

**Taxonomy of *Solenopotes* Enderlein, 1904,  
with redescription of *Linognathus panamensis* Ewing  
(Linognathidae: Anoplura)\***

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SUMMARY

All the known species of *Solenopotes* Enderlein, 1904 are discussed with a complete synonymy, major references, diagnoses, host associations and distribution; they are *S. binipilosus* (Fahrenholz, 1916a); *S. burmeisteri* (Fahrenholz, 1919); *S. capillatus* Enderlein, 1904; *S. capreoli* Freund, 1935a; *S. ferrisi* (Fahrenholz, 1919); *S. muntiacus* Thompson, 1938; *S. natalensis* Ledger, 1970 and *S. tarandi* (Mjöberg, 1915). The species of *Solenopotes* are compared on the basis of major taxonomic characters. *Solenopotes* and *Linognathus* are compared and a key to the known species of *Solenopotes* is also presented. Taxonomic relationships among the cervid-infesting species are quantitatively studied. The status of *Linognathus panamensis* Ewing, 1927, previously assigned to *Solenopotes*, is discussed and the species is redescribed and illustrated.

INTRODUCTION

The genus *Solenopotes* was first established by Enderlein (1904). Eight species of *Solenopotes* are now recognized: *S. binipilosus* (Fahrenholz, 1916a); *S. burmeisteri* (Fahrenholz, 1919); *S. capillatus* Enderlein, 1904; *S. capreoli* Freund, 1935a; *S. ferrisi* (Fahrenholz, 1919); *S. muntiacus* Thompson, 1938; *S. natalensis* Ledger 1970 and *S. tarandi* (Mjöberg, 1915). The species of *Solenopotes* are mostly parasitic upon Cervidae and only two are known from Bovidae, *S. capillatus* found on the cattle (*Bos taurus* and *S. natalensis* on the South African steenbok (*Raphicerus campestris*). The Cervidae are also infested with *Haematopinus*, whereas the Bovidae are more commonly infested with species of *Linognathus*.

*Solenopotes* and *Linognathus* constitute the family Linognathidae and are alike in many morphological traits, although definitely distinguishable. Two species, *Solenopotes capillatus* and *S. natalensis*, which are found on the bovid hosts, are aberrant forms in many ways, and the species infesting the caribou (*Rangifer*), white-tailed and black-tailed deer (*Odocoileus*) and the European red deer (*Cervus elaphus*) seem to form a definite taxonomic group.

Forty-four genera and 111 species of Bovidae and 17 genera and 40 species of

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Cervidae are currently known (Whitehead, 1972). *Solenopotes* are known only from the following six cervid genera; *Cervus*, *Odocoileus*, *Rangifer*, *Capreolus*, *Mazama* and *Muntiacus* (= *Cervulus* of Anderson & Jones, 1967).

*Solenopotes* has not been found on *Alces* despite careful examinations by Hopkins (1949) and other workers. The remaining genera, *Axis*, *Dama*, *Hydropotes*, *Elaphurus*, *Elaphodus*, *Ozotoceros*, *Blastocerus*, *Pudu*, *Hippocamelus* and *Moschus*, have not been systematically searched for sucking lice.

More than 35 different collections of *Solenopotes* from the Holarctic and Neotropical cervids and numerous other collections from various hosts have been available for this study. However, no single specimen of *S. capreoli* was available for study. The specimens studied were from the following sources: The National Museum of Natural History, Smithsonian Institution (USNM); Department of Entomology, University of California, Berkeley (UCB); The Frost Entomological Museum, The Pennsylvania State University (FEM); the K. C. Emerson Entomological Museum, Oklahoma State University (KCE); University of Heidelberg, Germany (UH); G. B. Thompson, England (GBT) and C. F. Weisser, Germany (CFW). The abbreviations for the collections are used throughout this paper.

The morphological terminology of Kim (1966) and Weisser & Kim (1973) is followed in this paper. To describe shapes and form the terminology of the simple symmetrical plane shapes developed by the Systematics Association (1962) is used here.

This paper discusses all the known species of *Solenopotes* with a complete synonymy, major references, diagnosis, host associations and distribution. The species of *Solenopotes* are compared on the basis of major taxonomic characters. *Solenopotes* and *Linognathus* are compared and a key to the known species of *Solenopotes* is also presented. The status of *Linognathus panamensis* Ewing, 1927, which was previously assigned to *Solenopotes*, is discussed and the species redescribed and illustrated. Taxonomic relationships among the cervid-infesting species are quantitatively studied.

#### Notes on the family Linognathidae

The sucking lice of the family Linognathidae Enderlein (1905) are mostly parasitic upon the even-toed ungulates, Artiodactyla. Only a few species of *Linognathus* are known from the canid carnivores. Ferris (1951) included four genera in the family, namely *Linognathus*, *Solenopotes*, *Microthoracius* and *Prolinognathus*. The first two genera, *Linognathus* and *Solenopotes*, are presently assigned to the Linognathidae.

*Microthoracius* is exclusively parasitic on camels (Camelidae) and *Prolinognathus* is the typical louse of the Procaviidae (hyrax, dassies). Although only two genera, *Lama* and *Camelus*, are extant, camels and camelid relatives were abundant in the late Tertiary. From the upper Eocene to Pleistocene 25 extinct genera of the Camelidae have been recognized and were assigned to five subfamilies in which only the single subfamily Camelinae is extant (Simpson, 1945). The Hyracoidea are known from the late Oligocene. Thirteen genera have been recognized and assigned to three families in which only the family Procaviidae

with three genera, *Dendrohyrax*, *Heterohyrax* and *Procavia*, is extant (Simpson, 1945). In view of a greater species diversity of the hosts in the late Tertiary and obvious morphological distinctness, *Microthoracius* and *Prolinognathus* are considered to be the remnants of once much larger taxa, and thus to constitute two separate families.

*Description of the family.* Medium to small Anoplura. *Head* with no external evidence of eyes; postantennal angles variously developed; occipital apophyses not developed; antennae 5-segmented. *Thorax* with meso- and metathoracic phragmata well developed and notal pit distinct or obscure; sternal plate absent, at most narrow, pigmented longitudinal band, or if present, its apex not free from the body. *Legs*: forelegs small and slender, with acuminate claw; midlegs and hindlegs subequal, and larger than forelegs, each with stout claw, and tibial thumb developed, with a single spiniform seta. *Abdomen* membranous, with no trace of sternal and tergal plates except for those associated with genitalic and terminal segments; paratergites absent or at most represented by small tubercles anterior to each spiracle; six spiracles present on segments 3–8; dorsally and ventrally with more than four longitudinal rows of long setae, and each segment usually with not more than two transversal row of setae. *Genitalia*: male with basal apodeme slender and pseudopenis elongate; parameres well developed, never fused apically and enclosing the aedeagus; female with genital plate variously shaped, sometimes lacking and gonopods well developed; genital lobes well developed and prolonged posteriorly, with either a spiniform genital seta or pointed apical process; spermatheca not strongly sclerotized.

