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LITOMOSOIDES (NEMATA: FILARIOIDEA) OF BATS FROM BOLIVIA WITH RECORDS FOR THREE KNOWN SPECIES AND THE DESCRIPTION OF A NEW SPECIES

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ABSTRACT: Herein, we describe *Litomosoides salazari* n. sp. collected from the body cavity of the yellow bat, *Lasiurus ega*, from Bolivia. This new species of filarioid nematode is most closely related to the *carinii* group and is characterized by its relatively small size with the vulva located slightly posterior to the esophago-intestinal junction; an arrow-shaped buccal capsule; and a short, rounded tail. New host and locality records for both *Litomosoides hamletti* and *L. chandleri* in phyllostomid bats, and *L. brasiliensis* occurring in both phyllostomid and vespertilionid bats, are provided. The morphological variability of the specimens is documented by providing comparative measurements of 3 known species. *Litomosoides brasiliensis* occurs in 6 species of bats from Bolivia and was the most common species of filarioid nematode encountered. All 4 species of nematodes, including the new species, were found in sympatry at Chijchijpa, a locality in the Yungas of Bolivia.

Bolivia is a country of great biological diversity (Anderson, 1997), with more than 300 species of mammals occurring there. Of these, approximately 5% are endemic, occurring nowhere else (Anderson, 1997). More than 100 species of bats have been identified from within the country (Anderson, 1997; Simmons, 2005). This great diversity is a result of a confluence of several biomes conjoining in the area, including high-altitude Andes and Puna-Altiplano, the Yungas in the eastern foothills of the Andes, Amazon tropical forest in the northeast, and a mixture of grassland and chaco thorn forest coming in from the southern and eastern lowlands (Unzueta, 1975).

Filarioid nematodes of *Litomosoides* Chandler, 1931 occur in the body cavities of bats, marsupials, and sigmodontine and hystricognath rodents throughout the Neotropical and southern Nearctic regions. Showing relatively high taxonomic diversity with approximately 30 described species, these nemas exhibit an indirect pattern of transmission between mammalian hosts, with all known life cycles requiring an arthropod vector or intermediate host to transfer microfilariae between and among definitive hosts (Bain et al., 1980).

As a result of the continuing work on the biodiversity of mammals of Bolivia as part of the Bolivian Parasite Biodiversity Project, we report herein the results of our work on the filarioid nematodes of bats from Bolivia. This work, funded by the National Science Foundation, was undertaken as a collaborative project by the Department of Mammalogy, the American Museum of Natural History (New York, New York); Division of Mammals in the Museum of Southwestern Biology (Department of Biology, University of New Mexico, Albuquerque, New Mexico); the Harold W. Manter Laboratory of Parasitology (HWML, University of Nebraska–Lincoln, Lincoln, Nebraska); and the Colección Boliviana de Fauna (CBF, La Paz, Bolivia). The results of investigations on filarioid nematodes include the description of several new species associated with bats, rodents, and primates (Brant and Gardner, 1997; Notarnicola et al., 2007, 2008), and a phylogeny of *Litomosoides* spp. based on morphological characters (Brant and Gardner, 2000). Brant and Gardner (2000) also provide a preliminary list of species of *Litomosoides* and their hosts and a discussion of their phylogenetic relationships.

Herein, we describe a new species of *Litomosoides* parasitizing the yellow bat, *Lasiurus ega* (Gervais, 1856), and we provide data on the morphology, localities, and hosts used by 3 other species in the genus occurring in bats from Bolivia.

MATERIALS AND METHODS

Specimens were collected following the methods outlined in Gardner (1996) and Gardner and Jiménez (2009). Filarioids were collected and placed directly in either 70% ethanol, 10% formalin solution, or 95% ethanol. They were transported in these solutions back to the Harold W. Manter Laboratory (Lincoln, Nebraska) and stored. For study of morphological characters, specimens were cleared in lactophenol and studied with an Ultraphot or Axiophot digital microscope (Carl Zeiss, Jena, Germany) using digital measuring software. To examine the oral papillae, an apical view of the head was prepared. 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. To determine the shape of the lateral chords, a cross section of a female was made posterior to the vulva. Microfilariae were dissected from the uterus of fixed females or studied from blood smears. Illustrations were made with the aid of a drawing tube. Measurements are presented as follows: holotype, male paratypes, allotype, and female paratypes. If more than 3 paratypes were examined, mean values and SDs are presented, with ranges in parentheses. Measurements are given in micrometers unless otherwise stated. Prevalence and mean intensity of infection also are provided for each species.

RESULTS

During our work throughout Bolivia, more than 600 individual bats were collected, primarily by netting, and then they were examined for both ecto- and endoparasites, including representative species from the Phyllostomidae, Vespertilionidae, Thyropteridae, and Mollosidae. Those bats positive for filarioids are given in Table I. We recovered 1 undescribed species and 3 previously known species, including *Litomosoides chandleri* Esslinger, 1973; *L. hamletti* Sandground, 1934; and *L. brasiliensis* Lins de Almeida, 1936.

We encountered filariod nematodes in bats from the following list of localities in Bolivia: Departamento Santa Cruz: San Rafael de Amboró (17°36′S, 63°32′W; 21 July–2 August 1985), San Miguel Rincón (17°23′S, 63°32′W; 14 August 1984), Estancia Cachuela Esperanza (16°47′S, 63°14′W; 22 August 1984), 10 km

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TABLE I. List of species and number of bats trapped from 5 departments in Bolivia. Superscript lowercase letters indicate the positive hosts for filarioid species as follows: [b], *Litomosoides brasiliensis*; [c], *L. chandleri*; [h], *L. hamletti*; and [s], *L. salazari* n. sp.

