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Two new species of *Litomosoides* (Nematoda: Onchocercidae) from pocket gophers (Rodentia: Geomyidae) in Colorado

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Summary

Two new species of nematodes representing the genus *Litomosoides* were obtained from pocket gophers collected in the early 1960s and during 1982 in Colorado. Individuals of *Litomosoides thomomydis* n. sp. were recovered from the abdominal cavities of two species of pocket gopher, *Thomomys talpoides* (Richardson) and *T. bottae* (Eydoux & Gervais). Nematodes representing *L. westi* n. sp. were recovered from the abdominal and pleural cavities of the plains pocket gopher *Geomys bursarius* (Shaw) from eastern Colorado. These two species of filarioid nematodes appear to be restricted in geographical range to those pocket gophers inhabiting the central grasslands and Rocky Mountain region of the United States and Canada.

Introduction

Nematodes of the genus *Litomosoides* Chandler, 1931 are parasites of the body cavities of bats, rodents and marsupials in Nearctic and Neotropical regions (Bain *et al.*, 1980; Esslinger, 1973; Muller, 1980; Table I). Chandler first proposed the genus *Litomosoides* to include *L. sigmodontis* Chandler, 1931. The specimens upon which he based the description were recovered from cotton rats, *Sigmodon hispidus* Say & Ord, and a white rat, probably *Rattus norvegicus* (Berkenhout), from Houston, Texas.

Burnham (1953) was the first to report filarioids from pocket gophers when she reported *Litomosa filaria* Beneden, 1873 from *Geomys bursarius* Shaw in Oklahoma. Other reports of filarioids from pocket gophers include Lubinsky (1957), who reported *L. carinii* (Travassos, 1919) from *Thomomys talpoides* (Richardson) in Alberta, Canada, and R.L. Rausch (pers comm. 1983), who found an

unidentified species of filarioid in *T. talpoides* in southern Saskatchewan, Canada. West (1961) reported finding many specimens of *Litomosoides* spp. from various localities in Colorado.

After detailed study of material obtained from pocket gophers by West in the early 1960s and after study of nematodes collected from *G. bursarius* by one of us (SLG), we found that two undescribed species of *Litomosoides* were present. The purpose of this report is to describe these nematodes.

The combination of characters of both species of filarioids from pocket gophers is slightly different from that described in other members of the genus *Litomosoides*. We feel that it is expedient to amend the generic diagnosis in order to accommodate these two new species.

Materials and methods

Most of the nematodes used for the following de-

Table I. Complete list of species of *Litomosoides* recovered from in the Nearctic and Neotropical regions.

Species	Type-host
<i>Litomosoides</i> sp. of Chitwood (1938)	<i>Artibeus jamaicensis</i> Leach
<i>L. artibeii</i> Esslinger, 1973	<i>Artibeus cinereus</i> (Gervais)
<i>L. barretti</i> Muller, 1980	<i>Marmosa cinerea</i> (Temminck)
<i>L. brasiliensis</i> Lins de Almeida, 1936	<i>Carollia perspicillata</i> (Linnaeus)
<i>L. caliensis</i> Esslinger, 1973	<i>Sturnira lilium</i> (E. Geffroy)
<i>L. carinii</i> (Travassos, 1919)	<i>Sigmodon hispidus</i> Say & Ord
<i>L. chandleri</i> Esslinger, 1973	<i>Artibeus jamaicensis</i>
<i>L. colombiensis</i> Esslinger, 1973	<i>Vampyrops dorsalis</i> (Thomas)
<i>L. fosteri</i> Caballero, 1947	<i>Glossophaga soricina</i> (Pallas)
<i>L. guiterasi</i> (Viguera, 1934)	<i>Glossophaga soricina</i>
<i>L. hoplomyis</i> Esslinger, 1973	<i>Hoplomys gymnurus</i> (Thomas)
<i>L. legerae</i> Bain <i>et al.</i> , 1980	<i>Oxymycterus quaestor</i>
<i>L. leonilavazquezae</i> Caballero, 1939	<i>Macrotus mexicanus</i> Sasseur
<i>L. molossi</i> Esslinger, 1973	<i>Molossus molossus</i> (Pallas)
<i>L. petteri</i> Bain <i>et al.</i> , 1980	<i>Marmosa cinerea</i>
<i>L. scottii</i> Forrester & Kinsella, 1973	<i>Oryzomys palustris</i> (Harlan)
<i>L. silvaei</i> Padihla & De Faria, 1977	<i>Akodon arviculoides</i> (Wagner) [= <i>Bolomys lasiurus</i> (Lund)]
<i>L. teshi</i> Esslinger, 1973	<i>Carollia perspicillata</i>
<i>L. thomomydis</i> n. sp.	<i>Thomomys talpoides</i> (Richardson)
<i>L. westi</i> n. sp.	<i>Geomys bursarius</i> (Shaw)