*Solenopotes* may be distinguished from *Linognathus* (Fig. 55) by the following characters:

Characters	Solenopotes	Linognathus
Thorax		
Sternal plate	Large and wide, occupying most of sternal area enclosed by the coxae	Absent, at most narrow longitudinal median, pigmented stripes
Mesothoracic phragmata	Continuous, usually with distinct notal pit	Abruptly disconnected; notal pit obscure
Abdomen		
Chaetotoxy on each segment	Dorsally with single transverse row of setae of varying size; no anterior row of microsetae	Dorsally with two transverse rows of setae; anterior row may be reduced to a few microsetae
Genitalia		
Male	Subgenital plate reduced, lyriform	Subgenital plate large, with a membranous area in its centre; rarely lyriform ( <i>L. pedalis</i> )
Female	Usually without median genital plate	Usually with median genital plate between gonopods
Hosts	Cervidae, Bovidae (Artiodactyla)	Bovidae, Giraffidae (Artiodactyla); Canidae (Carnivora)

Genus *Solenopotes* Enderlein, 1904

*Solenopotes* Enderlein (1904), *Zoologischer Anzeiger* 28, 143 (type species: *Solenopotes capillatus* Enderlein); Dalla Torre (1908), 6, 15; Bishopp (1921), 797; Ewing (1929), 139; Ferris (1932), 393; Freund (1935*b*), 5, 16; Ferris (1935), 616; Fahrenholz (1936), 56; Jancke (1938), 48, 57; Séguy (1944), 425, 446; Kloet & Hincks (1945), 27; Ansari (1951), 129; Ferris (1951), 251; Blagoveshtchensky (1960) 77; Kéler (1963), 10; Blagoveshtchensky (1964), 332; Stojanovich & (1965), 2, 22; Wegner (1966), 17.

*Cervophthirus*: Mjöberg 1915: 282 (type species: *Cervophthirus tarandi* Mjöberg); Ewing (1929), 136; Kéler (1963), 10.

*Haematopinus* (*Solenopotes*): Neumann (1909), 530.

*Linognathus* (*partim*): Ferris (1916*a*), 199; Ferris (1916*b*), 159; Fahrenholz (1916*a*), 24.

TYPE-SPECIES: *Solenopotes capillatus* Enderlein

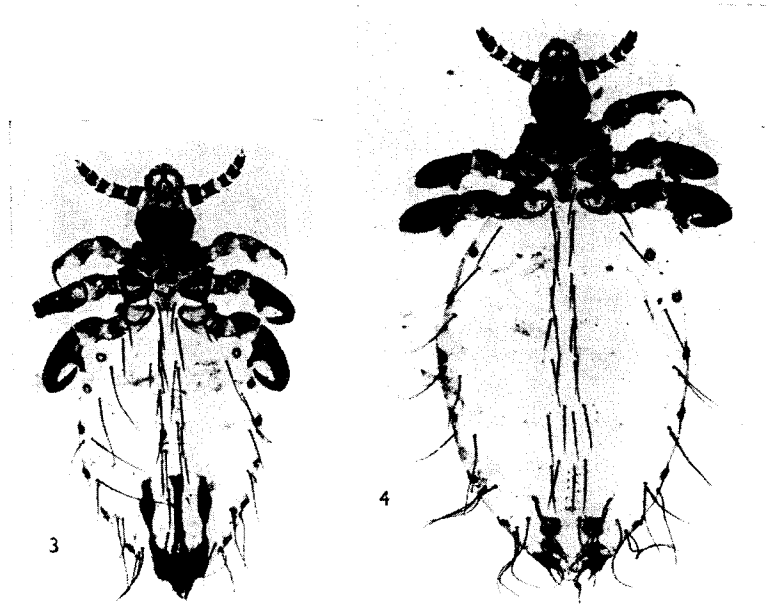
*Description.* Head without eyes and ocular points; antennae 5-segmented. Thorax broad and short, with a sternal plate large and wide, occupying most of the sternal area enclosed by the coxae but not apically free from the body; mesothoracic phragmata mediolaterally fused with metathoracic phragmata; notal pit distinct. Legs with forelegs smallest, having thin acuminate claw, midlegs larger and hindlegs subequal to or slightly larger than midlegs; midlegs and hindlegs similar in shape, with thicker claws. Abdomen membranous throughout, without any indication of tergites or sternites except the usual genital sclerotization; paratergites absent, but occasionally spiracles on dorsolaterally protruding tubercles; each segment dorsally and ventrally with a single transversal row of setae of varying size. *Genitalia*: male with subgenital plate reduced, lyriform and with parameres well developed, elongate and enclosing aedeagus and pseudopenis; pseudopenis sometimes indistinct; female with prominent gonopods and genital lobes but usually without median genital plate.

Key to the species of *Solenopotes*

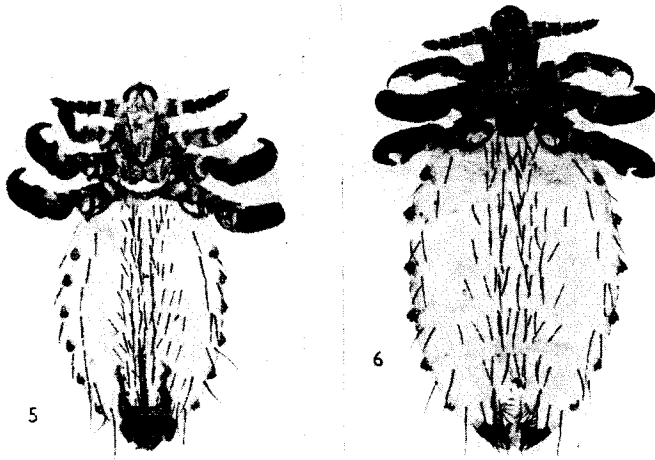
1. Antennal segments 4 and 5 each with a distinct, large sensorium (Fig. 23); female with distance between gonopods (WBG = width between gonopods) at least as long as width of gonopod (WG); male dorsally without transverse bar-shaped sclerite on abdominal segment 8 2
  - Antennal segments 4 and 5 without indication of round sensorium; female with gonopods broad and WBG much narrower than WG; male dorsally with transverse bar-shaped sclerite on abdominal segment 8 (Fig. 1), parameres strongly developed and pseudopenis indistinct, apparently lacking (Fig. 32); on *Mazama* (brockets) and *Odocoileus* (deer) in North and South America 1. *S. binipilosus* (Fig. 1, 2)
2. Abdominal spiracles present on pronounced sclerotized tubercles of segments 3-8, each tubercle protruding dorsolaterally (Fig. 46); thoracic sternal plate almost as wide as long (Fig. 27); male with slender parameres appearing as if broken by a thin, weak portion and pseudopenis large and V-shaped; on cattle of palaeartic origin, worldwide 3. *S. capillatus* (Figs. 5, 6)
- Abdominal spiracles not on distinct tubercles; thoracic sternal plate usually longer than wide; parameres entire and pseudopenis small or occasionally lacking 3



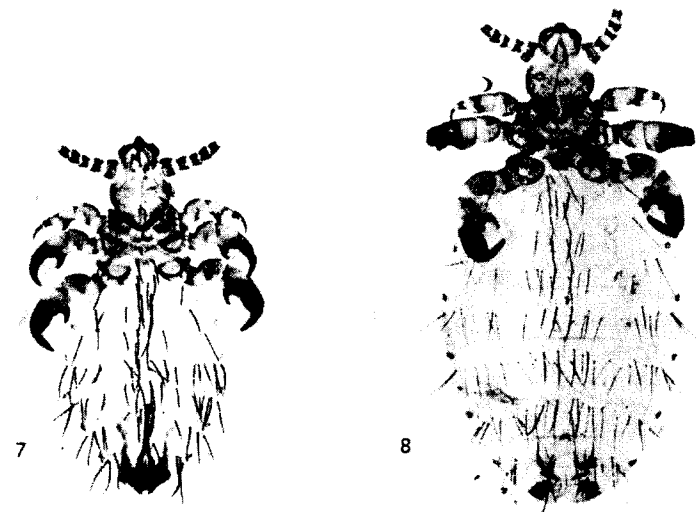
Figs. 1, 2. *Solenopotes binipilosus* (Fahrenholz). 1. Male. 2. Female.



