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Distribution and biology of the ectoparasitic beetles *Leptinillus validus* (Horn) and *L. aplodontiae* Ferris of North America
(Coleoptera: Leiodidae: Platypsyllinae)

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Distribution and biology of the ectoparasitic beetles *Leptinillus validus* (Horn) and *L. aplodontiae* Ferris of North America (Coleoptera: Leiodidae: Platypsyllinae)

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Abstract. The distribution and biology of the beetles *Leptinillus validus* (Horn) and *L. aplodontiae* Ferris are summarized for North America. The beetles are ectoparasitic on rodents; *L. validus* on the beaver, *Castor canadensis* Linnaeus (Castoridae) throughout the northern part of its range, and *L. aplodontiae* on the mountain beaver, *Aplodontia rufa* (Rafinesque) (Aplodontidae) in the Pacific Northwest.

Introduction

The beetle family Leiodidae contains 335 known species in America north of Mexico, and these have some markedly diverse biologies. Keys for the identification of North American subfamilies, tribes and genera of Leiodidae are in Peck (2000). The small subfamily Platypsyllinae, containing only four genera worldwide, all of which are ectoparasitic, is of special interest because it contains the most modified ectoparasites of all beetles (Lawrence and Newton 1982, 1995; Newton 1998). The genera are: *Leptinus* Müller 1817 with six Palearctic and three Nearctic species, ectoparasitic on rodents and insectivores (Peck 1982); *Leptinillus* Horn 1882 with two Nearctic species, ectoparasitic on rodents, the semiaquatic genus *Castor* Linnaeus (Castoridae) and the fossorial genus *Aplodontia* Richardson (Aplodontidae); *Silphopsyllus* Olsufiev 1923 with one Palearctic species, ectoparasitic on the semiaquatic insectivore *Desmana moschata* Pallas (Talpidae) of Ukraine, Kazakstan and adjacent southeast Russia; and *Platypsyllus* Ritsema with one apparently Holarctic species, ectoparasitic on the two species of the semiaquatic genus *Castor* (Peck 2006). All these beetle genera are wingless and eyeless or with reduced eyes, and with a striking dorso-ventral flattening.

The purpose of this paper is to summarize for the first time the widely scattered records and literature on the distribution and biology of *Leptinillus validus* (Horn) and *L. aplodontiae* Ferris in North America, to provide a key to the species, and to provide illustrations of the aedeagus of *L. aplodontiae*.

Methods and Materials

Primary literature and lists and catalogs were searched and locality records compiled and referenced. Acronyms for museums containing specimens seen follow those of Arnett et al. (1993) and are: AMNH, American Museum of Natural History, New York, New York, USA; BDMU, Biology Department, McMaster University, Hamilton, Ontario, Canada; CASC, California Academy of Sciences, San Francisco, California, USA (also with material formerly in collections of Stanford University, Stanford, California); CMNH, Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, USA; CNCI, Canadian National Collection of Insects, Ottawa, Ontario, Canada; CUIC, Cornell University Insect Collection, Cornell University, Ithaca, New York, USA; DEBU, Department Environmental Biology, University of Guelph, Guelph, Ontario, Canada; EMEC, Essig Museum of Entomology, Department of Integrative Biology, University of California, Berkeley, California, USA; FMNH, Field Museum of Natural History, Chicago, Illinois, USA; HAHC, Henry and Anne Howden Collection, Canadian Museum of Nature, Aylmer, Quebec, Canada; INHS, Illinois Natural History Survey, Urbana, Illinois, USA; LEMQ, Lyman Entomological Museum, McDonald College, McGill University, Ste. Anne de Bellevue, Quebec, Canada; MCZC, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA; OSUO, Oregon State University, Corvallis, Oregon, USA; PSUC, Frost Museum, Department Entomology, Pennsylvania State University, College Park, Pennsylvania, USA; SBPC, Stewart B. Peck collection, Ottawa, Ontario, Canada; SMDV, Spencer Entomological Museum, University of British Columbia, Vancouver, British Columbia,

