44 vs. 2.32). Finally, it differs from *Molinema raposoensis* (Esslinger, 1974) in the arrangement of the precloacal papillae with 4 pairs instead of 3, in the shape of the vagina, and in the length of the female tail (mean of 262.1 vs. 207) (Esslinger, 1974; Guerrero and Bain, 2001).

The species sharing the most similarities with *M. boliviensis* n. sp. include *Molinema peruviensis* Guerrero and Bain, 2001, *Molinema dessetae* (Bain, 1973), and *Molinema algardneri* Guerrero and Bain, 2001. These 4 species are all similar in that they have a flat head, similar body sizes, and similar shape of the vulva. However, *M. boliviensis* can be differentiated from *M. peruviensis* in the shape and length of the lappets and the buccal capsule. The new species shows a muscular and glandular esophagus, which is different from the one seen in *M. dessetae*; in addition, the tail of females is longer (mean of 262.1 vs. 390). Finally, the new species is different from *M. algardneri* in 4 main traits that include the length of the left spicule, the spicule ratio (mean of 1.4 vs. 1.7), a different pattern of the area rugosa, and the length of the microfilariae (210–270 vs. 165–185) (Bain, 1973; Guerrero and Bain, 2001).

REDESCRIPTION

Litomosoides esslingeri Bain, Petit and Diagne, 1989

(Figs. 21–32; Tables I, II)

Diagnosis: Filarioids were identified as *L. esslingeri* by the tubular buccal capsule with irregular thickenings, a smooth buccal cavity, a female tail with a constricted tip, the shape and length of the spicules, between 4–6 pairs of cloacal papillae (Figs. 27, 28), and conspicuous area rugosa (Fig. 32), and by a microfilaria with a large sheath (see Esslinger, 1973; Bain et al., 1989). Measurements of relevant traits for specimens collected in Bolivia and Argentina are included in Table II. In apical view, specimens possess 4 labial papillae and 4 cephalic papillae (Fig. 26).

Taxonomic summary

Type hosts: Oligoryzomys microtis Allen, 1916; *Oligoryzomys* sp. Bangs, 1900, *Eligmodontia puerulus* (Philippi, 1896); *Calomys lepidus* (Thomas, 1884); *Holochilus sciureus* Wagner, 1842; *Oecomys mamorae* (Thomas, 1906); and *Ctenomys opimus* Wagner, 1848 from Bolivia; *Eligmodontia puerulus* from Argentina.

Localities: See Appendix for details on the localities from Bolivia and Argentina.