Figs. 3, 4. *Solenopotes burmeisteri* (Fahrenholz). 3. Male. 4. Female.

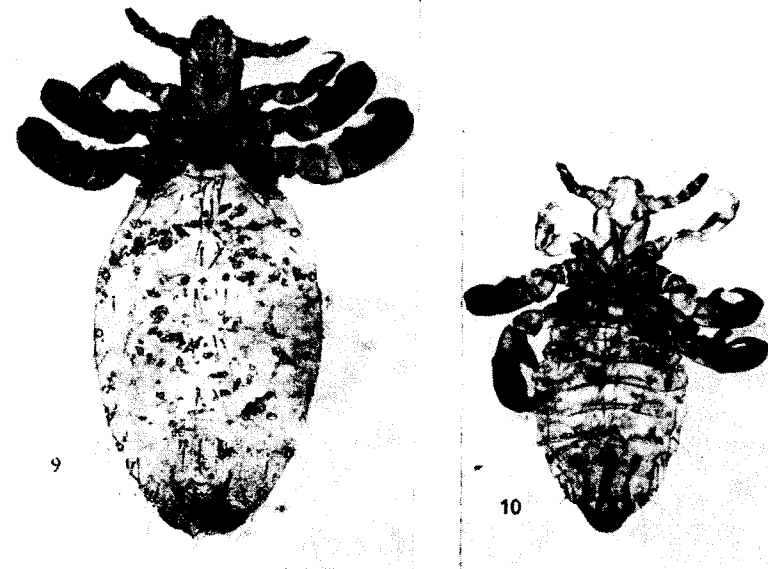


Figs. 5, 6. *Solenopotes capillatus* Enderlein. 5. Male. 6. Female.

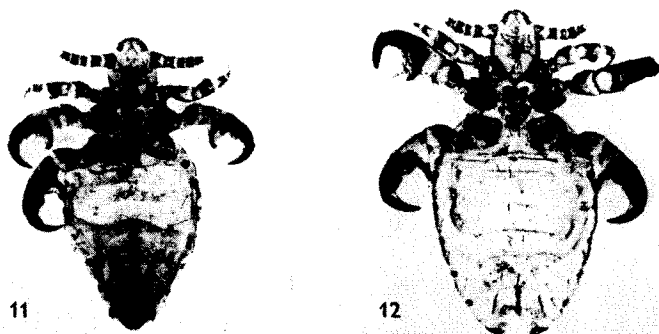


Figs. 7, 8. *Solenopotes ferrisi* (Fahrenholz). 7. Male. 8. Female.

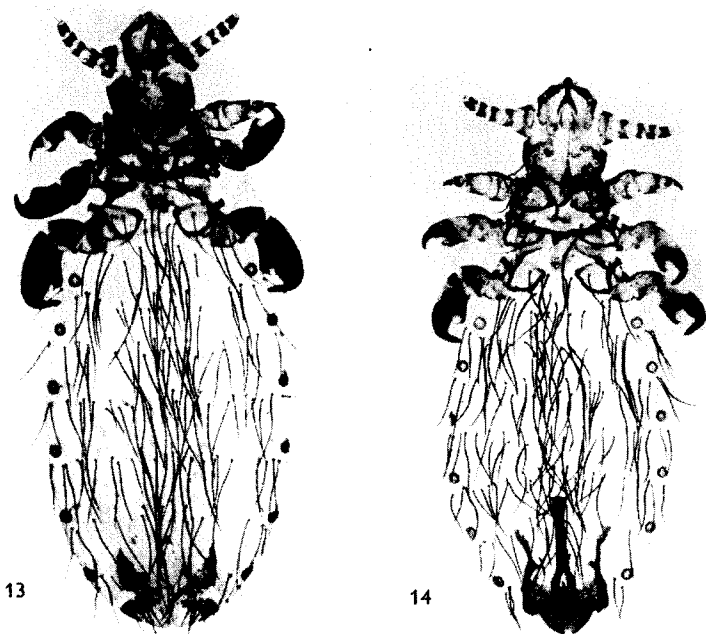
3. Abdomen with many long setae; segments 4-6 dorsally on each side with 2-4 long dorsal lateral abdominal setae (DLAS), 2-3 irregular dorsal median abdominal setae (DMdAS) of varying size between DLAS and dorsal central abdominal setae (DCAS), and in the centre of each segment with 4-6 DCAS; head with posterolateral angles pronounced, almost rectangular and not fused with posterior occipital angles 4  
Abdomen with only few setae; segments 4-6 dorsally each with one DLAS on each side, DMdAS very short to minute or lacking, and only 2 DCAS; head with posterolateral angles neither pronounced nor rectangular 5
4. Antennae shorter than head width (HW); most abdominal setae large and thick; abdominal spiracles about 50  $\mu$ m in diameter; total body length (TBL) 1.95-2.35 mm; on *Rangifer* (caribou) in arctic regions 8. *S. tarandi* (Figs. 13, 14)  
Antennae longer than HW; most abdominal setae long and thin; abdominal spiracles about 30  $\mu$ m in diameter; TBL 1.2-1.95 mm; on *Odocoileus* (deer) in North America 5. *S. ferrisi* (Figs. 7, 8)
5. Abdomen short, oval and less than twice as long as head and thorax combined (Fig. 12); thoracic sternal plate obpentagonal with its sides concave (Fig. 20); mid- and hindlegs very large; head short; male parameres long and slender, slightly shorter than basal apodeme; female with elongate median genital plate; on *Raphicerus* (steenbok), Southern Africa 5. *S. natalensis* (Figs. 11, 12)
- Abdomen long, elliptic, and more than twice as long as head and thorax combined (Fig. 13); thoracic sternal plate nearly rectangular (Fig. 29); mid- and hindlegs not conspicuously enlarged; head clearly longer than wide; male parameres not slender, much shorter than basal apodeme; female without median genital plate 6
6. Head with its lateral margins convex; thoracic sternal plate narrow, not produced at each anterolateral angle (Fig. 25); male pseudopenis apparently lacking (Fig. 33) 7  
Head with its lateral margins straight; thoracic sternal plate broad, produced at each anterolateral angle (Fig. 29); male with small pseudopenis; on *Muntiacus* (muntjak) in East, Central and Southeast Asia 5. *S. muntiacus* (Figs. 9, 10)



Figs. 9, 10. *Solenopotes muntiacus* Thompson. 9. Female. 10. Male.



Figs. 11, 12. *Solenopotes natalensis* Ledger. 11. Male. 12. Female.



Figs. 13, 14. *Solenopotes tarandi* (Mjöberg). 13. Female. 14. Male.

7. Thoracic sternal plate more than twice as long as wide; female with lateral sides of small gonopods heavily sclerotized and extending anteriorly into segment 8; on *Cervus* (red deer) in Europe *S. burmeisteri* (Figs. 3, 4)  
 Thoracic sternal plate much less than twice as long as wide; female with lateral sides of gonopods not unusually sclerotized; on *Capreolus* (roe deer) in the Palearctic region\* *S. capreoli* (Figs. 18, 26)

1. *Solenopotes binipilosus* (Fahrenheit, 1916a)

(Figs. 1, 2, 15, 24, 32, 39, 47)

*Linognathus binipilosus* Fahrenheit (1916a), 11, f. 11-13 [Type host: Mazama-Hirsch (*Reducina* spec.)].