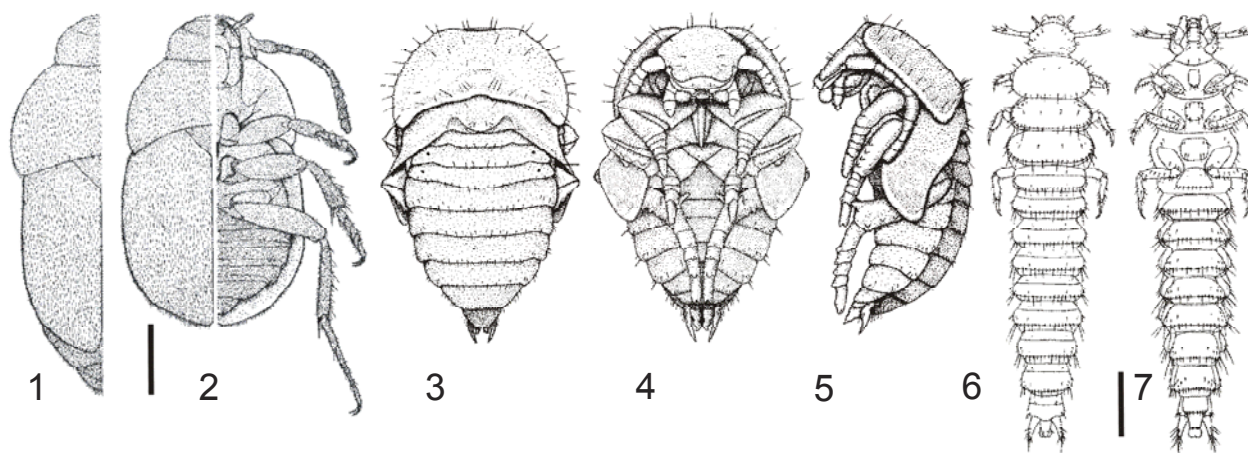


Figure 1-7. Habitus of life stages of *Leptinillus validus* (from Wood 1965). **1)** Dorsal view of left half adult male. **2)** Dorsal view (left) and ventral view (right) of adult female. **3-5)** Dorsal, ventral and lateral view of pupa. **6-7)** Dorsal and ventral view of third instar larva. Scale bars = 1.0 mm.

Canada; SMNH, Saskatchewan Museum Natural History, Regina, Saskatchewan, Canada; UCDC, University of California, Davis, California, USA; UCRC, UCR Entomological Collection, University of California, Riverside, California, USA; UMMZ, Division of Insects, Museum of Zoology, University of Michigan, Ann Arbor, Michigan, USA; UMSP, University of Minnesota, St. Paul, Minnesota, USA; USNM, National Museum of Natural History, Smithsonian Institution, Washington, District of Columbia, USA; UWEM, Insect Research Collection, Department of Entomology, University of Wisconsin, Madison, Wisconsin, USA.

Results

Genus *Leptinillus* Horn

Leptinillus Horn, 1882: 113. Type species: *Leptinus validus* Horn, 1872. Valid genus name of type species: *Leptinillus* Horn; by monotypy.

Key to species of *Leptinillus*

1. Body size larger, body length about 4.5-5.0 mm; posterior tip of prosternum with brush of long hairs; prosternal apex extending nearly as far as posterior margin of procoxae; prosternal apex truncate; host: *Castor canadensis*; distribution: USA, northern transcontinental ... ***L. validus* (Horn)**
- Body size smaller, body length about 3.0-3.5 mm; prosternal apex sparsely haired, without brush of long hairs; prosternal apex extending only about half length of procoxae; prosternal apex tip pointed; host: *Aplodontia rufa*; distribution: USA, Pacific Northwest ***L. aplodontiae* Ferris**

Leptinillus validus (Horn)

Fig. 1-8

Leptinillus validus (Horn), 1872: 145. Original genus: *Leptinus*. Type in MCZC, seen. Type locality: "Hudsons Bay Region."

Taxonomy: Hatch 1957: 17.