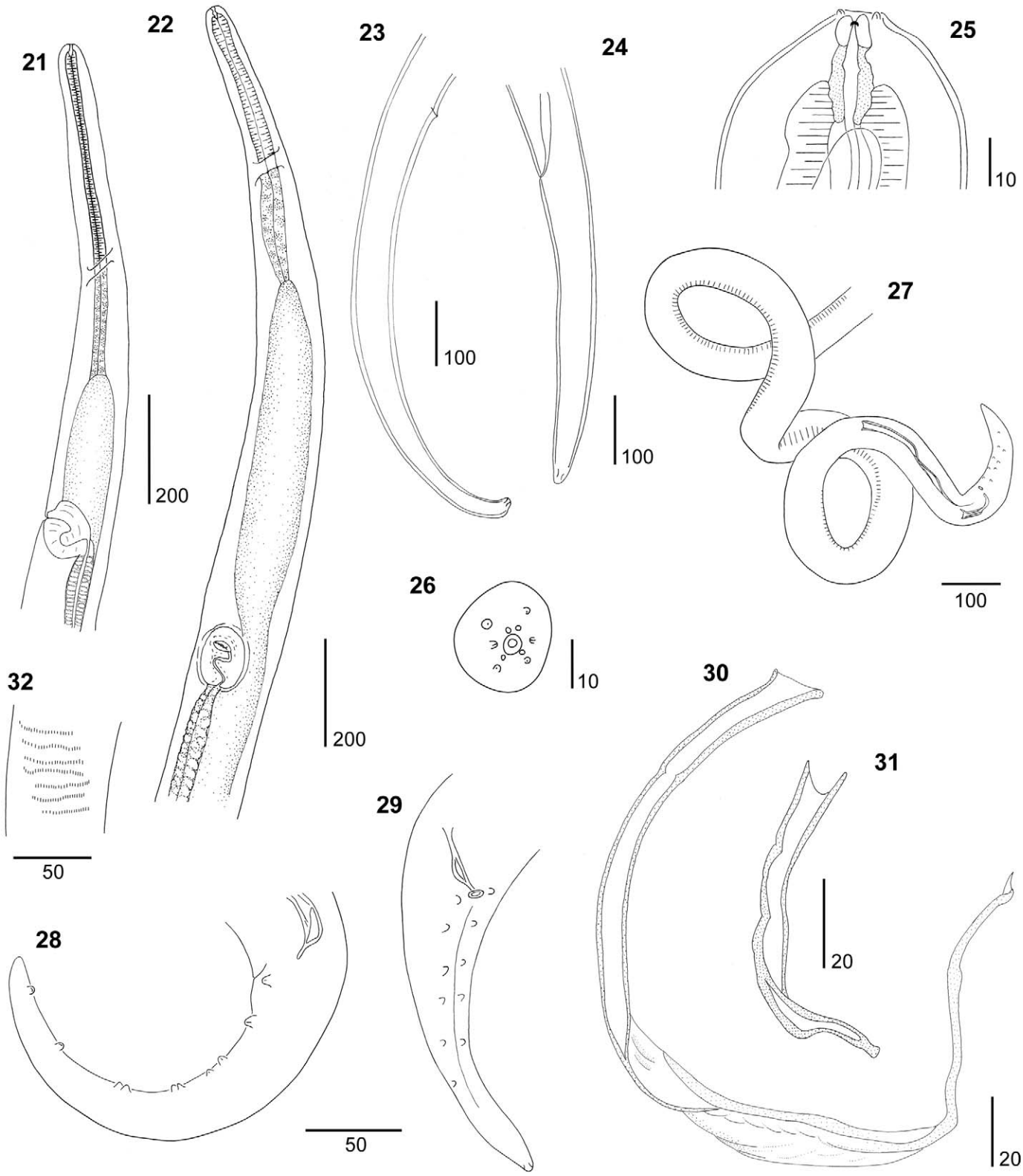
Vouchers: See Appendix for details on the collection numbers.

Site of infection: Abdominal cavity.

Prevalence and mean intensity: In *Oligoryzomys microtis* 21.73% (5/23); 6.33 (1–20) parasites.

Remarks

The measurements and most of the characters from specimens collected in Bolivia and Argentina match with those of paratype material and data available in the original description. The shape of the buccal capsule is uniform among all the specimens (see Fig. 25) as well as the shape of the spicules (Figs. 30, 31). Both should be considered reliable diagnostic characters. However, 3 traits show considerable variability in our specimens and in the lot from Colombia. These include the esophagus and tails of males and females which, in specimens from Argentina and Bolivia, appear to be longer. In addition, the vulva opening is placed about 1,899 from the anterior end in specimens from Argentina and



FIGURES 21–32. *Litomosoides esslingeri* (USNM72391) from *Melanomys caliginosus*, Colombia. (**21–22**) Anterior region of a slender and a robust female. (**23–24**) Female tails, lateral views. (**25**) Buccal capsule from male. (**26**) Apical view from a female. (**27**) Posterior region of male. (**28–29**) Male tails, lateral and ventral views. (**30**) Left spicule. (**31**) Right spicule. (**32**) Area rugosa at mid-length.

Table II. Male and female measurements of *Litomosoides esslingeri* from Bolivia and Argentina.