*Solenopotes binipilosus* (partim): Ferris (1932), 401, f. 245; Hopkins (1949), 525; Webb (1949), 146; Ferris (1951), 252; Stojanovich & Pratt (1965), 22; Wenzel & Johnson (1966), 276; Walker & Becklund (1970), 26.

*Linognathus angulatus* (Piaget): Mjöberg (1910), 157 (misidentification).

*Linognathus coassus* Fahrenheit (1916b), 92 (type host: '*Coassus* spec.');

Fahrenheit (1917), 16, f. 4.

(Non) *Linognathus panamensis* Ewing (1927), 119 (type host: *Odocoileus chiriquensis*).

(Non) *Solenopotes panamensis*: Ferris (1932), 401; Ferris (1951), 252; Johnson (1958), 48 (resurrected).

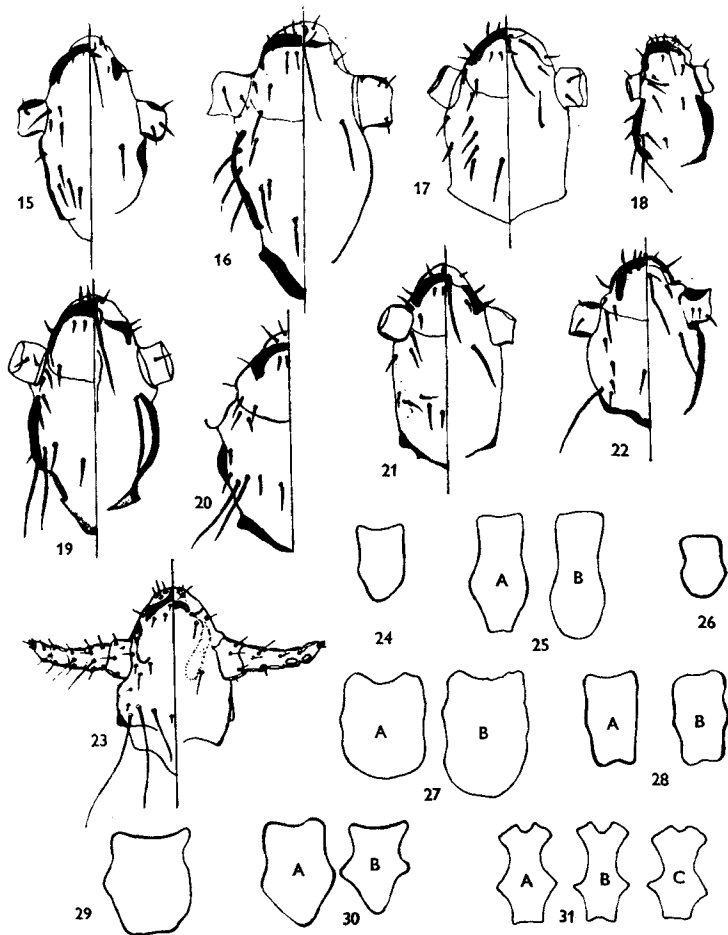
*Type data.* This species was originally described on the basis of specimens (male, female, nymphs) collected by Dr H. Friedenthal-Nicolassee from 'Mazama-Hirsch (*Reducina* spec.)', without indication of locality. This host is a Central and South American genus. The repository of the type specimens is not known at this time. The type host must be a species of *Mazama* in Central or South America.

*Diagnosis.* Total body length; female 1.72 mm ( $\bar{X}$ ) and male 1.45 mm ( $\bar{X}$ ). Head short, about as long as thorax, somewhat acute anteriorly, antennae without sensoria on segments 4 and 5. Thoracic sternal plate pentagonal. Female with width between gonopods (WBG) much narrower than width of gonopods (WG). Male dorsally with sclerotized band on segment 8; parameres large, strongly tapering; pseudopenis lacking.

*Remarks.* This species is principally parasitic on *Mazama* species and *Odocoileus virginianus* subspecies in the southern North America and South America.

*Specimens examined.* Ex *Mazama gouazoubira* (G. Fischer, 1814) (as *M. simplicicornis*), ARGENTINA: Jujuy, 2 females (USNM), 2 females (UCB, Ferris coll.); ex *Odocoileus virginianus* (Zimmermann, 1780), ALABAMA: 1 female (USNM); Clark Co., 13 Dec. 1966, R. F. Genish, 1 female and 1 nymph (W7-162); ARIZONA: Tucson, 2 females, 1 male and 1 nymph (KCE Coll.); ex *O. v. osceola* (Bangs, 1896) or Florida white-tailed deer, FLORIDA: Naples, 2 females (USNM, BISH. no. 21196); Ocala Forest, 2 females and 2 males (USNM, BISH. no. 22658); near Christmas, 2 females (USNM; host no. 57616C/lot 37-4487), 3 females, 1 male,

\* This diagnosis is made on the basis of descriptions and illustrations by Freund (1935a, b) and Ferris (1932).



Figs. 15-23. Head. 15. *S. binipilosus* (Fahrenholz). 16. *S. burmeisteri* (Fahrenholz). 17. *S. capillatus* Enderlein. 18. *S. capreoli* Freund (redrawn from Freund, 1935b). 19. *S. ferrisi* (Fahrenholz) ex *Odocoileus hemionus sitkensis*, Alaska. 20. *S. ferrisi* (Fahrenholz) ex *O. virginianus*, Pennsylvania. 21. *S. muntiacus* Thompson. 22. *S. natalensis* Ledger. 23. *S. tarandi* (Mjöberg).

Figs. 24-31. Thoracic sternal plate. 24. *S. binipilosus* (Fahrenholz). 25. *S. burmeisteri* (Fahrenholz) A, B, female, infraspecific variation. 26. *S. capreoli* Freund (redrawn from Freund, 1935b). 27. *S. capillatus* Enderlein, A, B, female, infraspecific variation. 28. *S. ferrisi* (Fahrenholz) A, Male; B, female. 29. *S. muntiacus* Thompson. 30. *S. natalensis* Ledger. 31. *S. tarandi* (Mjöberg); A-C, infraspecific variation.

1 nymph (USNM, BISH. no. 26825; host no. 57750c./lot 37-4487); Christmas, 2 females (USNM, BISH. no. 26735; host no. 57620c./lot 37-1075); 2 females and 1 male (USNM, BISH. no. 26747; host no. lot 37-2076); ex *O. v. chiriquensis* J. A. Allen, 1910, PANAMA: Canal Zone, 1 male (UCB, Ferris coll.); ex white-tailed deer, ARIZONA: 3 females (USNM, BISH. no. 22809); ex *Odocoileus* sp., TEXAS: Kleberg Co., 28 May 1938, 4 male and 15 females (USNM, A. P. no. 14183); PANAMA: Los Santos, 1 female (USNM, PHHC-9827); VENEZUELA: Falcon, Pastora, 1 male and 1 female (USNM, U-14969); ex deer, GUATEMALA: Guatalen, 1 female (USNM, BISH. no. 21771); ex 'Virginiahirsch', GERMANY: Rostock Zoo, 3 females and 3 males (UH coll. no. 10901-10906).

2. *Solenopotes burmeisteri* (Fahrenholz, 1919)

(Figs. 3, 4, 16, 25, 33, 40, 48)

*Linognathus burmeisteri* Fahrenholz (1919), 23 (type host: *Cervus elaphus*, Europe).