Redescription and morphology of adults: Hatch (1957: 17); Parks and Barnes (1955); Wood (1965).

Immatures: Bøving and Craighead (1930); Parks and Barnes (1955); Wood (1965).

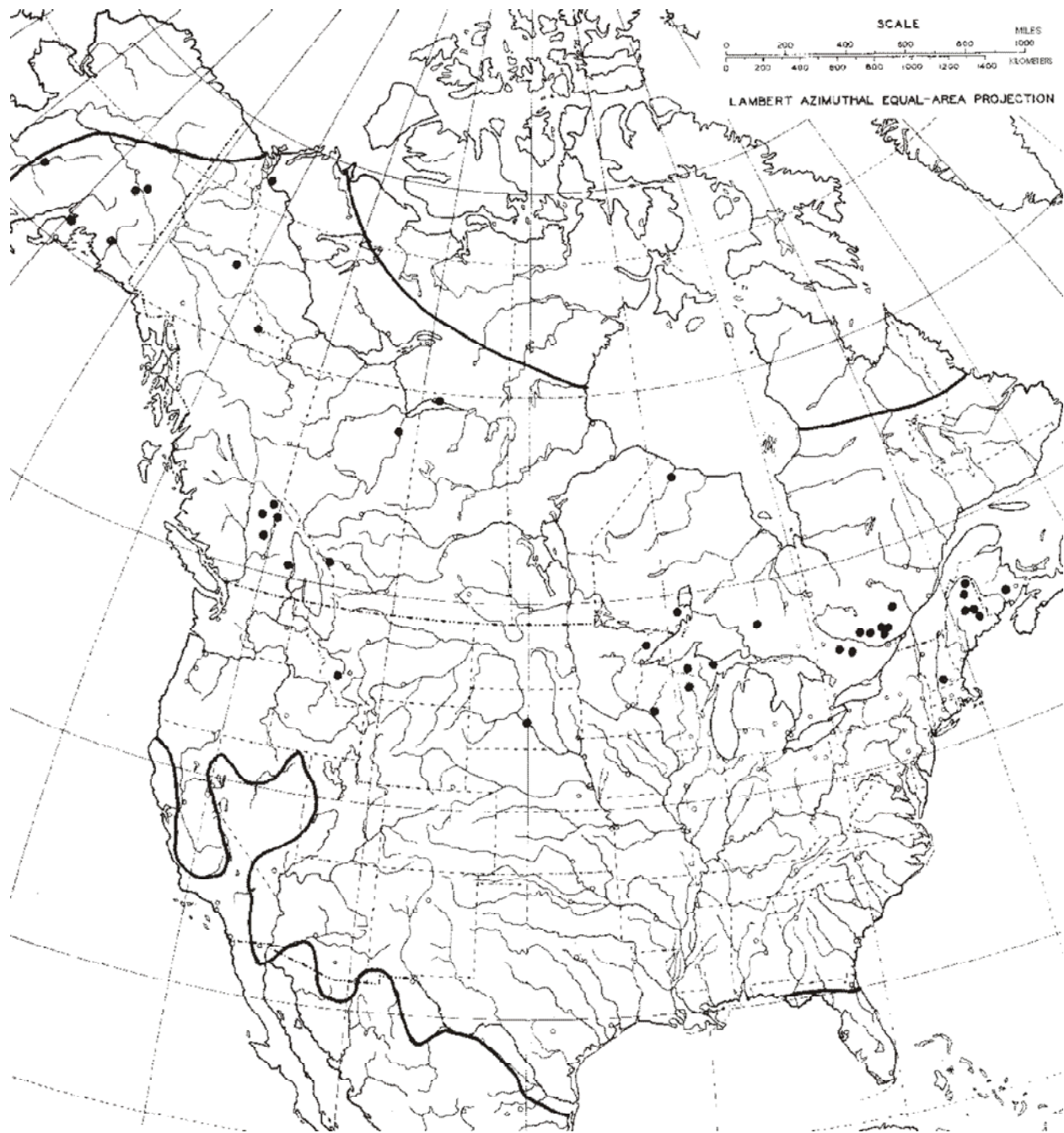


Figure 8. Dot map showing known sites of records for *Leptinillus validus* in North America. Dark line indicates approximate limits of the historical range of the host, *Castor canadensis* (after Hall 1981). The beetle appears to only occur on beavers throughout the northern half of the distributional range of the host.