	Bolivia				Argentina
Host species:	*Oligoryzomys microtis*	*Eligmodontia puerulus*	*Calomys lepidus*	*Ctenomys opimus*	*Eligmodontia puerulus*
Males	n = 13	n = 1	—	—	n = 2
Body length (mm)	21.1 (17–26.4)	28	—	—	25.45; 19.8
Body width	137.4 (119–162)	?	—	—	120; 120
Buccal capsule length	18.9 (15–25)	16	—	—	23; 17
Esophagus length	709.2 (500–1,632)	610	—	—	520; 520
Tail length	212.5 (183–240)	235	—	—	210; 180
Left spicule length	275.9 (228–330)	320	—	—	310; 270
Handle length	131.2 (100–160)	150	—	—	150; 140
Right spicule length	81.1 (65–91)	100	—	—	100; 90
Spicule ratio	3.36 (2.9–3.9)	3.2	—	—	3.1; 3
Females	n = 18	n = 2	n = 1	n = 1	n = 2
Body length (mm)	68.9 (45–91.3)	? ; 91	?	57.10	73.4; ?
Body width	284.2 (200–366)	277; 324	290	230	230; 200
Body with at vulva	189.3 (140–250)	? ; 210	150	230	200; 150
Buccal capsule length	22.8 (19–27)	18; 19	17	18	19; 22
Esophagus length	774.8 (528–1,009)	682; 680	640	550	760; 610
Tail length	654 (450–1,004)	476; 630	570	380	540; 730
Vulva to apex	1,899.9 (1,350–2,436)	2,284; 1,940	1,300	2,000	1,500; 1,300
Microfilaria length	(n = 42) 83.57 (68–103)	—	—	—	—
Microfilaria width	4.5 (4–5)	—	—	—	—

Bolivia whereas it opens 1,330 from anterior end in specimens from Colombia.

There is morphological variability among mature females that allows the identification of 2 morphs. Both morphs are present in specimens from Argentina, Bolivia, and Colombia. One of the morphs includes females possessing a slender anterior end, with a width no greater than 100 at the level of the esophago-intestinal junction and a width no greater than 180 at the level of the vulva (Fig. 21). The second morph includes females possessing a robust anterior extremity, with a width greater than 120 at the esophago-intestinal junction and a width greater than 200 at level of the vulva (Fig. 22). Both morphs of females were observed in the same individual host in the material from Colombia (USNM 72391), as well as in the material labeled HWML63479, and HWML67116–67118. Robust females were observed in HWML63481, and HWML63483. The variability of both the body width at the level of esophago-intestinal junction (range of 70 to 130) and in the tail of females was also noted in Esslinger's description (Esslinger, 1973). Most of the tails appear to be slender (ratio of 7.7 to 10; Fig. 23), but 2 females have thicker and shorter tails (ratio of 6.4 and 6.7; Fig. 24) whereas 2 females have slender tails (ratio of 11.5 and 19.6). This variability was also documented for the material from Colombia by establishing a range of 414 to 710 and a width range 60 to 85 (Esslinger, 1973). However, all specimens show the tip of the tail constricted (see Figs. 23, 24; and Fig. 48 from Esslinger, 1973).

Female filarioids found in *Ctenomys opimus* and *Calomys lepidus* are immature specimens; therefore, no uterine microfilariae were observed. Those specimens show the diagnostic traits for the species including the shape of the buccal capsule, anterior end, and tip of tail.

DISCUSSION

Molinema boliviensis n. sp. presents characters that are similar to species collected from other spiny rats (*Proechimys*). Those characters include an esophagus not exceeding 2 mm, small buccal capsule, anterior end flat, and a complete set of precloacal papillae. The cephalic ratio in our specimens suggests that the cephalic plate is elongated laterally, and cephalic and labial papillae are present in a cuticular shield.