*Solenopotes burmeisteri*: Freund (1935a), 278; Freund (1935b), 18, figs. 78-83; Ferris (1935), 616; Kloet & Hincks (1945), 27; Hopkins (1949), 524; Ferris (1951), 253; Ansari (1958), 280; Andrews (1964), 106; Blagoveshtchensky (1964), 333.

*Solenopotes burmeisteri* (partim): Ferris (1932), 406-8, fig. 249.

*Cervophthirius burmeisteri*: Jancke (1938), 61-2; Conci (1946), 9; Brinck (1948a), 129; Kéler (1963), 10.

*Pediculus crassicornis* Nitzsch (1818), 305 (not *P. crassicornis* Scopoli, 1763, a Mallophaga; preoccupied); Gervais (1844), 305 (under *Haematopinus*); Giebel (1861), 292; Nitzsch (1864), 26.

*Haematopinus crassicornis*: Denny (1842), 7; Giebel (1871), 175-6; Giebel (1874), 41; Piaget (1880), 644; Osborn (1891), 12; Osborn (1896), 170; Dalla Torre (1908), 11; Bagnall (1930), 105.

*Cervophthirius crassicornis*: Grimshaw (1917) 65; Jancke (1932), 527.

*Linognathus crassicornis*: Fahrenholz (1916a), 34, 272; Kohn (1929), 60.

(Non) *Cervophthirius crassicornis*: Ferris (1916a), 197, figs.; Ferris (1916b), 167; (?) *Pediculus cervi* Linnaeus (partim) (1758), 611; Stephens (1829), 329.

*Type data.* This species was originally described by Nitzsch (1818) as *Pediculus crassicornis*, which was found to be preoccupied by a Mallophaga species, *Pediculus crassicornis* Scopoli, 1763. Fahrenholz (1919) gave a new name to this species, *Linognathus burmeisteri*. The species has been collected from *Cervus elaphus* Linnaeus, 1758, in Europe. The Nitzsch's collection has been deposited in the Zoological University Museum, Martin-Luther Universität in Halle-Wittenberg, Halle (Saale), Domplatz 4, Germany, and we have received a vial containing four types specimens of '*Haematopinus crassicornis* Nitzsch, 1818'. This type series, consisting of one male, one female, one nymph 2 and one nymph 3, was individually mounted on the slide. The male was selected and designated as the lectotype of this taxon. They have been returned to the Zoologisches Institut, Martin-

Luther Universität, Halle, Germany. The lectotype and female paralectotype agree with the Fahrenholz's description.

**Diagnosis.** Total body length: male 1.62 mm ( $\bar{X}$ ), female 1.99 mm ( $\bar{X}$ ). Head much longer than wide, with its lateral margins strongly convex and posterolateral angles not pronounced; antennal segments 4 and 5 each with a distinct sensorium. Thoracic sternal plate more than twice as long as wide, with its lateral margins convex. Abdomen long, elliptical and more than twice as long as head and thorax combined, with only few setae; segments 4–7 dorsally each with one or no MAS and one DLAS on each side, 2 DCAS and ventrally 2 VCAS.

**Remarks.** This species has been known from *Cervus elaphus* subsp. from various parts of the world. To date 12 subspecies of *C. elaphus* have been recognized (Whitehead, 1972) and are distributed throughout Great Britain, Europe, North Africa and the Middle East including Chinese Turkestan. The European red deer has also been introduced to New Zealand and Australia in addition to those kept in zoos in many countries.

**Specimens examined.** Ex *Cervus elaphus* Linnaeus, 1758, ENGLAND: ROSS Torridon, Scotland, 4 May 1970, 9 males, 26 females, and 15 nymphs (1970/50) (FEM, GBT coll.); Isle of Mull, Auchnacraig, Nov. 1970, G. B. Thompson, 9 females (1970/33) (GBT coll.); GERMANY: Black Forest, 1 female, 1 nymph (Univ. of Heidelberg Coll. no. 11301, 11302); ex *Cervus nippon* Temminck, 1838, ENGLAND: Yorkshire, Studley Park, 1 July 1972, 19 females, 3 males (FEM, BGT coll.); these specimens were almost exclusively taken from the heads of the hosts.

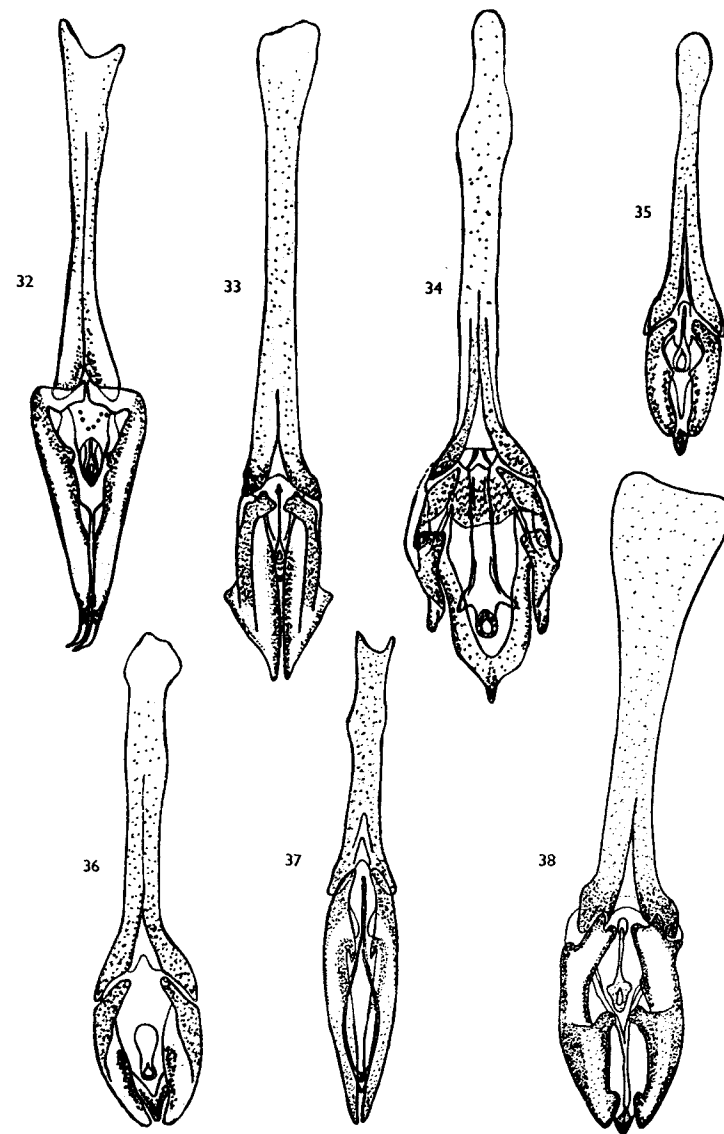
### 3. *Solenopotes capillatus* Enderlein, 1904

(Figs. 5, 6, 17, 27, 34, 43, 46, 49)