scriptions were collected by West (1961) and deposited in the collection of Dr. O.W. Olsen in the Department of Zoology and Entomology, Colorado State University, Fort Collins, Colorado. Material derived from the collection of Dr. Olsen had been preserved in glycerol after fixation in 10% aqueous formalin. Nematodes obtained in 1982 were fixed in 10% aqueous formalin, stored in 70% aqueous ethanol and cleared in glycerol and 2% lactic acid. The following descriptions are based on ten males and ten females of each species. All measurements are in micrometres unless otherwise indicated; means are in parentheses and SD signifies standard deviation.

Genus *Litomosoides* Chandler, 1931

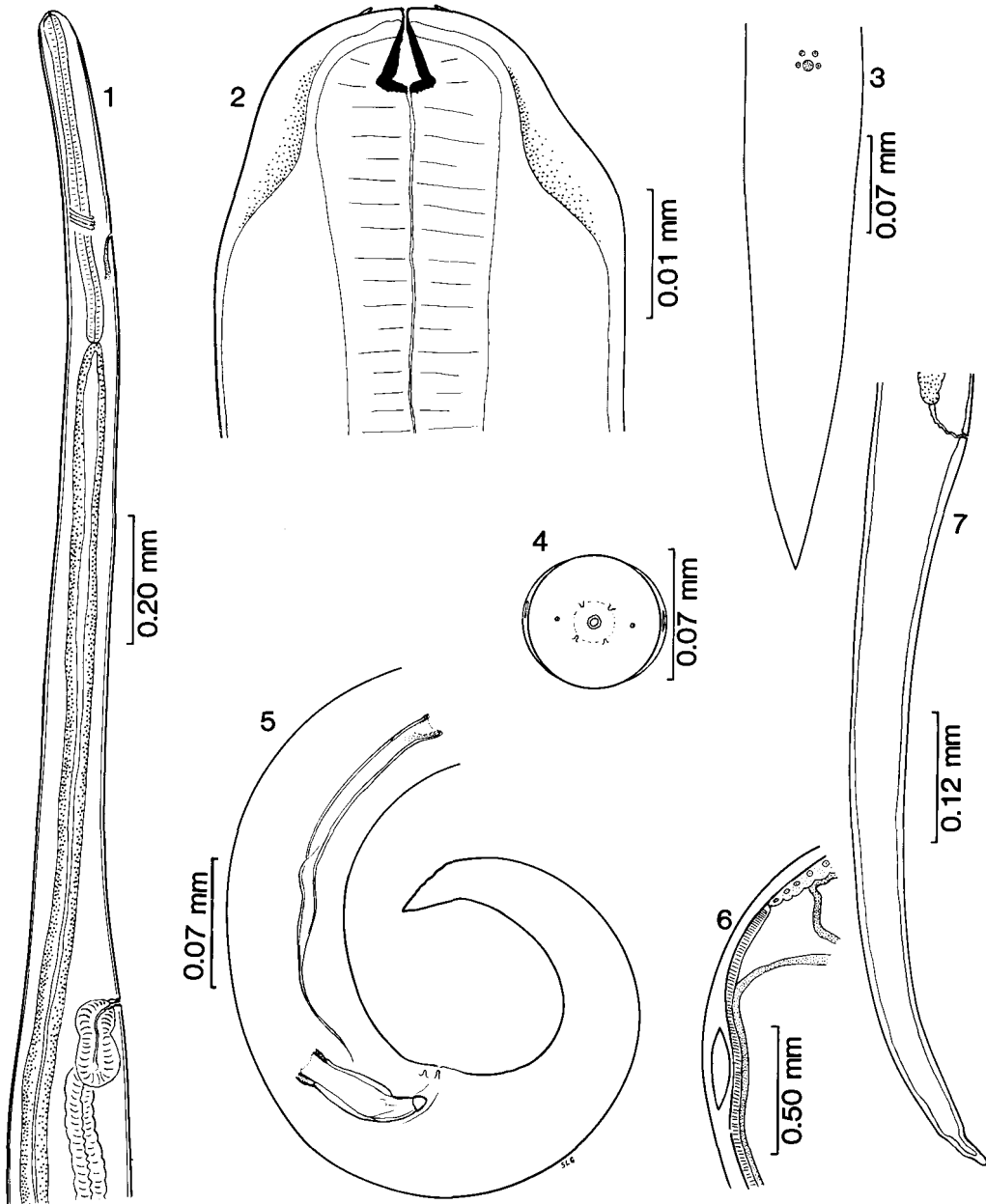
Amended diagnosis (cf. Esslinger, 1973): Filarioidea; Onchocercidae; Onchocercinae. Body slender and cylindrical. Cuticle finely striated except for extremities. Head bluntly rounded without lips; circumoral papillae very small or absent. Buccal capsule a slender tube with thick walls, not