Family	Host species	Department of Bolivia				
		Santa Cruz	Beni	La Paz	Cochabamba	Tarija
Phillostomidae	*Trachops cirrhosus*	1[b]	—	—	—	—
	Lonchophilla thomasi	—	4[b]	1[b]	—	—
	Lonchophilla sp.	—	—	3	—	—
	Anoura caudifer	—	—	2[b]	—	—
	Anoura geoffroyi	—	—	2	—	—
	Glossophaga soricina	3	10	25[h]	8	—
	Glossophaga sp.	—	2	3	4	1[h]
	Carollia brevicauda	22[b]	11[b]	3[b]	3[b]	—
	Carollia castanea	—	3[b]	—	1	—
	Carollia perspicillata	28[b]	20[b]	31[b]	32[b]	—
	Carollia sp.	7	27[b]	43[b]	60[b]	—
	Artibeus anderseni	—	—	—	6	—
	Artibeus glaucus	1	—	—	—	—
	Artibeus jamaicensis	1	2	9	16	—
	Artibeus lituratus	9	6	4	32	—
	Artibeus obscurus	—	—	6	3	—
	Artibeus sp.	—	—	4	1	5
	Chiroderma salvini	—	1	—	—	—
	Platyrrhinus helleri	3	9	—	—	—
	Sturnira lilium	6	3	7[b]	2	6
	Sturnira oporaphilum	22	1	12[c]	7	2
	Sturnira sp.	4	3	26	4[b]	3
	Uroderma bilobatum	11	1	—	—	—
	Uroderma magnirostrum	—	2	—	—	—
	Desmodus rotundus	—	1	—	—	6
Thyropteridae	*Thyroptera tricolor*	—	1	—	—	—
Vespertilionidae	*Eptesicus furinalis*	—	—	—	—	5
	Histiotus velatus	—	—	—	—	1
	Lasiurus ega	—	1[s]	—	—	1
	Myotis nigricans	2	17	—	—	2
Molossidae	*Molossus molossus*	—	—	19	—	—
	Nyctinomops aurispinosus	—	—	1	—	—
	Nyctinomops laticaudatus	—	2	—	—	—
	Nyctinomops macrotis	—	1	—	—	—

N San Ramón (16°36′S, 63°14′W; 7 August 1987), 6 km by road W of Ascención (15°43′S, 63°9′W; 13 August 1985), 4 km SW Buena Vista (17°28′S, 63°42′W; 7 August 1987), and 2 km S Caranda (17°33′S, 63°32′W; 12 August 1987); Departamento El Beni: Río Beni (13°27′S, 67° 21′W; 8 September 1985), km 35 NW of Yucumo (14°52′S, 67°07′W; 11 July 1992), and Serranía de Pilón (15°17′S, 67°04′W; 18–22 July 1992); Departamento La Paz: La Reserva (15°44′S; 67°31′W; 22–26 July 1992) and Chijchijpa (16°09′S, 67°44′W; 5–7 July 1992); Departamento Cochabamba: Sajta (17°06′S, 64°46′W; 20–23 June 1993) and El Palmar-Río Cochi Mayu (17°06′S, 65°32′W; 5 July 1993); and Departamento Tarija: Tapecua (21°26′S, 63°55′W; 3 June 1995). See Anderson (1997) for a complete list of localities from which mammals were collected up to approximately 1995.

DESCRIPTION

Litomosoides salazari n. sp.

(Figs. 1–18)