*Solenopotes capillatus* Enderlein (1904), 144, figs. 14, 15 (type host: domestic cattle, Germany); Dalla Torre (1908), 15; Freund (1918), 40–1; Freund (1920), 146; Bishopp (1921), 797–801, figs. 1–6; Pillers (1923), 162–4; Freund (1924), 64–66; Freund (1927), 215–27; Ewing (1929), 139; Kohn (1929), 60; Bagnall (1930), 105; Hase (1931), 30. 6, 10, 30. 21; Ferris (1932), 397; Freund (1935b), 17, figs. 70–7; Hearle (1938), 69; Jancke (1938), 57; Thompson (1938), 636; Matthyse (1944), 436–42; Seguy (1944), 81, 446; Kloet & Hincks (1945), 27; Conci (1946), 9; Matthyse (1946), 3–61; Brinck (1948a), 132–3; Brinck (1948b), 136, 141, 151; Brinck (1948c), 12; Brinck (1949), 56; Hopkins (1949), 527; Webb (1949), 147; Ansari (1951), 129; Ferris (1951), 253–4, figs. 113–14; Gerwell (1954a), 122; Gerwell (1954b), 175; Britz (1955), 152–3; Lancaster (1957), 2–16; Ignoffo (1959), 474; Blagoveshtchensky (1960), 79–83; Dubitskii (1960), 192–3; Scanlon (1960), 121; Markevich (1961), 111; Dubitskii (1962), 108–9; Kéler (1963), 10; Patnaik (1963), 33; Blagoveshtchensky (1964), 333; Ma (1965), 6; Stojanovich & Pratt (1965), 22; Bussieras (1966), 210; Spencer (1966), 28; Wegner (1966), 17; Piotrowski (1967), 643–51; Segal, Humphrey, Edwards & Kirby (1968), 423.

*Linognathus vituli*. Ferris (1916a), 166; Ferris (1916b), 199 (misidentification).

*Solenopotes capillatus dubius*: Gerwell (1953), 153–65; Gerwell (1954a), 122.



Figs. 32–38. Male genitalia. 32. *S. binipilosus* (Fahrenholz). 33. *S. burmeisteri* (Fahrenholz). 34. *S. capillatus* Enderlein. 35. *S. ferrisi* (Fahrenholz). 36. *S. munitiacus* Thompson. 37. *S. natalensis* Ledger. 38. *S. tarandi* (Mjöberg).

**Type data.** This species was described by Enderlein (1904) on the basis of one male specimen collected from a cow in the fall of 1895 at Leipzig, Germany. Enderlein's collection is known to be deposited in the Zoological Museum at Berlin (Horn & Kahle, 1937). However, there is no holotype of *S. capillatus* in the collection of the Museum für Naturkunde, Zoologisches Museum at Berlin, Germany (Göllner, 1971). *S. capillatus* is a distinctive species easily distinguished from other species and widely found on various strains and varieties of *Bos taurus*.

**Diagnosis.** Total body length: male about 1.4 mm, female about 1.8 mm. Head comparatively short and broad, with its lateral margins nearly straight; antennal segments 4 and 5 each with a distinct sensorium. Thoracic sternal plate subrectangular, almost as wide as long, with its anterior margin concave and posterior margin rounded. Abdomen with numerous setae; segments 3–5 each with one DLAS and 2 or 3 DMdAS on each side and 4 DCAS; segments 3–8 each with spiracles on clearly pronounced sclerotized tubercles which are protruding dorso-laterally. Male with parameres appearing as if broken by a thin, weak portion and pseudopenis large and V-shaped. Female with gonopods small and rounded apically.

**Remarks.** The little blue cattle louse, *S. capillatus* Enderlein (1904), was in fact previously described as *Pediculus eurysternus* Nitzsch (1818) by Burmeister (1838) and Nitzsch (1864). *Pediculus eurysternus* Nitzsch (1818) is *nomen nudum*, and the Burmeister's work must be considered the first description of this species. Denny (1842) mistakenly used for the first time the name *H. eurysternus* for the short-nosed cattle louse instead of the little blue cattle louse. Following Denny (1842), all of the subsequent workers used *H. eurysternus* in the sense of Denny not Nitzsch and Burmeister. According to the strict application of the code the name *S. capillatus* Enderlein (1904) should become a junior synonym of *H. eurysternus* Burmeister. However, for the stability of nomenclature in Anoplura the present usage of the names *Haematopinus eurysternus sensu* Denny (1842) and authors for the short nosed cattle louse and *Solenopotes capillatus* Enderlein (1904) for the little blue cattle louse should remain unchanged by suppressing the material and descriptions of Burmeister (1838) and Nitzsch (1864), and designating a lectotype for *H. eurysternus* Denny (Kim & Weisser, 1973). The application for this action has been published by the International Commission on Zoological Nomenclature.

**Specimens examined.** Ex cattle, CANADA: QUEBEC: La Trappe, 17 males, 32 females and 95 nymphs (FEM coll.); WYOMING: Guonstun (?), 1 nymph (FEM, no. 58-21180).

#### 4. *Solenopotes capreoli* Freund (1935a)

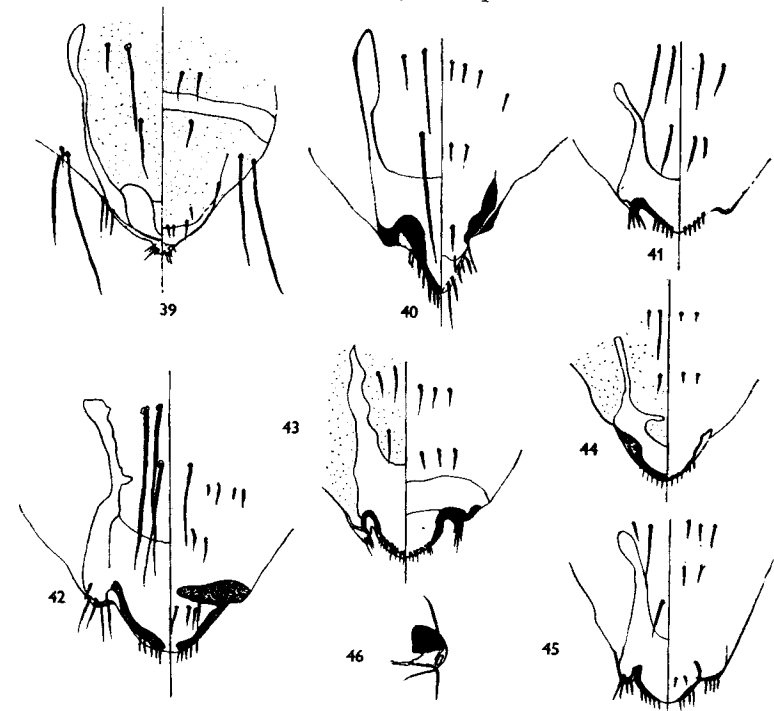
(Figs. 18, 26, 50)

*Solenopotes capreoli*. Freund (1935a), 278, fig. B (type host: *Cervus capreolus*); Freund (1935b), 19–20, figs. 84–6; Ferris (1951), 256; Blagoveshtchensky (1964), 333.

*Cervophthirius capreoli*. Conci (1946), 9; Brinck (1948a), 129; Kéler (1963), 10.

*Solenopotes burmeisteri* (partim): Ferris (1932), 407–8 (misidentification).