complex in form. Oesophagus of moderate length, straight; anterior part muscular and posterior part glandular; anterior end enclosing buccal capsule. Vulva either post- or pre-oesophageal. Ovijector strongly muscular, bulb-like; vagina long with thick walls; ovaries extending to region of anus or beyond. Tail of female long, simple or with more than one point. Cuticle at level of vulva with prominent lateral, internal, cuticular ridge. Tail of male long, usually coiled; pre-anal papillae present or absent; post-anal papillae present or absent, if present may be variable in number. Spicules dissimilar; left long and slender, right much shorter and wider. Microfilariae sheathed, small, fusiform or cylindrical, with anterior and posterior ends attenuated.

Litomosoides thomomydis n. sp. (Figs 1–7)

Description

General: Lateral internal cuticular ridge fusiform, well developed. Four small circumoral papillae



Figs 1–7. *Litomosoides thomomydis* n. sp. 1. Anterior end of female, showing nerve ring, excretory pore and vulva. 2. Anterior end of female, showing degree of development of buccal capsule. 3. Posterior end of male, ventral view, showing cloaca and anal papillae. 4. *En face* view of female, note small circumoral papillae. 5. Posterior end of male, lateral view, showing anal papillae and spicules. 6. Cross section of female, showing lateral internal cuticular ridge. 7. Posterior end of female.

present; amphids indistinct. Buccal capsule with markedly thickened walls posteriorly. Posterior 3/8 of buccal capsule embedded in oesophagus.

Male: Length 13.4–30.0 mm (22.79 mm) SD = 5.13 mm. Maximum width at about 1/16 of length

from posterior extremity 113–164 (138) SD = 19. Width at anterior end 24–56 (34) SD = 11. Buccal capsule 6–10 (8) SD = 1 long by 5–11 (8) SD = 2 wide. Width of body at base of oesophagus 47–54 (51) SD = 3, at level of anus (measured dorso-

ventrally) 49–75 (57) SD = 4. Nerve ring 136–494 (321) SD = 106 from anterior end. Excretory pore at level of nerve ring. Oesophagus 322–550 (454) SD = 81 long by 15–23 (18) SD = 3 in maximum width. Spicules dissimilar in size and shape; right spicule 59–73 (65) SD = 4 long by 14–19 (16) SD = 2 in maximum width, left spicule 164–287 (241) SD = 2 in maximum width. Number of coils in tail from 4–5. Tail 204–310 (252) SD = 35 long, tapering to single point. One pair of distinct adanal papillae. Postanal papillae absent.