Host. The primary host of the beetle is the American beaver, *Castor canadensis* Kuhl (Rodentia, Sciuromorpha, Castoridae). The beetles are ectoparasitic as both adults and larvae but apparently spend more time in the host's lodge and off the host than on it. Records appear in surveys or summaries of beaver parasites: e.g., Erickson (1944), Lawrence and Graham (1955), and Lawrence *et al.* (1961). It is of interest that no records were found in the extensive study of Janzen (1963) on the other beaver beetle, *Platypsyllus castoris* Ritsema, near Hastings, Minnesota. Most specimen labels do not actually cite beavers as the host. Wood (1965) reports a few adults recovered from muskrats, *Ondatra zibethicus* (Linnaeus) (Rodentia, Muroidea, Cricetidae). Since muskrats are known to share beaver lodges (Banfield 1974), a

transfer to muskrats would be easy but there is no evidence that this is anything other than an accidental occurrence.

Distribution. There are relatively few literature records for the beetle's distribution: e.g., Clark (1961), Hatch (1957), Judd (1954), and Parks and Barnes (1955). I have seen material from the following Provinces and States: **Canada.** AB, BC, NB, NT, ON, PQ, SK, YK. **United States.** AK, ME, MI, MN, NH, SD, WI. The species is known only from the northern half of its hosts range (Fig. 8) and can be expected in other northern provinces and states in which it is not yet known. That it actually does not occur in the southern part of its hosts range is supported by the absence of records which would be expected to have been made in conjunction with those of the other beaver beetle, *Platypsyllus castoris* Ritsema (Peck 2006), which does live in the southern part of the range of the host. The two beetle species have been infrequently reported from the same host animal (Wood 1965).

Beavers themselves have been or were extirpated in many parts of North America. For example, they were gone from Massachusetts in the early 1700's and only 15 were known in the Adirondacks of New York in 1900 (Müller-Schwarze and Sun 2003). With the regulation of hunting and trapping and institution of wildlife management programs, beavers are now returning in much of North America (Müller-Schwarze and Sun 2003), often to levels judged to be a nuisance.

Ecology and biology. The beetles can be collected by combing them from the fur of captured or recently dead beavers or more commonly by collecting them in opened beaver lodges. Both larvae and adults have sharply pointed mandibular incisors and feed on epidermal tissue such as shed skin cells and possibly on skin secretions and wound exudates (Wood 1965). It seems unlikely that blood is normally ingested. Wood (1965) opened 55 beaver lodges throughout the year in Algonquin Provincial Park, Ontario and beetles were present in 27 of these. Early instar larvae were found in October, all instars were present in January, and last instar larvae were predominant in March. Pupae were recovered from soil in the ceilings of the lodges in June. Adults emerged in June and only adults were encountered from June to September. Adults cluster on twigs and sticks hanging from the ceiling of the lodge, sometime as many as 1000 per lodge. This was observed by J. M. Campbell and myself in lodges in October in Gatineau Park, Quebec. In the fall, adults moved to the beaver nest itself. At this time their gonads were developed, and small larvae present (Wood 1965). Adults and larvae were also recovered in small numbers on live and dead trapped beavers with the same seasonality as in the lodges (present on 31 of the 45 beavers examined, Wood 1965). Wood (1965) obtained additional data on the