**Type data.** *S. capreoli* was originally described by Freund (1935a) on the basis



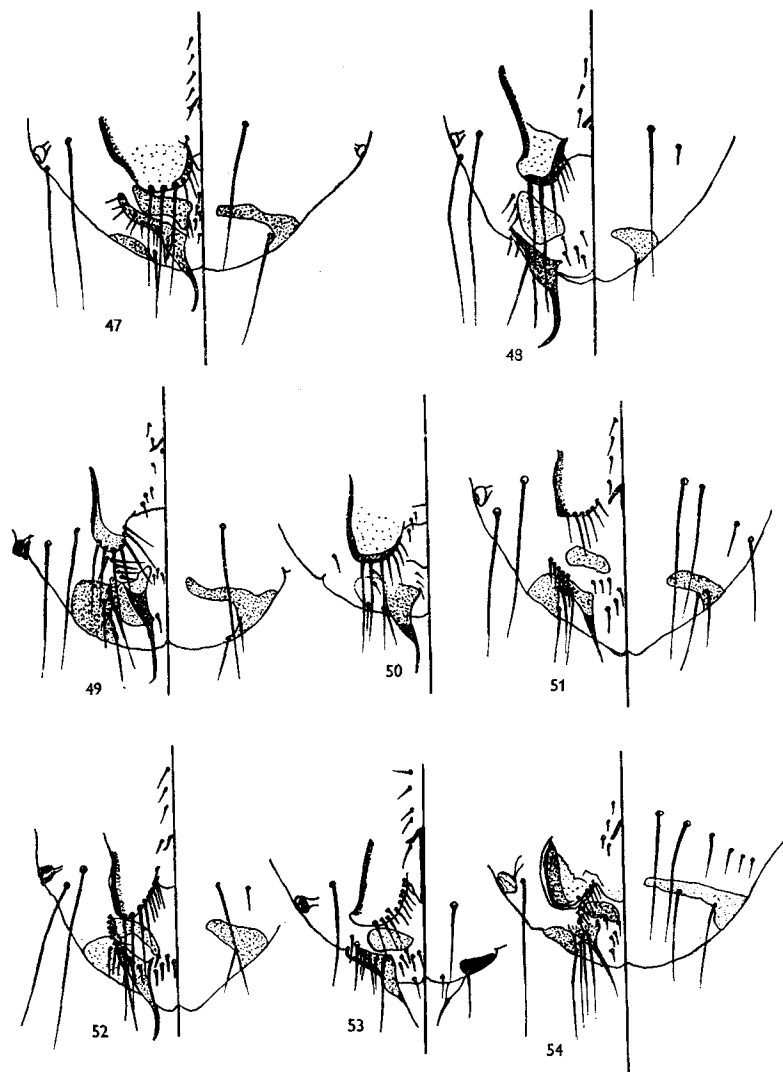
Figs. 39–45. Male terminalia. 39. *S. binipilosus* (Fahrenholz). 40. *S. burmeisteri* (Fahrenholz). 41. *S. ferrisi* (Fahrenholz). 42. *S. tarandi* (Mjöberg). 43. *S. capillatus* Enderlein. 44. *S. muntiacus* Thompson. 45. *S. natalensis* Ledger. Fig. 46. *S. capillatus* Enderlein, female, 6th abdominal spiracle.

of specimens collected from the roe deer, *Cervus capreolus* Linnaeus, 1758, without indicating the locality. Prior to Freund's description this species was identified by Ferris (1932) as *S. burmeisteri* (Fahrenholz) collected from the same host, *Capreolus capreolus* (Linnaeus, 1758) (as *C. caprea*). The depository and identity of the types specimens is unknown at present.

**Diagnosis.** Total body length: male 2.5 mm (*vide* Ferris, 1932). Head long, with its lateral margin convex and posterolateral angles not pronounced; antennal segments 4 and 5 each with a distinct sensorium. Thoracic sternal plate subquadrate, with its anterior margin nearly straight and posterior end rounded. Abdomen wide oval, with only few setae. Female with lateral sides of gonopods not specially sclerotized and the apex of gonopods rounded. [This diagnosis is based on the descriptions and drawings by Freund (1935a, b) and Ferris (1932).]

**Remarks.** No specimen was available for study.





Figs. 47-54. Female terminalia. Left side-ventral view; right side-dorsal view. 47. *S. binipilosus* (Fahrenholz). 48. *S. burmeisteri* (Fahrenholz). 49. *S. capillatus* Enderlein. 50. *S. capreoli* Freund (redrawn from Freund, 1935b). 51. *S. ferrisi* (Fahrenholz). 52. *S. muntiacus* Thompson. 53. *S. natalensis* Ledger. 54. *S. tarandi* (Mjöberg).

5. *Solenopotes ferrisi* (Fahrenholz, 1919)

(Figs. 7, 8, 19, 20, 28, 35, 41, 51)

*Linognathus ferrisi* Fahrenholz (1919), 24 (type host: *Odocoileus columbianus*, Calif.). (New Name.)

*Solenopotes ferrisi*. Ferris (1932), 404; Ferris (1935), 616; Hopkins (1949), 524; Ferris (1951), 256; Holdenried, Evans & Langenecker (1951), 11, 14; Ignoffo (1956), 9-17; Scanlon (1960), 121; Scholten, Ronald & McLean (1962), 606; Stojanovich & Pratt (1965), 22; Spencer (1966), 28; Walker & Becklund (1970), 26, 27.

*Cervophthirus ferrisi*. Jancke (1932), 529.

*Cervophthirus crassicornis* (Nitzsch). Ferris (1916a), 197-200 (type host: *Odocoileus columbianus*) (misidentification); Ferris (1916b), 167; Peters (1933), 94.

(Non) *Linognathus ferrisi* Bedford (1927), 351, fig. 5-6 (a junior synonym of *Linognathus gnu* Bedford.)

(Non) *Cervophthirus crassicornis*. Grimshaw (1917), 65; Jancke (1932), 527.

*Type data*: Ferris (1916a) described this species as *Cervophthirus crassicornis* (N.) on the basis of several specimens collected from the blacktailed deer, *Odocoileus columbianus*, taken at Laytonville, Mendocino County, California. Fahrenholz (1919) recognized the Ferris' *C. crassicornis* as a new species and gave it a new name, *Linognathus ferrisi* Fahrenholz. Ferris (1932) considered the specimens used in 1916 would stand as the types of the species.

Through the kindness of Dr John A. Chemsak of the Department of Entomology, University of California, Berkeley, we have received two slides for study bearing the following handwritten labels: (1) 1 female, '*Cervophthirus crassicornis* (N.); from *Odocoileus columbianus*, Laytonville, Mendocino Co., California, W. B. Herms, G. F. Ferris coll.', (2) 2 females and 1 male, '*Cervophthirus crassicornis* (N.), from *Odocoileus columbianus scaphiotus*, San Gregario, California, J. F. Ferris coll.'. The first slide was part of the original series and the second slide was the one studied by Ferris in 1932. The lectotype was designated for *S. ferrisi* (Fahr.); lectotype female, ex *Odocoileus hemionus columbianus* (Richardson, 1829) (as *O. columbianus*), Laytonville, Mendocino Co., California, W. B. Herms. The lectotype is deposited in the G. F. Ferris collection, Department of Entomology, University of California, Berkeley, California.

*Diagnosis*. Total body length: male 1.35 mm ( $\bar{X}$ ), female 1.71 mm ( $\bar{X}$ ). Head short, with its lateral margins convex and posterolateral angles pronounced, almost rectangular before posterior occipital angles; occipital area narrowed into a neck; antennae longer than head width; antennal segments 4 and 5 each with a sensorium. Thoracic sternal plate suboblong, with its anterior and posterior margins slightly concave (Fig. 28). Abdomen with many, mostly long setae; segments 4-6 each dorsally with 2-3 DLAS and 2-3 irregular DMdAS on each side and 4-6 DCAS. Female with gonopods small and short, broadly rounded, sclerotized only at the margins (Fig. 51). Male with basal apodeme deeply bifid at the posterior end; parameres broad and short; pseudopenis small and slender (Fig. 35).