Female: Length 35.7–80.59 mm (59.61 mm) SD = 12.97 mm. Width at anterior end 28–52 (39) SD = 10. Buccal capsule 7–11 (9) SD = 1 long by 5–11 (8) SD = 2 wide. Maximum width about 20 mm posterior to vulva, 188–236 (225) SD = 26. Width at base of oesophagus 54–80 (68) SD = 9, at level of vulva 125–149 (140) SD = 12, at level of nerve ring 53–75 (64) SD = 7, at level of anus 40–110 (69) SD = 19. Nerve ring 317–456 (337) SD = 40 from anterior extremity. Excretory pore at level of nerve ring. Vulva post-oesophageal, 1502–2112 (1766) SD = 233 from anterior end. Muscular ovjector 114–164 (131) SD = 4 long by 54–82 (62) SD = 8 wide anteriorly and 34–70 (58) SD = 9 wide posteriorly. Oesophagus 466–619 (513) SD = 58 long by 25–27 (26) SD = 2 maximum diameter. Anus 503–1219 (776) SD = 209 anterior to tip of tail, tail tapering to single point.

Microfilariae: Measured *in utero* 70–101 (86) SD = 11 long by 4–5 in maximum width; sheath not visible.

Type-host: *Thomomys talpoides* (Richardson).

Site of infection: Abdominal cavity.

Type-locality: USA, Colorado, Heurfano Co., 19 km NW Gardner (lat. 37° 47' 30'' N.; long. 105° 10' W).

Type-material: Holotype: Male from *Thomomys talpoides*, USNM Helm. Coll. No. 78960. Allotype: Female, from *Thomomys talpoides*, USNM Helm. Coll. No. 78961. Paratypes: Two females and two males from *T. bottae*, from type-locality. USNM Helm. Coll. No. 78962.

Etymology: Named after the genus of pocket gopher in which it was found.

Discussion

Litomosoides thomomydis n. sp. is distinguished immediately from the five congeners described from rodents and from the two in marsupials by the lack of postanal papillae. The same criteria serve to distinguish *L. thomomydis* from nine congeners described from bats. Additionally, *L. thomomydis* differs from *L. molossi* Esslinger, 1973 in the following ways: *L. thomomydis* completely lacks ventral postanal papillae, while *L. molossi* possesses a 'single minute subterminal pair' of papillae (Esslinger, 1973); *L. thomomydis* possesses a single pair of pre-anal and a single pair of adanal papillae, while *L. molossi* has none; the length of the tail in males of *L. thomomydis* has a range of 204–310 compared to a value of only 87 for the single specimen of *L. molossi* from which Esslinger (1973) reported measurements; and the buccal capsule of *L. thomomydis* is shorter and much more robust than that of *L. molossi*. *L. thomomydis* also differs from *L. molossi* in other morphological characteristics.

L. thomomydis differs from *L. artibeii* Esslinger, 1973 (described from only the anterior end of a female nematode recovered from a fruit bat in Colombia) by possessing a much more robust internal cuticularized ridge (visible in cross section) and in the morphological characteristics of the buccal capsule; the buccal capsule of *L. thomomydis* is much shorter and wider than that of *L. artibeii*.

Additionally, two species, *L. caliensis* Esslinger, 1973 and *L. colombiensis* Esslinger, 1973 have been described from microfilariae identified in blood smears from bats (see Table I) In the case of *L. thomomydis*, no blood smears were prepared from infected pocket gophers, thus stained preparations of microfilariae were not available. However, the microfilariae of *L. thomomydis* are much larger in overall size than those of *L. caliensis* and are shorter and wider than those of *L. colombiensis*.