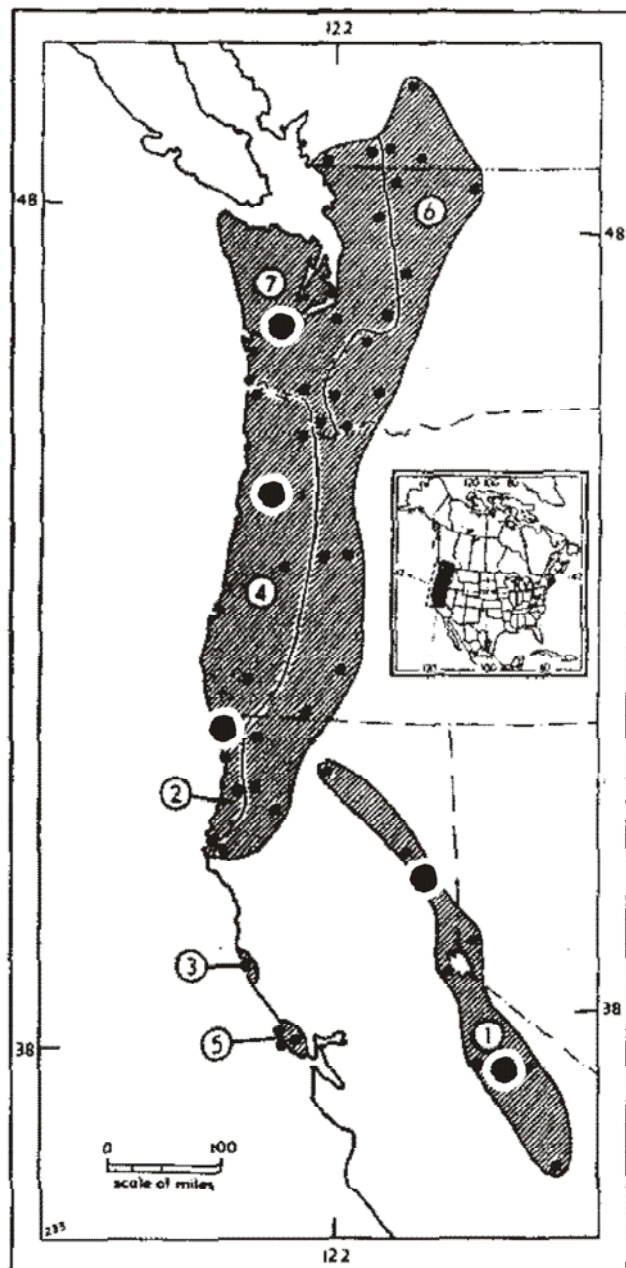


Figure 9. Dot map showing known distribution of *Leptinillus aplodontiae* (large black dots ringed in white) in the Pacific Northwest of USA and adjacent Canada. Shaded area is distribution of the mountain beaver host, *Aplodontia rufa* (Rafinesque). Numbers indicate ranges of the described mountain beaver subspecies, some of which are disjunct. Small black dots are individual locality records for the mountain beaver (after Hall 1981).

beetles by rearing young beavers in artificial lodges. Both larvae and adults spend more time off the beaver than on the beaver. He was unable to get larvae to survive on foods other than on live beavers, but adult beetles did feed on beef, mouse, beaver, and human blood.

***Leptinillus aplodontiae* Ferris**
Fig. 9-12

Leptinillus aplodontiae Ferris, 1918: 125. Type in CASC, seen, type number 675. Type locality: Fallen Leaf Lake, Plumas Co., CA.

Immatures. Unknown.

Adults. The only description is that of Ferris (1918). It is of note that the species was not included in Hatch's (1957) summary of beetles of the Pacific Northwest. The aedeagus is fully illustrated here for the first time (Figs. 10-12).

Biology and ecology. Unknown.

Distribution. There are few literature and specimen records. Other than the species description, I know only of the additional published record of Spencer (1957). I have seen only 28 specimens, and they are in the following collections: CASC, CUIC, CNCI, OSUO, SMDV, USNM. The species is known only from five general localities in the following states (Fig. 9). **United States.** CA, OR, WA. The distribution may be as broad as that of their hosts in the Sierra Nevada and Coast ranges of California northwards to British Columbia.