Infections caused by *M. boliviensis* in the spiny rat, *Proechimys brevicauda*, were documented in 4 localities from 3 different Departments in Bolivia. This contrasts with the infection of a single marsh rat, *Holochilus sciurus*, in Ascención, locality where the infection was also detected in spiny rats. This finding suggests rodents that share habitats may be exposed to the same vectors. In addition, the presence of *M. boliviensis* n. sp. in rodents of 2 different lineages (Echimyidae and Cricetidae) suggests that the phenomenon of host capture is frequent between filarioids.

Specimens from *L. esslingeri* showed variability in the morphology of the anterior extremity of females and the length of tails. This is not the first time variability is recorded for species of *Litomosoides*, as other authors have noted it (Esslinger, 1973; Guerrero et al., 2002; Notarnicola, 2005; Notarnicola et al., 2010).

Litomosoides esslingeri is distributed from south Colombia (3°N) to northwestern Argentina (23°S). DNA sequences show homogeneity in specimens from Argentina (data not shown); however, no sequences have yet been obtained from specimens from Bolivia or Colombia. A wide geographic distribution and a low host specificity have been observed in species of *Litomosoides* parasitizing bats. This contrasts with the patterns observed in species parasitizing marsupials and rodents, which seem to have a reduced geographic distribution and appear to be more host-specific (Notarnicola, 2004; Notarnicola and Navone, 2011). Our data show that a species of *Litomosoides* infecting rodents may exhibit a wide geographic distribution and a low host-specificity (6 host species). This suggests that filarioid nematodes should be surveyed in several species occurring in sympatry, especially in rodents known to form an ecological guild, and that more biodiversity studies should be carried out in order to understand the distribution and the host range of the genus.

Two New World species of filarioids *Molinema raposoensis* and *Litomosoides hoplomyis* Esslinger, 1973 were reported for *Proechimys semispinosus* Tomes, 1860 in Colombia (Esslinger,

1973; 1974). Similarly, we record here the presence of *M. boliviensis* and *L. esslingeri* parasitizing the rodent *Holochilus sciureus* in Bolivia. These findings were made possible only due to a substantial effort to sample many thousands of individual specimens in Colombia, by Esslinger, and in Bolivia and Argentina by the authors.

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APPENDIX

We include the data as follows: Host collection number, sex, date collected, collector, field number, locality, and parasite collection number.

***Molinema boliviensis* n. sp.**

Holochilus sciureus Wagner, 1842: MSB55987, M, 12 August 1985, T. I. Mercado, NK13055, Bolivia, Santa Cruz, 15°43′S, 63°09′W, 6 km. W (by road) Ascension, 240 m, HWML63461.

Proechimys brevicauda Gunther, 1876: MSB56095, F, 13 August 1985, T. I. Mercado, NK13087, Bolivia, Santa Cruz, 15°43′S, 63°09′W, 6 km W (by road) Ascension, 240 m, HWML60291; MSB56092, F, 25 August 1985, S. Anderson, NK13320, Bolivia, Beni, 14°51′S, 66°21′W, 1 km SW Estación Biológica del Beni, Totaizal, 300 m, HWML63463; MSB56093, M, 29 August 1985, T. I. Mercado, NK13399, Bolivia, Beni, 4 km N Yucumo, 400 m, HWML63460.

Proechimys sp. not determined: DGR Mammals 5599, F, 13 July 1992, NK25354, Bolivia, Beni, 14°52′S, 67°07′W, 35 km NW of Yucumo, 400 m, HWML63459; MSB68544, F, 15 July 1992, S. Anderson, NK25369, Bolivia, Beni, 14°52′S, 67°07′W, 35 km NW of Yucumo, 253 m, HWML61804; ND, F, 29 August 1989, S. Anderson, NK13392, Bolivia, Beni, 14° 42′S, 67° 04′W, 45 km N

Yucumo, 400m., HWML63458; ND, ND, 7 September 1985, ND, NK13520, Bolivia, La Paz, Rio Beni, HWML63457.

Litomosoides esslingeri (Esslinger, 1973)

Oligoryzomys sp.: MSB98868, M, 31 May 2004, J. L. Dunnum, NK102195, Bolivia, Beni, 15°14′11″S, 63°54′23″W, 4.5 km N of San Pablo, HWML63466.

Oligoryzomys microtis Allen, 1916: MSB56023, M, 19 August 1985, ND, NK13145, Bolivia, Beni, 14°56′S, 65°09′W, Rio Tijamuchi, 240 m., HWML63478; AMNH262182, M, 19 August 1985, ND, NK13159, Bolivia, Beni, 14°56′S, 65°09′W, Rio Tijamuchi, 240 m., HWML63480; AMNH262175, F, 18 August 1985, ND, NK13162, Bolivia, Beni, 14°56′S, 65°09′W, Rio Tijamuchi, 240 m, HWML63481; AMNH262177, F, 17 August 1985, ND, NK13167, Bolivia, Beni, 14°56′S, 65°09′W, Rio Tijamuchi, 240 m, HWML63482.

Eligmodontia puerulus (Philippi, 1896): AMNH260310, M, 6 August 1984, ND, NK11521, Bolivia, Oruro, 17.40°S 67.30°W, 1 km W of Huancaroma, 3,730 m., HWML63477; MSB57112, M, 7 September 1986, S.L Gardner, NK14507, Bolivia, Oruro, 18.9°S, 67.24°W, 37 Km. SW Camino de Oruro, 3.5 K. NE Toledo, 3,650 m., HWML60453; AMNH262808, F, 7 September 1986, S.L Gardner, NK14509, Bolivia, Oruro, 18.9°S, 67.24°W, 37 Km. SW Camino de Oruro, 3.5 K. NE Toledo, 3,650 m, HWML60455; MACN22563, F, 25 March 2006, B. S. Coyner, ARG6687, Argentina, Salta, 23°24′58″S, 66°12′23″W, La Poma, 16 km S, 1.8 km W Barrancas, along Río de las Burras, HWML67115; OMNH34763, M, 25 March 2006, B. S. Coyner, ARG6688, Argentina, Salta, 23°24′58″S, 66°12′23″W, La Poma, 16 km S, 1.8 km W Barrancas, along Río de las Burras, HWML67116, HWML67117, HWML67118; OMNH34765, ND, 25 March 2006, J. K. Braun, ARG6693, Argentina, Salta, 23°24′58″S, 66°12′23″W, La Poma, 16 km S, 1.8 km W Barrancas, along Río de las Burras, HWML67119; CML8549, 28 March 2006, B. S. Coyner, ARG6741, Argentina, Jujuy, 24°08′39.9″S, 66°24′30.0″W, Susques, 12.3 km N, 11.5 km W San Antonio de los Cobres (by road), HWML67120; OMNH34751, M, 1 April 2006, F. A. Jimenez, ARG6845, Argentina, Jujuy, 24°00′48.8″S, 66°30′52.8″W, Susques, 8.2 km S Sey, HWML67121.

Oecomys mamorae (Thomas, 1906): AMNH262012, M, 24 July 1985, NK13158, ND, Bolivia, Beni, 14°56′S, 65°09′W, Rio Tijamuchi, 240 m, HWML63479.

Holochilus sciureus Wagner, 1842: AMNH261985, F, 18 August 1985, ND, NK13169, Bolivia, Beni, 14°56′S, 65°09′W, Rio Tijamuchi, 240 m, HWML63483.

Calomys lepidus (Thomas, 1884): AMNH262790, M, 7 September 1986, NK14519, ND, Bolivia, Oruro, 18.9°S, 67.24°W, 37 km. SW Camino de Oruro, 3.5 K. NE Toledo, 3650 m, HWML63485.

Ctenomys opimus Wagner, 1848: AMNH263043, M, 11 September 1986, NK14557, S.L Gardner, Bolivia, Oruro, 5 km. W and 1 km. N of Pomata Ayte, Rio Barros, 18.19°S, 67.59°W, HWML63486.