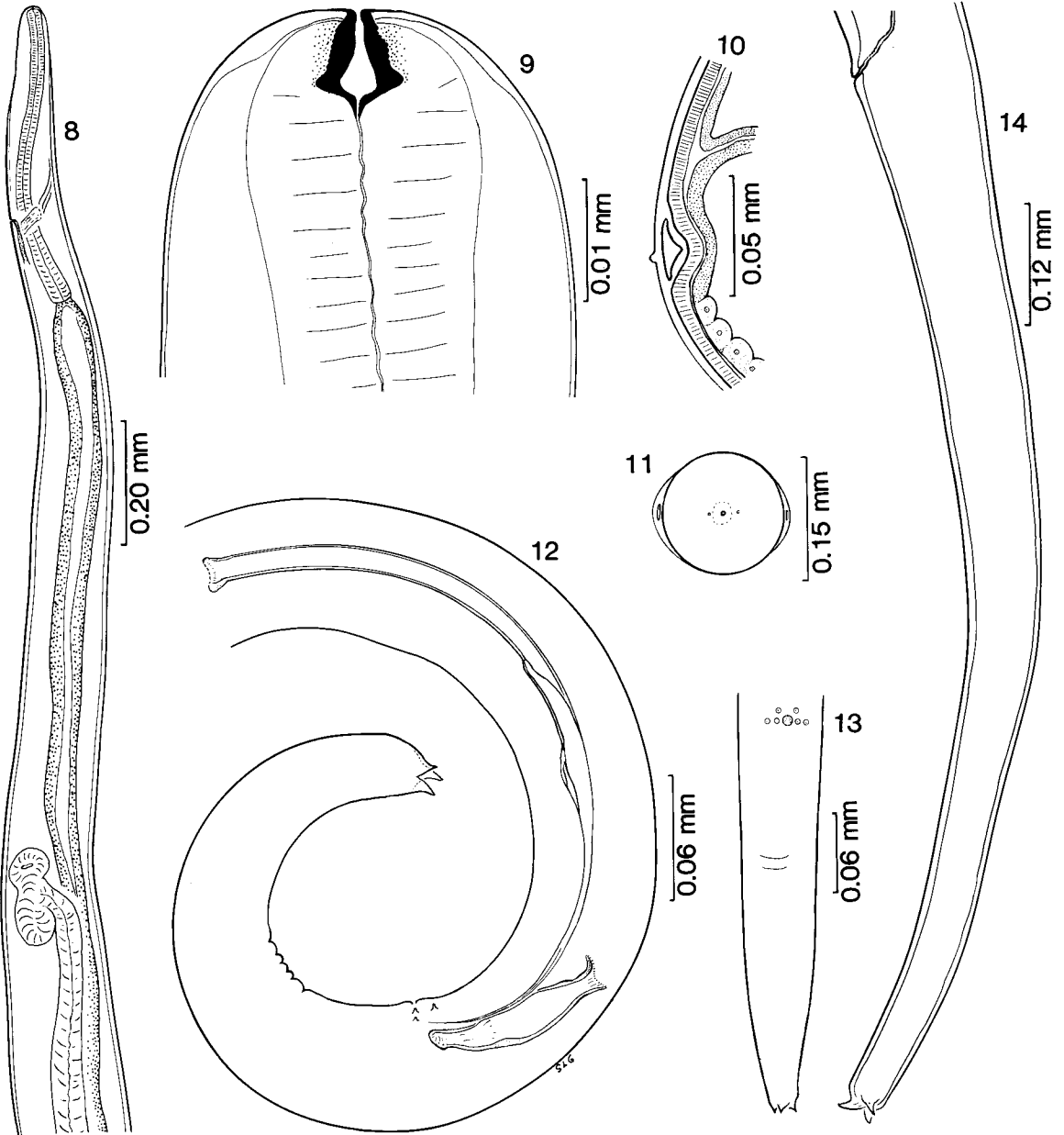
Litomosoides westi n. sp. (Figs 8–14)

Description

General: Lateral cuticular ridge visible in cross section, delta-shaped, strongly developed. Small sa-

lient external cuticular ridge extending longitudinally associated with lateral, internal, cuticular ridge. Oral papillae absent; amphids indistinct.

Male: Length 17.45–23.3 mm (20.13 mm) SD = 2 mm. Maximum diameter about 1/16 of length from posterior extremity, 132–164 (151) SD = 10.



Figs 8–14. *Litomosoides westi* n. sp. 8. Anterior end of female showing nerve ring, excretory pore and vulva. 9. Anterior end of female showing degree of development of buccal capsule. 10. Cross section of female showing lateral internal cuticular ridge. 11. *En face* view of female showing lack of circumoral papillae. 12. Posterior end of male, lateral view, showing spicules, anal papillae and tail ending in three points. 13. Posterior end of male, ventral view, showing anal papillae. 14. Posterior end of female showing tip of tail with three caudal points.

Buccal capsule 8–10 (9) SD = 1 long by 7–9 (8) SD = 1 wide. Width at anterior end 34–49 (40) SD = 5. Body width at base of oesophagus 60–77 (67) SD = 6, at level of nerve ring 39–64 (53) SD = 9, at level of anus (measured dorso-ventrally) 59–70 (66) SD = 4. Nerve ring 192–378 (271) SD = 45 from anterior end. Excretory pore at level of nerve ring. Oesophagus 421–564 (507) SD = 45 long by 23–32 (28) SD = 3 in maximum width. Spicules dissimilar in size and shape; right spicule 67–90 (77) SD = 6 long by 12–20 (17) SD = 2 in maximum width; left spicule 258–397 (348) SD = 45 long by 8–14 (10) SD = 2 in maximum width. Number of tail coils 4–5. Tail 173–256 (206) SD = 27 long, ending in 3, or less often, 4 sharp points. Anal papillae present in the following arrangement; one pair pre-anal, 2 pairs adanal.

Female: Length 36.22–48.63 mm (42.69 mm) SD = 4 mm. Width at anterior end 25–52 (39) SD = 11. Buccal capsule 8–11 (9) SD = 1 long by 7–9 (8) SD = 1 wide. Maximum diameter at level about 15 mm posterior to vulva, 200–244 (232) SD = 15. Body width at base of oesophagus 73–93 (84) SD = 8, at level of vulva 101–148 (127) SD = 15, at level of nerve ring 63–85 (74) SD = 6, at level of anus 66–87 (80) SD = 7. Nerve ring 246–343 (296) SD = 28 from anterior end. Oesophagus muscular, 475–590 (534) SD = 61 long. Excretory pore at level of nerve ring. Vulva post-oesophageal, 1194–2821 (1361) SD = 176 from anterior end. Muscular ovijector 125–169 (152) SD = 13 long by 59–70 (65) SD = 4 wide anteriorly and 46–66 (52) SD = 6 wide posteriorly. Anus 583–798 (686) SD = 82 anterior to tip of tail; tail ending in 3 or 4 sharp points.

Microfilariae: Measured *in utero*, 85–100 (92) SD = 6 long by 4–6 in maximum width; larval sheath not visible.

Type-host: *Geomys bursarius* (Shaw).

Site of infection: Abdominal and pleural cavities.

Type-locality: USA, Colorado, Weld County, 10 km S.W. Lasalle, near Milton Reservoir (lat. 40° 15' N.; long. 104° 40' W).

Type-material: Holotype: Male, from *Geomys bursarius* USNM Helm. Coll. No. 78963. Allotype: Female, from *Geomys bursarius* USNM Helm. Coll. No. 78964. Paratypes: Two males and two

females from *Geomys bursarius* USNM Helm. Coll. No. 78965.

Other locality: USA, Colorado, Logan County, near Sterling (lat. 40° 37' 30'' N.; long. 103° 2' 30'' W.).

Etymology: Named after Richard West, who originally collected most of the specimens used in this study.

Discussion

Litomosoides westi n. sp. can be differentiated from all species of *Litomosoides* described up to the present time, except *L. artibeii*, *L. caliensis*, *L. colombiensis*, *L. molossi* and *L. thomomydis*, by the lack of post-anal papillae. *L. westi* is distinguished from *L. artibeii* in having: a buccal capsule that is shorter, wider and with walls that are much thicker; a greater distance from the anterior end to the vulva; and a lateral internal cuticular ridge that is more strongly developed and is 'delta shaped' compared to the 'low rounded' form in *L. artibeii*. *L. colombiensis* and *L. caliensis* were described from microfilariae recovered from bats by Esslinger (1973). Thus no comparisons of adult morphological characteristics can be made between *L. westi* and these two species. However, the microfilariae of *L. westi* are longer 85–100, compared to 53–65 for *L. caliensis* and the microfilariae of *L. westi* are shorter than those of *L. colombiensis* which have a range of 100–125. *L. westi* can be distinguished from *L. molossi* by the complete lack of post-anal papillae (*L. molossi* has one minute subterminal pair), a buccal capsule that is much shorter and of greater width, and an internal cuticular ridge that is 'delta shaped' compared to that of *L. molossi* which has a cuticular ridge that is 'rectangular'. *L. westi* differs from *L. thomomydis* in the following ways: in both sexes of *L. westi*, the tail ends in three points, compared to that of *L. thomomydis* in which the tail invariably terminates in a single point; and *L. westi* possesses three distinct pairs of anal papillae, whereas *L. thomomydis* has only two. Other morphological characteristics of the two species are similar.