Host. The only host is *Aplodontia rufa* (Rafinesque), 1817 (Rodentia, Protrogomorpha, Aplodontidae). Common names are mountain beaver, boomer, or sewellel. Mountain beaver is a misnomer for they do not live high in the mountains, are not semiaquatic (as is the common beaver), and evolutionarily have no close relationship with the beaver. There are seven subspecies, and some of these have discontinuous distributions (see Fig. 9 and Hall 1981). The animals are secretive, nocturnal, and do not hibernate or store food. They live at lower elevations in burrows in dense streamside vegetation in dense wet forests. Their burrows are under logs, stumps, and upturned roots (Gyug 2000). The burrow is from 10-25 cm (4-10 inches) in diameter, and may be as long as 200-300 meters.

The family Aplodontidae is the least derived or most primitive known group of living rodents, with a fossil record from the late Paleocene to the present, and may include the ancestors of all living rodents (Korth 1994). The family was represented by several genera which were widely distributed throughout western North America in moist habitats during the early and mid Tertiary (Shotwell 1958). This is the only surviving rodent with the primitive character of the masseter muscle attaching to the zygoma bone (Hall 1981), a feature of many Eocene rodents. The derived state of this character is a more forward muscle attachment. The kidney is also primitive, with 70% of the nephrons located entirely in the cortex. In addition, few of the other nephrons have long loops of Henle or with a thin segment (Dicker and Eggleton 1964). These primitive kidney features prevent the animals from excreting concentrated urine (a water-conservation adaptation of most modern rodents) and explains the need of *A. rufa* for ready access to water, and its present limitation to the wet Pacific Northwest.

Discussion

It is likely that the ectoparasitic habit of the subfamily is derived from an ancestor that was a scavenger in mammal nests or burrow systems (Waage 1979, Wood 1965). Presently, many Cholevinae leioidids are known to be mammal burrow and nest inhabitants (Peck and Skelley 2002) but it remains unclear whether Platypsyllinae are closely related to Cholevinae (Newton 1998). The species of *Leptinillus*

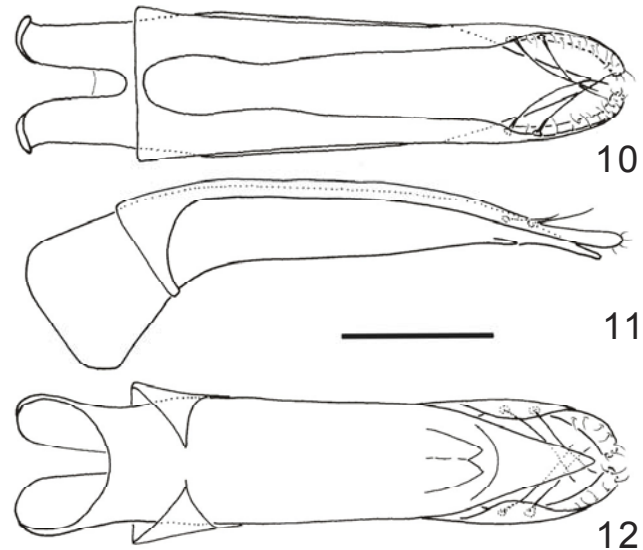


Figure 10-12. Aedeagus of *Leptinillus aplodontiae*: specimen from Wawona, Yosemite National Park, California. **10)** Dorsal view. **11)** Lateral view. **12)** Ventral view. Scale line = 0.1 mm.

presently seem limited to North America, although the host rodent family Castoridae occurs now in Eurasia and Aplodontidae did occur in the past in Eurasia. This can be considered weak evidence for a North American origin for the genus. Additionally, their overall morphology suggests a derivation from a more basal *Leptinus*-like ancestor, rather than the more derived genus *Platypsyllus* (Peck 2006). The association with semi-aquatic rodent and insectivore hosts for all species of *Silphopsyllus*, *Platypsyllus*, and *Leptinillus* (except *L. aplodontiae*) seems to be a shared derived character which is absent in *Leptinus*, whose hosts are all non-aquatic rodents and insectivores. A phylogenetic analysis should help to clarify the relationships of the genera.

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