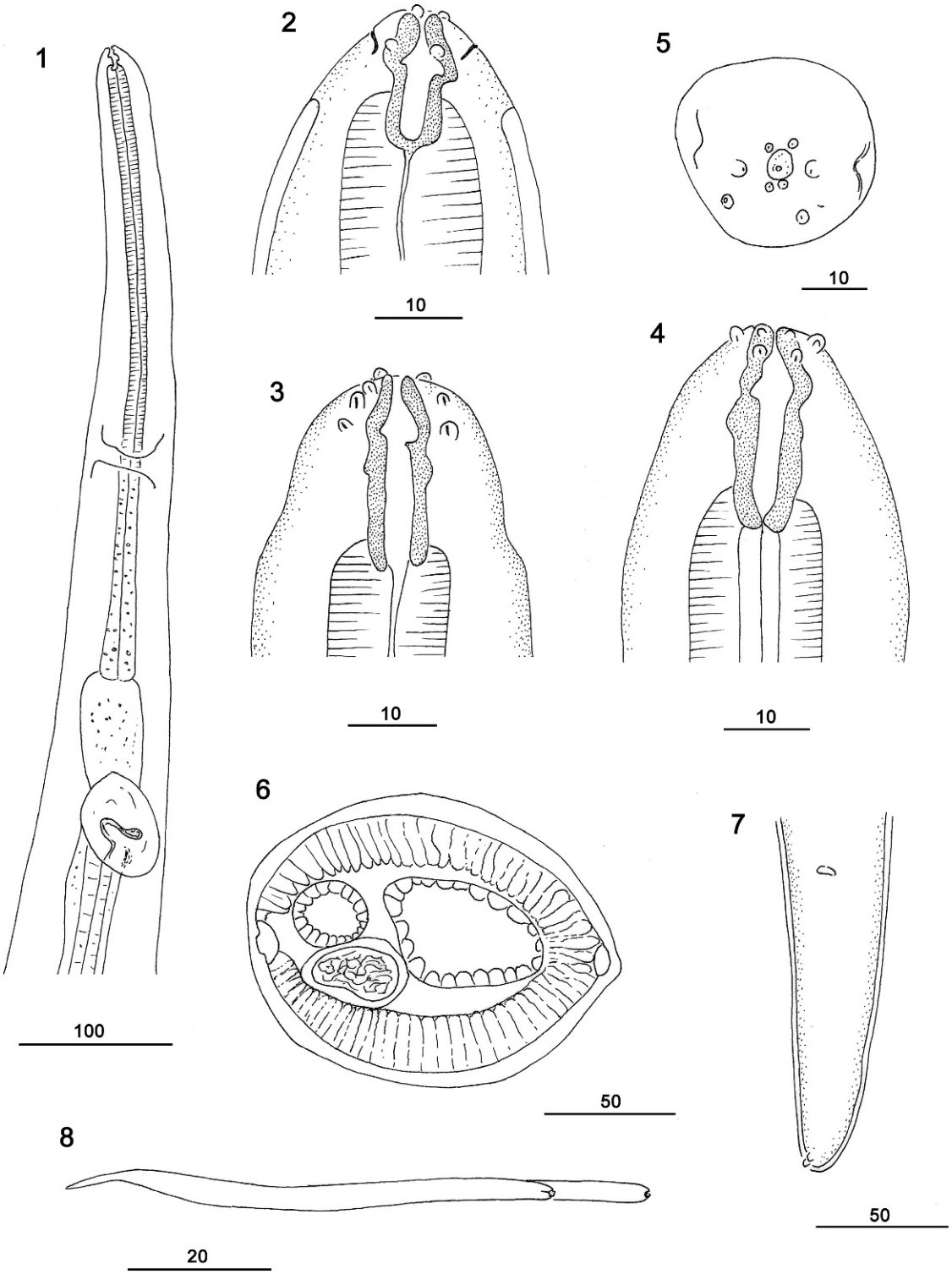
General description (based on 5 males, 7 females): Males 1.5 times smaller than females. Anterior extremity rounded, dome-like. Four conspicuous labial papillae forming rectangle, stretched dorso-ventrally, 2 cephalic ventral papillae and small amphids present (Fig. 5). Arrow-shaped buccal capsule well cuticularized. Esophagus undivided or slightly glandular at posterior end.

Male: Posterior region coiled with 3–7 loops (Fig. 13). Left spicules with handle longer than blade; blade consisting of filament and membranous alae. Right spicules cuticularized, with prominent dorsal heel and terminal cap (Figs. 15–17). Tail short and rounded. Posterior end with 3 pairs of subventral cloacal papillae. Area rugosa begins anterior to cloaca, consisting of transverse ridges made of small longitudinal crests, generally extending posteriad through coiled region.

Holotype: Length 12.231 mm; maximum width 100; at level of esophagus 50; buccal capsule 17 long, external diameter 10, buccal cavity 3; esophagus 330 long. Nerve ring 130 from anterior extremity. Tail 100 long. Left spicule 205 long, with handle 110 long; right spicule 75; spicular ratio 1:2.7. Area rugosa beginning 300 to 1,700 anterior from tail end; 1,400 long, width of rows 100–120; crests 5–7 in height, spaced 25–30.

Paratypes (n = 5): Length 9.76 ± 0.9 (8.92–10.8) mm; width 95 ± 21.7 (75–120); buccal capsule 18.2 ± 1.6 (17–21) long and external diameter 8.2 ± 1.4 (6–10); esophagus 310 ± 36.7 (270–360) long; nerve ring 160 and 220 from anterior end (n = 2); tail 80.2 ± 10.6 (70–95); left spicule 207.5 ± 9.5 (200–220) long, handle 110 ± 8.1 (100–120); right spicule 77.5 ± 6.4 (70–85); spicular ratio 2.69 ± 0.34 (2.35–3.14). Area rugosa from 2 specimens 1,100 and 1,570 long; beginning 190 and 230 to 1,100 and 1,570, respectively, from tail end.

Female: Vulva slightly posterior to esophago-intestinal junction; vagina globular; ovejector directed posteriad. Tail short, rounded. No cuticular