*Remarks.* This species has also been recorded from *Odocoileus virginianus* (Scholten *et al.* 1962), *O. v. borealis* (Peters, 1933), and *Cervus canadensis* (Spencer, 1966).

*Specimens examined.* Lectotype; Ex *Odocoileus hemionus* (Rafinesque, 1817), MONTANA: Ravalli Co., 17 March 1939, 4 females (USNM; AP no. 15507); 7 females and 6 nymphs (USNM; AP no. 9044); WYOMING: Mammoth, 2 females and 1 male (KCE coll., A-65); ex *O. h. columbianus* (Richardson, 1829) (as *O. columbianus*), CALIFORNIA: San Gregorio, 2 females and 1 male (UCB, Ferris coll.); ex *O. h. sikensis* Merriam, 1898 (male fawn), ALASKA: Hawkins 9sl., 1 male and 1 female (FEM coll.); ex Mule deer fawn, MONTANA: Medicine Springs, 28 Feb. 1952, Jellison and Sargent, 4 females (USNM; AP no. 30113); ex Black-tailed deer, ARIZONA: Phoenix, 6 females and 2 males (KCE coll., A-63-c; host 17R-12/lot 53-3094); ex *Odocoileus virginianus* (Zimmermann, 1777), MINNESOTA: Lake Co., 22 April 1932, W. L. Jellison, 1 female and 13 nymphs (USNM; AP no. 18786); ex *Odocoileus virginianus borealis* Miller, 1900, PENNSYLVANIA: Centre Co., about 150 females, males and nymphs (FEM coll.); deer no. 222, Animal Disease Laboratory, Pennsylvania State University, March 1971, 30 females, 25 males, 30 nymphs (FEM coll.); NEW YORK: Tomkins Co., 2 females, 2 males and 3 nymphs (CFW coll.); ex *O. virginianus* ssp., ONTARIO: Manitou Island, 1 female and 1 male (KCE coll.); ex deer, PENNSYLVANIA: Clinton Co., 2 males (KCE coll.; A-65-a); MINNESOTA: Itasca Park, 1 female and 1 male (FEM coll., nos. 1185 and 1206); ex 'Deer': 1 female (USNM, a specimen no. 5); OREGON: Benton Co., 1 female, 2 males and 1 nymph (USNM; lot 60-11741); ex White-tailed deer, PENNSYLVANIA: Pike Co., 1 female (KCE coll., A-65-b); ex *Odocoileus* sp., CALIFORNIA: Alameda Co., 6 Oct. 1944, H. Pratt, 2 males and 6 females (USNM: AP no. 21139); MONTANA: Ravalli Co., 28 April 1933, Kramis and Humble, 1 female (USNM).

#### 6. *Solenopotes muntiacus* Thompson, 1938

(Figs. 9, 10, 21, 29, 36, 44, 52)

*Solenopotes muntiacus.* Thompson (1938), 634, figs. (type host: *Muntiacus malabaricus* = *M. muntjac*); Hopkins (1949), 523; Ferris (1951), 256; Johnson (1962), 108-9, figs. 6-10 (redescription).

*Type data.* Male holotype, female allotype, seven male and eight female paratypes from *Muntiacus muntjac* Zimmermann (as *M. malabaricus*), Mousakande, Gammaduwa, Ceylon. The type specimen is deposited in the G. B. Thompson collection, Cambridge, England.

*Diagnosis.* Total body length: male 1.12 mm, female 1.65 mm ( $\bar{X}$ ). Head long, with its lateral margins straight and posterolateral angles not pronounced; occipital area short, with posterior occipital angle angular; antennal segments 4 and 5 each with a distinct sensorium. Thoracic sternal plate broadly suboblong and produced slightly at each anterolateral angle, with its anterior margin concave and posterior end slightly convex (Fig. 29). Abdomen long, elliptical, more than twice as long as head and thorax combined; with 3-4 DLAS, at least one long, and 2-3 short DMdAS on each side; centrally with 2 long DCAS. Female without median

genital plate (Fig. 52). Male with short parameres set broadly apart; pseudopenis short and triangular (Fig. 36).

*Remarks.* Johnson (1962) redescribed and illustrated *S. muntiacus* Thompson in detail.

*Specimens examined.* Ex *Muntiacus muntjak* (Zimmerman, 1780), THAILAND: Chiang Mai, Poi Inthanon, 2720 m elev., 4 Feb. 1971, 1 male (KT-1319; XIE19) (FEM); CAMBODIA: Koské, 3 April 1952, Charles Wharton, 1 male and 1 female (RTB-15374) (FEM); NEPAL: Melimche, Sindhu Distr., 7 Aug. 1968, 4 females (USNM, NP-879); ENGLAND: Welwyn, Herts, 1, 1967, 3 females and 3 males (BMNH, 1967-283); ex Muntjac deer (male), TAIWAN: Chun Yany, NTHF, at 3500 ft elev., 29 Jan. 1962, Nan Tou Hsien, 1 nymph (BM172; 62-17329) (FEM).

#### 7. *Solenopotes natalensis* Ledger, 1970

(Figs. 11, 12, 22, 30, 37, 45, 53)

*Solenopotes natalensis* Ledger (1970), 276, figs. 1-6.

*Type data.* This species was originally described by Ledger (1970) on the basis of 4 males and 4 females collected from *Raphicerus campestris* (Thunberg, 1811), Empangeni, Natal, South Africa, 12 Aug. 1967 by B. Lamara. The holotype female and 3 paratypes (2 males and 1 female) are deposited at the South African Institute for Medical Research, Johannesburg, South Africa.

*Diagnosis.* Total body length: male 1.14-1.2 mm, female 1.5-1.83 mm. Head with its lateral margins more or less straight; antennae with large sensoria on segments 4 and 5. Thoracic sternal plate obpentagonal with its sides concave (Fig. 30). Female with a median genital plate between gonopods. Male with parameres long and slender, tapering and pseudopenis apparently lacking.

*Specimens examined.* Ex *Raphicerus melanotis* (Thunberg), MOZAMBIQUE: Tete, 21 July 1964, 1 male and 2 females (FEM coll.).

#### 8. *Solenopotes tarandi* Mjöberg, 1915

(Figs. 13, 14, 23, 31, 38, 42)

*Cervophthirus tarandi.* Mjöberg (1915), 283, figs. 1-4; Brineck (1949), 56.

*Solenopotes tarandi.* Ferris (1932), 136; Blagoveshtchensky (1960), 82-3; Weisser & Kim (1973), 123-32.

*Type data.* This species was originally described on the basis of specimens collected from *Rangifer tarandus tarandus* (Linnaeus, 1758) (reindeer) in Karesuando, Sweden. The type specimen was deposited in the Riksmuseum in Stockholm, but has not been located since it was loaned to a specialist in South America (Weisser & Kim, 1973).

*Diagnosis.* Total body length: male 2.13 mm ( $\bar{X}$ ) and female 2.2 mm ( $\bar{X}$ ). The largest of all known *Solenopotes*. Head about 1.5 times longer than wide, with its posterolateral angles pronounced, almost rectangular and not fused with the posterior occipital angles; antennae shorter than head width; antennal segments 4 and 5 each with a distinct sensorium. Thoracic sternal plate large, suboblong, with its lateral margin convex and anterior and posterior ends slightly concave

(Fig. 31). Legs obviously short and claws of forelegs very small. Abdomen densely covered with rather long and thick setae; abdominal spiracles about  $50\ \mu\text{m}$  in diameter, without tubercular sclerites. