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TWO NEW SPECIES OF *LITOMOSOIDES* (NEMATA: ONCHOCERCIDAE) FROM *CTENOMYS OPIMUS* (RODENTIA: CTENOMYIDAE) ON THE ALTIPLANO OF BOLIVIA

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**ABSTRACT:** Two filarioid nematodes, *Litomosoides andersoni* n. sp. and *Litomosoides ctenomyos* n. sp. (Nemata: Onchocercidae), are described from the mesenteries of the subterranean rodent *Ctenomys opimus* (Rodentia: Hystrichognathi) collected on the altiplano of Bolivia. Specimens collected near Rancho Huancaroma (Oruro Dept.) in 1984 and 1986 can be recognized as undescribed by the structures of the spicules and stoma and the shape of the ovjector. This record represents the first time members of the genus *Litomosoides* have been recovered from rodents of the family Ctenomyidae; this also represents the first published report of these nematodes from mammals in Bolivia.

Species of the genus *Ctenomys* de Blainville occur in all major habitat types in the neotropics south of about latitude 16°S in lowland subtropical savanna and about latitude 11°S in the high altitude (>3,500 m) Puna, Altiplano, and Cerrado de Andes (Mares and Ojeda, 1982; Reig, 1986; Contreras et al., 1987). The northern limit of distribution of these subterranean rodents in central lowland Bolivia is about 16°30' S, defined by the termination of the northernmost extent of the Chaco-dry forest and the beginning of lowland subtropical forest and palm-nut savannas (Unzueta, 1975). In lowland Bolivia, ctenomyids occur in friable, well-drained soils (S. L. Gardner, pers. obs.); in the high-altitude region of western Bolivia, these rodents occur in colonies in friable soils throughout their range (S. L. Gardner, pers. obs.). The northern limit of distribution of ctenomyids in high-altitude habitats in the Andes is undefined.

Presently, 39 species of ctenomyids are recognized (Mares and Ojeda, 1982; Wilson and Reeder, 1993); however, in rodents of the genus *Ctenomys*, levels of variation in diploid and fundamental numbers of chromosomes are extremely high (Cook and Yates, 1994). Thus, a species of *Ctenomys* described and defined without data on chromosomes may actually represent a complex of undetected species, and as many as 60 or more cryptic species may exist in southern South America.

Filaroid nematodes of the genus *Litomosoides* Chandler, 1931, occur in the abdominal and thoracic cavities of mammals of the orders Didelphimorphia, Chiroptera, and Rodentia in the Neotropical and Nearctic regions (Bain et al., 1989). Filaroid nematodes of the genus *Litomosoides* have been reported from hosts in the Palearctic region (Gupta and Trivedi, 1989); however, the specimens of Gupta and Trivedi (1989) appear more similar to filarioid nematodes of the genus *Litomosoa* Yorke and Mapleton, 1926.

Scott et al. (1951) detailed the life history of *Litomosoides carinii* Travassos, 1919, from experimental infections. The cotton rat, *Sigmodon hispidus* Say and Ord, was used as the definitive host, and the tropical rat mite, *Bdellonyssus bacoti* (Hirst), was used as the intermediate host. In the arthropod, microfilariae exsheath in the gut, enter the hemocoele, and develop into third-stage juveniles (Anderson, 1992). During the blood meal, the microfilariae are transmitted as infective third-stage juveniles to the definitive host (mammal). Within the circulatory system of the definitive host, third-stage microfilariae undergo an additional molt to fourth-stage juveniles that later molt into adults in the mesenteries.

Subsequent to the work by Scott et al. (1951), additional life cycle experiments were conducted with *Litomosoides galizae* Bain, Petit, and Diagne, 1989, *Litomosoides petteri* Bain, Petit, and Berteaux, 1980, and *Litomosoides legereae* Bain, Petit, and Berteaux, 1980, using *B. bacoti* as the intermediate host. These experimental infections were used to characterize more completely the details of microfilariae at each stage in the life cycle (Bain et al., 1980, 1989). However, except for the work by Forrester and Kinsella (1973), there have been no experiments on host specificity and identity of the intermediate hosts for those species of *Litomosoides*.

The present paper includes the descriptions of 2 new species of filarioid nematodes of the genus *Litomosoides* sensu Gardner and Schmidt, 1986, found in the mesenteries of rodents of the genus *Ctenomys* (Rodentia: Ctenomyidae) collected in 1984 and 1986 from a single locality on the altiplano of Bolivia.

**MATERIALS AND METHODS**

Individual nematodes that we determined represent 2 new species of the genus *Litomosoides* were recovered from *Ctenomys opimus* Wagner collected in Bolivia during May through August in the years 1984 and 1986. These collections were part of a larger study to survey the biodiversity of the parasites of mammals of Bolivia. Blood smears were prepared, fixed in 100% methanol, stained with Wright’s stain, and examined for the presence of microfilariae. Adult filarioid nematodes were isolated from the abdominal and thoracic regions of freshly killed hosts and were killed in glacial acetic acid. The adult filarioid nematodes were then fixed in 10% formalin or stored in 70% ethanol.

In the laboratory, specimens were cleared over a period of 5–7 days by evaporation of a solution of 70% ethanol, 2% glycerol, and 2% lactic acid. Quantitative measurements were taken using both a calibrated ocular micrometer and a computer-aided image measurement system. Drawings were made with the aid of a drawing tube. Microfilariae were dissected from broken females for detailed drawing and measurement. In the description, n = number of individuals, SD = standard deviation, CV = coefficient of variation, and means are in parentheses.

**DESCRIPTION**

*Litomosoides andersoni* n. sp. (Figs. 1–14)

**General:** With characters of the genus (sensu Gardner and Schmidt, 1986). Males about ½ length of females. Lateral amphids visible with slightly narrowing cephalic extremity. Reduced lateral alae (Fig. 14). Well-culticulated stoma wider than long, expanding posteriorly to a width greater than the anterior part; posterior ½ of the stoma embedded in the muscular part of esophagus. Nerve ring about ½ distance from anterior extremity (Fig. 1); excretory pore at level of nerve ring. Long

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and tapering tail (Fig. 10). Sheath of microfilaria longer than body, with longest part at tail (Fig. 4).

**Male:** n = 16, total length 21–31 (27) mm, SD = 2 mm, CV = 0.09. Maximum body width 19–172 (147), SD = 15, CV = 0.11. Anterior body width 25–43 (37), SD = 4, CV = 0.12. Width of stoma 4–10 (8), SD = 2, CV = 0.24. Length of stoma 3–8 (5), SD = 1, CV = 0.24. Body width at base of esophagus 56–74 (64), SD = 5, CV = 0.07. Length of esophagus 501–764 (661), SD = 77, CV = 0.12. Esophagus width at midpoint 15–37 (23), SD = 5, CV = 0.24. Distance from nerve ring to anterior end 220–531 (362), SD = 71, CV = 0.20. Body width at nerve ring 31–65 (49), SD = 7, CV = 0.14. Length of left spicule 286–654 (556), SD = 125, CV = 0.23. Distance from posterior body part being embedded in the esophagus. However, the stoma of *L. andersoni* is shorter and thicker and possesses a different shape than those of *L. thomonydis* and *L. westi.*

*Litomosoides andersoni* n. sp. can also be distinguished from *L. thomonydis* by the shape of the spicules; in *L. andersoni*, the right spicule terminates distally in a sharp hook, whereas the lamina of the right spicule of *L. thomonydis* is more rounded and lacks a hook. The spicules resemble those of the “carinii” group as defined by Bain et al. (1989; p. 285) in the following: “Dans le deuxième type, représenté par *L. carinii* et *L. scotti*, le spicule droit est scellé avant son extrémité distale, avec un bourrelet subterminale, bien marqué sur la face dorsale, qui peut délimiter un capuchon terminal (*L. carinii*); le talon est fort. Le spicule gauche a une lame composée d’une partie simple et bien scellée, plus courte que la manche; la partie postérieure entièrement membraneuse n’est bien visible que chez *L. scotti.*”

*Litomosoides andersoni* can be differentiated from *L. westi* on the shape of the tail; *L. andersoni* lacks any caudal projections, whereas *L. westi* has a tail ending in 3 well-developed points (see Gardner and Schmidt, 1986).

### *Litomosoides etsynenos* n. sp.

**(Figs. 15–28)**

**General:** With characters of the genus (sensus Gardner and Schmidt, 1986). Viewed en face, cephalic extremity lacking visible structures. Cylindrical stoma longer than wide with irregularly thickened walls, about 4/5 of stoma embedded in esophagus (Figs. 16, 17). Nerve ring located about 4/5 of length of esophagus from anterior end (Fig. 15), excretory pore at level of nerve ring. Reduced lateral alae (Fig. 27). Sheath of microfilariae about the length of the body (Fig. 19).

**Description:**

1. Total length 27–31 (28) mm, SD = 0.23; Maximum body width 92–170 (140), SD = 27, CV = 0.19. Body width at anterior end 39–43 (41), SD = 1, CV = 0.03. Stoma width 7–9 (8), SD = 1, CV = 0.11; stoma length 13–18 (15), SD = 2, CV = 0.10. Body width at esophagus base 60–77 (67), SD = 6, CV = 0.09. Esophagus length 511–730 (640), SD = 75, CV = 0.11; esophagus width 24–28 (25), SD = 2, CV = 0.06. Distance of nerve ring to anterior end 205–425 (317), SD = 90, CV = 0.28. Width of body at nerve ring 56–61 (58), SD = 2, CV = 0.04.

2. **Description of spicules:** Spicules similar to those described for the “*simegnodontis*” group by Bain et al. (1989). Right spicule much shorter than left. Manubrium and calomus well ciliated, much longer than the lamina portion of the spicule. Lamina without vellum, strongly ciliated. Spicule tapers posteriorly ending in a slender tip (Fig. 28). Right spicule less ciliated than those usual for the carinii group, blade is lacking a phalange and it tapers with 2 ciliarus borders. Length of right spicule 73–91 (81), SD = 7, CV = 0.08. Left spicule long and slender, calomus and lamina portions of almost equal proportions. Vellum relatively well developed, extending from the junction of the calomus and the lamina, disappearing in about the distal 3/5 of the length of the spicule. Distal portion becoming narrow and ending in a rodlike structure with a slightly hooked terminus (Fig. 20). Blade simple and not longer than handle, vellum not as well developed as those of the carinii group. Length of left spicule 189–385 (296), SD = 66, CV = 0.22; calomus length 119–131 (125), SD = 5, CV = 0.03; manubrium width 7–14 (12), SD = 3, CV = 0.21; lamina length 143–192 (160), SD = 19, CV = 0.11; vellum length 32–71 (52), SD = 14, CV = 0.26; tail length 151–194 (171), SD = 16, CV = 0.09.

3. Body width at cloaca 45–51 (48), SD = 2, CV = 0.04. Number of postcloacal papillae 6–12 (10), SD = 2, CV = 0.20. Tail rounded with 4–5 coils, 8–9 postcloacal papillae and 1 pair of cloacal papillae (Figs. 18, 21).

**Female:** n = 5. Maximum body width 264–333 (300), SD = 25, CV = 0.08. Width at anterior end 44–62 (569), SD = 7, CV = 0.13. Body width at esophagus base 98–144 (116), SD = 17, CV = 0.15. Stoma length 17–20 (18), SD = 2, CV = 0.06; stoma width 6–11 (9), SD = 2, CV = 0.33. Length of esophagus 0.13–0.26 (0.18), SD = 0.02. Width of esophagus 27–39 (31), SD = 5, CV = 0.15. Length of nerve ring to anterior end 110–598 (416), SD = 186, CV = 0.45. Body width at nerve ring 70–118 (91), SD = 20, CV = 0.22. Vellum posterior to esophagus with a bulbous muscular ovicentral (Figs. 15, 23). Distance from vellum to anterior end 1,125–2,170 (1,474), SD = 415, CV = 0.28. Body width at vulva 124–181 (158), SD = 21, CV = 0.14. Tail tapers with visible phasmids (Figs. 24, 26).

**Microfiliaria:** From specimens dissected from uterus of female nematode, mean measurement lengths including sheath (n = 10): length 65, width 5. Sheath of microfilaria longer than body, with longest part at sheath at posterior end (Fig. 4). From specimens measured without sheath in blood smear, mean measurements (n = 100): length 37, width 6.

### Taxonomic summary

**Symbiote:** Holosymbiote: *Ctenomys opinus*. American Museum of Natural History (AMNH) catalog no. 260839; field collection no. SG#61-84; Museum of Southwestern Biology (MSB); Division of Biologial Materials, New Mexico, kroyvoucheur no. NK11511. Allosymbiote: *Ctenomys opinus*. AMNH catalog no. 260843; field collection no. SG133-84; MSB Division of Biological Materials, New Mexico, kroyvoucheur no. NK11583. Collected August 1984.

**Type locality:** 3.5 km northeast of Rancho Huancaroma, Departamento de Oruro, Bolivia, South America (17°40′S, 67°27′W, elev. 4,000 m).

**Specimens deposited:** Holotype male (NK11511G): H. W. Manter Laboratory (HWML) 39122. Allotype female (NK115853A): HWML 39123.

**Etymology:** Named in honor of Dr. Sydney Anderson, leader of our field expeditions and a pioneering mammologist in Bolivia.