Comments on previous records of filarioid nematodes from geomyid rodents.

Burnham (1953) reported *Litomosa filaria* (Beneden, 1873) (a parasite of bats) from *Geomys bursarius* in Oklahoma. She stated: 'This, then is a new host record for the genus, as well as the first time that it has ever been reported from the pleural cavity of any animal, although a closely related genus, *Litomosoides*, seems to prefer this location'. The filarioid nematodes that we collected from individuals of *G. bursarius* were found in the abdominal cavity, and West (1962) indicated that the specimens of *Litomosoides* that he collected from individuals of *G. bursarius* in Colorado were recovered from both the abdominal and pleural cavities. It is probable that the worms identified as *Litomosa filaria* by Burnham (1953) were in fact *Litomosoides westi*.

Litomosoides carinii was reported to occur in the 'coelom' of *Thomomys talpoides* collected from middle and southern Alberta by Lubinsky (1957). *L. carinii* apparently infects a wide range of hosts (Esslinger, 1973; Forrester & Kinsella, 1973); however, the reports of *L. carinii* from *T. talpoides* in Canada can probably be attributed to misidentifications. In fact, the specimens that Lubinsky (1957) recovered may represent *L. thomomydis*, or a closely related species.

It is of interest that Herman Douthitt, during a study of the anoplocephalid cestodes of *Geomys* spp. obtained in the midwestern United States, apparently did not collect filarioids (cf. Douthitt, 1915). His complete collection of nematodes was sent to M. C. Hall who published many descriptions of nematodes from rodents (see Hall, 1916). No descriptions of filarioids from geomyid rodents were included. Despite extensive surveys of the endoparasite fauna of geomyids in the western United States (see Gardner, 1983, for a complete review), filarioids have been reported from these hosts only from the Rocky Mountain and Great Plains regions.

The restriction in distribution of species of *Litomosoides* to pocket gophers in the central part of the Nearctic region indicates that the precursors of the two species found in geomyid rodents may have

been transferred to members of the genera *Thomomys* and *Geomys* sometime after the establishment of the present patterns of distribution of these mammals. Ectoparasitic mites (*Ornithonyssus* spp.), which are the vectors of *L. carinii* in cotton rats and rice rats and which are the probable vectors of other species of *Litomosoides* (see Forrester & Kinsella, 1973), may be restricted in geographical range to gophers occupying the central grasslands and Rocky Mountain regions. This would limit the range of the species of *Litomosoides* to gophers that are infested with these mites. Miller & Ward (1960) reported a single specimen of *Ornithonyssus* from *T. talpoides* in Colorado. This has been the only report of a mite of this genus from geomyids.

The lack of post-anal papillae in both species of filarioids from pocket gophers, compared to the ubiquity of post-anal papillae in all other species of *Litomosoides*, indicates that both *L. thomomydis* and *L. westi* were derived from the same ancestral species. In addition, general morphological similarity between both species (eg. lack of well-developed circumoral papillae, and buccal capsules that are very well developed and thickened posteriorly) indicate close phylogenetic relationship.

Additional detailed studies of both the endo- and ectoparasites of geomyid rodents throughout their range (particularly central America and northern Colombia) need to be carried out. The parasite fauna of the genera *Orthogeomys* Merriam, *Pappogeomys* Merriam and *Zygogeomys* Merriam have been little studied. Additional data derived from studies of these three groups should increase our understanding of the zoogeographical and evolutionary relationships that exist between pocket gophers and their helminth parasites.

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