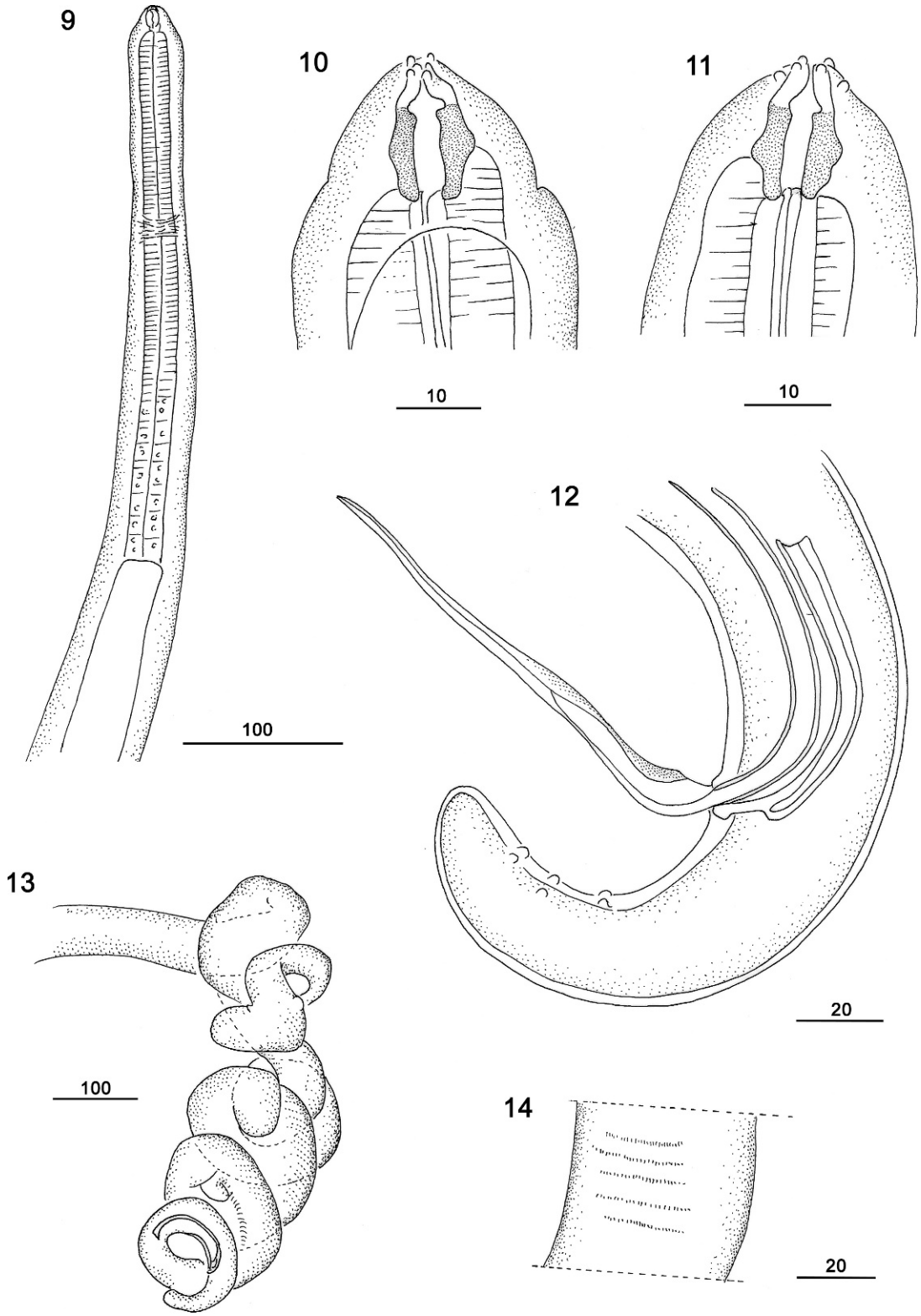


FIGURES 1–8. *Litomosoides salazari*. Female. (**1**) Anterior region, ventral view. (**2**) Female allotype anterior end median view. (**3–5**) Female paratype, median, lateral, and apical views. (**6**) Cross section posterior to the vulva. (**7**) Tail, ventral view. (**8**) Uterine microfilaria.

ornamentations observed. In transversal section, lateral hypodermic chords well developed, dome-shaped (Fig. 6).

Allotype: Length 20.53 mm; maximum width 170; with at level of vulva 100; buccal capsule 16 long, and external diameter 8; buccal cavity 3; nerve ring 260 from anterior end; esophagus 370 long; vulva from apex 480; vulva located 100 from esophago-intestinal junction; ovejector 80 long; tail 115 long.

Paratypes (n = 8): Length 14.7 ± 5.1 (10.12–24.6); maximum width 137.6 ± 28.1 (106–170); buccal capsule 21.1 ± 1.4 (19–23) long, external diameter 8.3 ± 0.7 (7–9); nerve ring 200 from apex (n = 2); esophagus 412.5 ± 54.4 (330–510) long; vulva 510.6 ± 35.5 (480–580) from apex; distance of vulva to esophago-intestinal junction 118 ± 70.8 (30–200); tail 127.1 ± 16.5 (110–160) long.

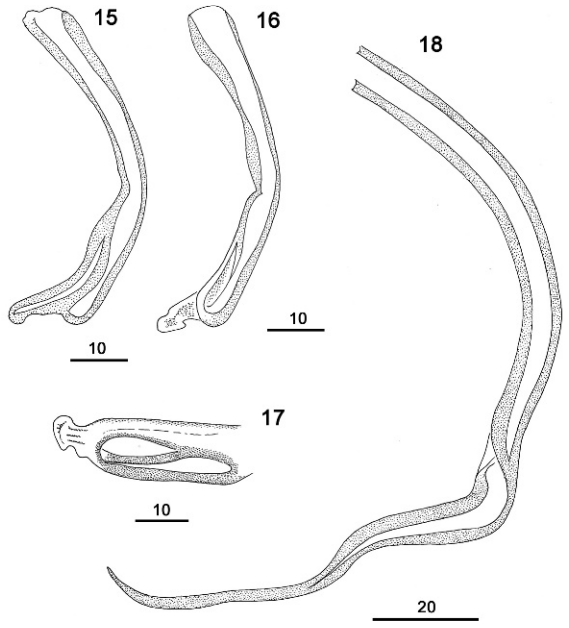


FIGURES 9–14. *Litomosoides salazari*. Male holotype. (**9**) Anterior region. (**10–11**) Buccal capsule, lateral and median views. (**12**) Tail, lateral view. (**13**) Posterior region. (**14**) Area rugosa at midlength.

Microfilariae: Sheath visible at anterior extremity. Body fusiform, with salient cephalic hook. Tail attenuated, without nuclei at tip of tail. Measurement based on uterine microfilariae collected from 2 females (n = 6): body length 75 ± 5.25 (70–85); width 3.33 ± 0.51 (3–4).

Taxonomic summary

Type host: Lasiurus ega Gervais, 1856 (Chiroptera, Vespertilionidae), collected 11 July 1992 by Jon Dunnum, deposited at CBF NK25336.



FIGURES 15–18. *Litomosoides salazari*. Male paratype. (**15–16**) Right spicule, lateral and ventral view. (**17**) Detailed of the distal extremity of the right spicule, ventral view. (**18**) Left spicule, lateral view.

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

Type locality: Bolivia: Departamento del Beni: 35 km north NW of Yucumo "by road" (14°52′S, 67°07′W; 253 m).

Specimens deposited: Holotype (male), allotype (female), 12 paratypes (7 females and 5 males), and 2 blood slides at the Harold Manter Laboratory of Parasitology, HWML61785.

Prevalence and intensity: One of 1 host parasitized; 14 (6 males, 8 females).

Etymology: Named after Dr. Jorge Salazar-Bravo, one of the primary proponents of the study of the mammalian biodiversity in Bolivia. He keeps going when times are hard.

Remarks

Litomosoides salazari n. sp. belongs to the *carinii* group of species (Bain et al., 1989, 2003; Notarnicola et al., 2000) based on the morphological characteristics of both spicules. The left spicule has a handle longer than the blade, and a blade divided into a short proximal folded lamina and a terminal filament. The right spicule possesses a well cuticularized dorsal heel and a terminal cap.

Litomosoides salazari is a smaller sized species compared with those known to occur in rodents and marsupials. The new species has a shorter tail in both males and females, and a vulva that is located near the esophago-intestinal junction.

In comparison with 6 species in the *carinii* group that occur in rodents, the new species differs from *L. carinii* (Travassos, 1919) in having an unattenuated tail (Bain et al., 1989) and shorter spicules; from *L. scotti* Forrester and Kinsella, 1973 in having a buccal capsule without an outer lateral extension and inconspicuous amphids (Forrester and Kinsella, 1973); and from *L. silvai* Padilha and Faria, 1977 in having a rounded tail without a constricted end, a globular vagina, and a shorter right spicule (Moraes Neto et al., 1996). It differs from *L. bonaerensis* Notarnicola, Bain and Navone 2000 in possessing 3 pairs of cloacal papilla and lacking the single precloacal papilla (Notarnicola et al., 2000); from *L. odilae* Notarnicola and Navone, 2002 in having neither a protruded cloacal opening, nor a muscular esophagus (Notarnicola and Navone, 2002); and finally, from *L. andersoni* Brant and Gardner, 1997 in the simplest terminal part of the right spicule, the presence of cloacal papillae, and a rounded tail (Brant and Gardner, 1997).

Litomosoides salazari also can be differentiated from 2 species parasitizing marsupials as follows: from *L. petteri* Bain, Petit, and Berteaux, 1980 by the shorter muscular esophagus and the symmetrical cloacal papillae (Bain et al., 1980); and from *L. wilsoni* Guerrero, Martin, Gardner and Bain, 2002 in the length of the esophagus (males 474–522 vs. 270–360 μm and females 546 vs. 330–510 μm) and the longer microfilaria (61.8 vs. 75 μm) (see Guerrero et al., 2002).

There are 5 *Litomosoides* species known to infect bats, yet several characters can be used to separate them from the new species. The new species is smaller than *L. hamletti*, *L. brasiliensis*, and *L. yutajensis* Guerrero, Martin and Bain, 2003. In addition, the walls of the buccal capsule of *L. hamletti* are narrower (Jiménez-Quirós and Arroyo, 1960; Guerrero et al., 2002; Bain et al., 2003), and the tail of the male is shorter (mean of 64 vs. 80.2 μm). *Litomosoides salazari* differs from *L. brasiliensis* in having a simple shape of the heel of the right spicule, the vulva being very near the esophago-intestinal junction, and by the inconspicuous ventral cephalic papillae (Guerrero et al., 2002). It also differs from *L. yutajensis* in the absence of a bell-like–shaped buccal capsule, and a longer and slender microfilaria instead of a stout microfilaria (length 58 vs. 75 μm, width 4.3 vs. 3.3 μm; see Guerrero et al., 2003). The new species also differs from *L. guiterasi* (Perez Vigueras, 1934), a parasite of *Artibeus jamaicensis parvipes* Rehn 1902 from Cuba, in the shape of the buccal capsule and the head papillae. It also has obvious cephalic papillae and a characteristic bottle-shaped buccal cavity, not shown in figure 1 of Pérez-Vigueras (1934). Finally, *L. salazari* differs from *L. molossi* Esslinger, 1973 and *L. chandleri* Esslinger, 1973 in the absence of lateral cuticular ornamentation, and in lacking the 2 annular thickenings of the buccal capsule characteristic of *L. molossi* (Esslinger, 1973; Guerrero et al., 2002).

There is a group of 5 species of *Litomosoides* in which the male is unknown. The descriptions are based on the females for 3 species and 2 on only microfilariae. Those species can be separated from *L. salazari* as follows. Females of *L. salazari* are shorter than those of *L. solarii* Guerrero, Martin, Gardner, and Bain, 2002, possess a more anteriorly placed vulva (510 vs. 910 μm), and the tail of the microfilaria is not a sharp point as in *L. solarii* (Guerrero et al., 2002). The females of the new species can be recognized as distinct from those of *L. artibei* Esslinger, 1973 in having a shorter buccal capsule and a vulva very near the esophago-intestinal junction (Esslinger, 1973). The new species is different from *L. chitwoodi* Bain, Guerrero, and Rodriguez, 2003 in having a longer buccal capsule and a more anterior vulva (Chitwood, 1938; Bain et al., 2003). The microfilariae of *L. salazari* are shorter than those described from *L. colombiensis* Esslinger, 1973 [a parasite of *Platyrrhinus dorsalis* (Thomas, 1900)—mentioned as *Vampyrops dorsalis*—and *A. jamaicensis* Leach, 1821 from Colombia] and lacks any nuclei in the tail in contrast to those of *L. colombiensis*, which has a single row of nuclei in the tail (see Esslinger, 1973). Finally, the microfilariae of *L. salazari* are longer than those of *L. caliensis* Esslinger, 1973 (mean 75 vs. 60 μm), with an attenuated tail that is not rounded.

REDESCRIPTIONS

Litomosoides chandleri Esslinger, 1973

(Tables I, II)

Diagnosis: Table II provides measurements for our specimens. They were identified as *L. chandleri* by shape of buccal capsule, disposition of cephalic papillae (see Guerrero et al., 2002), cloacal papillae in males, and by lateral embellishments of cuticle in posterior extremity of both males and females.

Taxonomic summary

Hosts: 3 Tschudi's yellow-shouldered bats, *Sturnira oporaphilum* (Tschudi, 1844).

Site of infection: Abdominal cavity.

Locality: Chijchijpa, La Paz. See Appendix for details on the collection numbers and locality references.

Specimens deposited: Vouchers (7 females and 5 males), at the Harold Manter Laboratory of Parasitology. See Appendix for details on the collection numbers.

Prevalence and mean intensity: 60% (3/5); 4 (2–6) parasites.

Remarks

The measurements and most of the characters from our specimens agree with that published by other authors. However, there are 2 main

TABLE II. Measurements of *Litomosoides chandleri* and *L. hamletti* from Bolivia.

Host species:	*Litomosoides chandleri*		*Litomosoides hamletti*	
	Sturnira oporaphilum		*Glossophaga soricina*	
	Males (n = 5)	Females (n = 7)	Males (n = 10)	Females (n = 15)
Length (mm)	11.6 (9.9–14)	23.4 (17.4–27.6)	16.8 (14.7–24)	50.05 (39–56)
Width	97.6 (88–116)	162.1 (116–193)	81.2 (57–99)	164.8 (136–257)
Buccal capsule	18.8 (17–21)	19.1 (17–21)	27.4 (18–35)	29.2 (23–40)
Esophagus	424.4 (390–473)	483.8 (400–550)	531.3 (390–752)	728.5 (509–1,038)
Tail	116 (95–140)	284 (230–350)	66.7 (55–78)	161.1 (105–233)
Left spicule	216.5 (213–220)	—	218.1 (190–274)	—
Handle	110 (100–120)	—	127.2 (110–142)	—
Right spicule	61.6 (60–65)	—	73.2 (60–93)	—
Vulva to apex	—	706.1 (565–850)	—	584.4 (455–829)
Microfilaria length	(n = 2) 63; 64		(n = 12) 51.66 (48–55)	
Width	3; 3		5	

differences between our specimens and those described by Esslinger (1973) and Guerrero et al. (2002): the buccal capsule from our specimens is longer (males 14.4 and 13.7 μm, respectively, vs. 18.8 μm; females 15.4 and 15.8 μm, respectively, vs. 19.1 μm). However, the shape of the buccal capsule and cavity resembles figure 11 in Esslinger (1973) and also figure 59 from Guerrero et al. (2002). The vulva of the females of our specimens is located posterior to the esophago-intestinal junction, a structure that was usually reported near, or slightly anterior, to that structure.

Litomosoides chandleri has been reported from *Artibeus jamaicensis* Leach, 1821 from Colombia, Venezuela, French Guiana, and Peru (in this last country, mentioned as *Artibeus planirostris*) (Esslinger, 1973; Guerrero et al., 2002) and *Phyllonycteris poeyi* Gundlach, 1860 and *Nyctinomops laticaudatus* (E. Geoffroy, 1805) from Cuba (Rutkowska, 1980). Ten species of bats were trapped in Chijchipa, La Paz, including *Artibeus jamaicensis* (n = 8), *A. lituratus* (n = 4), and *A. obscurus* (n = 2), but no filarioid worms were found. The presence of this species in *S. oporaphilum* reported herein is a new host record.

Litomosoides hamletti Sandground, 1934

(Tables I, II)

Diagnosis: Measurements for these specimens are included in Table II. The specimens were identified as *L. hamletti* because of the thin and narrow buccal capsule, presence of a single cephalic papilla, vulva at the level of the esophagus, short tail in both sexes, and no more than 2 pair of cloacal papillae.

Taxonomic summary

Hosts and localities: 4 Pallas's Long-tongued bats, *Glossophaga soricina*, from Chijchijpa; and 1 *Glossophaga* sp. from Tapecua, Tarija. See Appendix for details on the collection numbers and locality references.

Site of infection: Abdominal cavity.

Specimens deposited: Vouchers (20 females and 16 males) at the Harold Manter Laboratory of Parasitology. See Appendix for details on the collection numbers.

Prevalence and mean intensity: From *G. soricina* 16.6% (4/24); 5 (1–9) parasites; from *Glossophaga* sp. 100% (1/1); intensity = 16 parasites.

Remarks

After re-examination of the type material, Bain et al. (2003) suggested 2 subspecies for *L. hamletti*, i.e., *Litomosoides hamletti hamletti* to include the specimens of Sandground (1934), Rego (1961), Esslinger (1973), and Guerrero et al. (2002)—mentioned as *L. guiterasi*—and *L. hamletti penai* to include the specimens of Jiménez-Quirós and Arroyo (1960)—mentioned as *L. penai*. The justification is that because females of the latter subspecies are longer, the vulva is located posterior to the esophago-intestinal junction, and the tail is more attenuated. Our material is in agreement with the morphologic and metric characters of *L. hamletti hamletti*. Some males and females presented longer buccal capsules (35 and 40, respectively), and most of the males examined had an adcloacal pair of papillae and 1 pair of asymmetric post-cloacal papillae. This subspecies has been reported from *G. soricina* from Brazil, Mexico, Colombia, and Venezuela (Sandground, 1934; Chitwood, 1938; Rego, 1961; Esslinger, 1973; Guerrero et al., 2002). It represents the first record for the species in Bolivia.

Litomosoides brasiliensis Lins de Almeida, 1936

(Tables I, III)

Diagnosis: Specimens identified as *L. brasiliensis*. Table III contains measurements of specimens recovered from *C. pespicillata* and *C. brevicauda*, the host species most frequently found infected. Males possess

TABLE III. Measurements of *Litomosoides brasiliensis* from Bolivia.

Host species:	*Carollia brevicauda*		*Carollia perspicillata*	
	Males (n = 7)	Females (n = 9)	Males (n = 21)	Female (n = 26)
Length (mm)	56.6 (39.2–83)	134.52 (79.2–174)	52 (36.2–81.1)	124.1 (72.3–156.7)
Width	143.8 (130–158)	232.3 (135–297)	138 (94–188)	230.8 (149–307)
Buccal capsule	22.12 (17–25)	22.44 (17–30)	20.7 (15–25)	22.6 (16–28)
Esophagus	663 (534–860)	775.4 (645–1,048)	750 (572–1,127)	863.6 (620–1,211)
Tail	239 (189–318)	340.6 (193–505)	225.5 (149–346)	351.4 (219–465)
Left spicule	511.5 (383–616)	—	454.6 (299–663)	—
Handle	197.7 (141–257)	—	207.6 (148–314)	—
Right spicule	175.5 (142–213)	—	157.1 (101–220)	—
Vulva to apex	—	2,843.4 (2,330–3,657)	—	2,603.8 (1,706–3,185)
Microfilaria length	—		(n = 5) 56.4 (48–61)	

a distinctive right spicule, with a folded heel, buccal capsule with 2 rings (as shown in figures 20 and 21 in Guerrero et al., 2002), vagina subglobular, posteriorly elongated, cloacal papillae disposed in tandem on ventral longitudinal line.

Taxonomic summary

Hosts and localities: Trachops cirrhosus (Spix, 1823), *Lonchophila thomasi* Allen, 1904, *Anoura caudifer* (E. Geoffroy, 1818), *Carollia brevicauda* (Schinz, 1821), *C. castanea* H. Allen, 1890, *C. pespicillata* (Linnaeus, 1758), *Carollia* sp. Gray, 1838, and *Sturnira lilium* (E. Geoffroy, 1810) in 4 of the 5 Departments surveyed. See Table I and Appendix for detailed localities.

Site of infection: Abdominal cavity.

Specimens deposited: Vouchers (111 females and 108 males) and blood slides at the Harold Manter Laboratory of Parasitology. See Appendix for detailed numbers of collection.

Prevalence and mean intensity: From *T. cirrhosus* 100% (1/1), Intensity = 3 parasites; from *L. thomasi* 100% (5/5), 6.5 (4–10) parasites per host; from *A. caudifer* 50% (1/2), Intensity = 1; from *C. brevicauda* 28.5% (11/39), 4 (1–10) parasites per hosts; from *C. castanea* 33% (1/3), Intensity = 1; from *C. pespicillata* 33% (37/111), 4.4 (1–21) parasites per hosts; from *Carollia* sp. 8% (11/137), 5.9 (1–11) parasites per hosts; from *S. lilium* 4% (1/24), intensity = 1.

Remarks

Worms of *L. brasiliensis* are longer compared with the 3 filarioid species collected in this survey. Moreover, the rows of the area rugosa are closer, one from another, compared with *L. chandleri* and *L. hamletti*, which are more spaced. The morphological character as well as the measurements from our specimens fit with those reported by Caballero (1947), Esslinger (1973), and Guerrero et al. (2002). However, microfilariae reported by these authors are longer than ours (92 from Esslinger, 1973 and 71.8–94.5 from Guerrero et al., 2002 vs. 56.4 from present study). This difference could be explained because our measurements provide from blood smears instead of mature females or blood concentrated 2% aqueous formalin and was reported that microfilariae frequently shrink with this technique (Esslinger, 1973).

This filarioid was the most common species found in the present survey. Its ubiquitous presence is due to its ability to infect both phyllostomid and vespertillionid bats (Lins de Almeida, 1936; Caballero, 1947; Diaz-Ungria, 1963; Guerrero et al., 2002).

Litomosoides brasiliensis has been frequently reported from several species of *Carollia* from Central and South America. Recently, Guerrero et al. (2002) added *Lyonycteris spurrelli* Thomas, 1913, *A. caudifer*, and *S. lilium*, to the list of hosts. The latter 2 host species also were recorded in Bolivia infected by this species. In addition, the presence of *L. brasiliensis* in *T. cirrhosus* and *L. thomasi* represent new host records.

DISCUSSION

Several authors have found small variability in both quantitative and qualitative morphological characters of some species of *Litomosoides* (Esslinger, 1973; Guerrero et al., 2002; Notarnicola, 2005); however, the landmarks for each species remain stable. The 4 species recovered in the present study were identifiable by the combination of characters such as the buccal capsule, the shape of the spicules, the caudal papillae in males, and the vulva.

An examination of the gazetteer and list of species of mammals known from Bolivia in Anderson (1997) shows that the species of mammals that we have reported on up to the present time represents a very small proportion of the total. Therefore, the results presented in the present paper, as well as those presented by Dick et al. (2007), which focus only on ectoparasites, fall short in summarizing the diversity of parasites infecting the bats of Bolivia. Additional students and researchers are encouraged to continue to work with these specimens, especially as many of the areas in which we made our collections from 1984 to 2000 have been reduced from diverse forest ecosystems to monotonous cleared landscapes covered with introduced grasses and populated mostly by bovids.

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APPENDIX

Locality data and host species of the filarioid nematodes. HWML: Collection number of the filarioid specimens at Harold Manter Laboratory. NK: Field number of the host species.

Litomosoides chandleri

Departamento La Paz: Chijchijpa (16°09′S, 67°44′W) 6 July 1992: *Sturnira oporaphilum* NK25260; HWML61758 *S. oporaphilum* NK25262; HWML61771 *S. oporaphilum* NK25285.

Litomosoides hamletti

Departamento La Paz: Chijchijpa (16°09′S, 67°44′W) 5 July 1992: HWML61750 *Glossophaga soricina* NK25221; HWML61752 *G. soricina* NK25227; HWML61753 *G. soricina* NK25228; HWML61776 *G. soricina* NK25295.

Departamento Tarija: Tapecua (21°26′S, 63°55′W) 5 June 1995: *Glossophaga* sp. NK30829.

Litomosoides brasiliensis

Departamento Santa Cruz: San Miguel Rincón (17°23′S, 63°32′W) 14 August 1984: HWML63396 *Carollia perspicillata* NK11652; HWML63397 *C. perspicillata* NK11654; Estancia Cachuela Esperanza, Santa Cruz (16°47′S, 63°14′W) 22 August 1984: HWML63398 *C. perspicillata* NK11697; HWML63399 *C. perspicillata* NK11700; HWML63400 *C. perspicillata* NK11710; HWML63401 *C. perspicillata* NK11716; HWML63402 *C. perspicillata* NK11717; HWML63403 *C. perspicillata* NK11767; HWML63404 *C. brevicauda* NK12739; HWML63405 *C. brevicauda* NK12783; HWML63406 *C. brevicauda* NK12794; HWML63407 *C. perspicillata* NK12834; HWML63408 *C. brevicauda* NK12937; HWML63409 *Carollia* sp. NK12954. Ten km N San Ramón (16°36′S, 63°14′W) 7 August 1987: HWML63410 *C. brevicauda* NK12981. Six kilometers by road W of Ascención (15°43′S, 63°9′W) 13 August 1985: HWML63411 *Trachops cirrhosus* NK13096. Four kilometers SW Buena Vista (17°28′S, 63°42′W) 7 August 1987: HWML63413 *Carollia* sp. NK15230. Two kilometers S Caranda (17°33′S, 63°32′W) 12 August 1987: HWML63414 *C. perspicillata* NK15263; HWML63415 *Carollia* sp. NK15265; HWML63416 *Carollia* sp. NK15271; HWML63417 *C. perspicillata* NK15273. Eight kilometers SE Santa Cruz (17°44′S, 63°17′W) 9 June 1988: HWML63418 *C. brevicauda* NK15642.

Departamento La Paz: Chijchijpa (16°09′S, 67°44′W) 5 July 1992: HWML63419 *C. brevicauda* NK25238; HWML63420 *Carollia* sp. NK25244; HWML61773 *C. perspicillata* NK25290; *Sturnira lilium* NK25319. La Reserva (15°44′S, 67°31′W) 24 July 1992: HWML63435 *C. perspicillata* NK25592; HWML63436 *C. perspicillata* NK25597; HWML63437 *Carollia* sp. NK25627; HWML63438 *Anoura caudifer* NK25628; HWML63439 *C. perspicillata* NK25636; HWML63440 *Lonchophylla thomasi* NK25665.

Departamento del Beni: Rio Beni (13°27′S, 67°21′W) 8 September 1985: HWML63412 *Carollia* sp. NK13533. Serranía de Pilon (15°17′S, 67°04′W) 19 July 1992: HWML63421 *Lonchophylla thomasi* NK25399; *C. perspicillata* NK25404; *C. perspicillata* NK25405; HWML63422 *Carollia* sp. NK25413; HWML63423 *C. brevicauda* NK25414; HWML63424 *C. perspicillata* NK25417; HWML63425 *C. perspicillata* NK25420; *Carollia* sp. NK25421; *L. thomasi* NK25423; HWML63426 *C. perspicillata* NK25424; HWML63427 *L. thomasi* NK25429; HWML63428 *L. thomasi* NK25430; *C. perspicillata* NK25431; *C. perspicillata* NK25432; HWML63429 *C. perspicillata* NK25435; *C. perspicillata* NK25436; HWML63430 *C. perspicillata* NK25437; HWML63431 *C. perspicillata* NK25438; HWML63432 *C. castanea* NK25439; HWML63433 *Carollia* sp. NK25447; HWML63434 *C. brevicauda* NK25450.

Departamento Cochabamba: Sajta (17°06′S, 64°46′W) 22 June 1993: HWML63441 *C. perspicillata* NK29945; HWML63442 *C. perspicillata* NK30014; HWML63443 *Carollia* sp. NK30065; HWML63444 *C. perspicillata* NK30067; HWML63445 *C. perspicillata* NK30068; HWML63446 *Carollia* sp. NK30080. El Palmar-Rio Cochi Mayu (17°06′S, 65°32′W) 5 July 1993: HWML63447 *C. perspicillata* NK30174; HWML63448 *C. perspicillata* NK30195; HWML63449 *C. perspicillata* NK30199; HWML63450 *C. brevicauda* NK30200.