**Prevalence:** In 1984, 9/22 (40%) of individuals of *C. opinus* examined from the type locality were infected with *L. andersoni*.

### Diagnosis

*Litomosoides andersoni* n. sp. can be distinguished from all other species of *Litomosoides* except *L. thomonydis* Gardner and Schmidt, 1986, and *L. westi* Gardner and Schmidt, 1986, by the structure of the stoma. These 3 species possess a stoma that is broader than long with most of the posterior part being embedded in the esophagus. However,
atode, mean measurements (n = 10): length 72, width 5. Sheath of microfilaria about length of body (Fig. 19). No microfilaria were found in blood smears.

**Taxonomic summary**

**Symbiotype:** Holosymbiotype: *Ctenomys opimus*, MSB Division of Mammals catalog no. 57198; Division of Biological Materials, New Mexico, kryovoucher no. NK14766. Field collection number SG328-86. Collected October 1986.

**Type locality:** 3.5 km northeast of Rancho Huancaroma, Departamento de Oruro, Bolivia, South America (17°40′S, 67°27′W, elev. 4,000 m).

**Specimens deposited:** Holotype male (NK14766B): HWML 39124. Allotype female (NK14766A): HWML 39125.

**Etymology:** Named after the genus of host, meaning “of Ctenomys.”

**Prevalence:** In 1986, 2/8 (25%) of individuals of *C. opimus* examined from the type locality were infected with *L. ctenomyos*.

**Diagnosis**


*Litosomoides cenomoids* can be distinguished from *L. barretti* by the shape of the right spicule and the lack of papillae near the tip of the tail; from *L. teshi* in the shape of the stoma and the shape of the tail in the female, and from *L. sigmodonitis* in lacking anteriorly directed cephalic structures (papillae) and in the shape of the spicules. *Litomosoides cenomoids* can be differentiated from *L. leonilavazqueziae* by the size of the body of both males and females and the greater number of unpaired post-cloacal papillae.

**DISCUSSION**

The finding of filarial nematodes of the genus *Litomosoides* in rodents of the family Ctenomyidae from Bolivia greatly increases the known host range and known geographic distribution of these filarid nematodes. Rodents of the genus *Ctenomys* exhibit a strongly subterranean lifestyle (Nevo, 1979). Our observations of individuals of *C. opimus* in colonies in at least 3 different geographic localities in Bolivia indicate that these rodents rarely emerge completely from their burrow systems during daylight hours. On several occasions at 1 locality (Bolivia: Cruce Ventilla, 19°08′S, 66°07′W, elev. 3,950), individuals of *C. opimus* were collected from the same burrow systems from which were collected rodents of the genera *Galea* Meyen (Hystricognathi: Caviidae) and *Phyllotis* Waterhouse (Sciurognathi: Muridae). At this locality, no adult helminths were found that are shared by other rodents living sympotically with *C. opimus*. The rodents of the genera *Galea*, *Ctenomys*, and *Phyllotis* represent 2 major phylogenetic lineages: 1 lineage in the Hystricognathi Tulberg and 1 lineage in the Sigmodontinae Wagner. Only 1 species of helminth (represented by metacercoides of *Taenia taliensis* Dollfus, 1960) was found to be shared among species of *Galea*, *Ctenomys*, and *Phyllotis* sharing burrow systems.

It is interesting to note the morphological similarities in the stoma of *L. andersoni*, *L. thomomoidis*, and *L. westi*. The latter 2 species occur only in rodents of the family Geomyidae in the central Nearctic region. Geomyid rodents are a relatively old group, having originated in North America with no evidence of a fossil history outside the Nearctic region (Russell, 1968). Members of the family Geomyidae occur from southern Canada south through suitable habitat across the isthmus of Panama into northern Colombia in South America, whereas ctenomyid rodents have a strictly southern neotropical distribution, having originated from hystricognath ancestors, perhaps as late as the Pliocene (Gardner, 1991). There is no evidence of any possible contact between geomyids and ctenomyids; therefore, the similarity of morphological characters between at least 2 species of their nematodes appears to be a result of morphological convergence. It is also possible that there may have been a host switch from an ancestor derived from the Nearctic region. The questions presented above can probably be answered most readily by performing an historical–phylogenetic analysis including species of both *Litomosoides* and *Litomosa* using data derived from studies of both morphological and molecular characters. This analysis would provide some spatial/temporal frame that would allow an understanding of the diversification of many of these genera of nematodes.

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**LITERATURE CITED**


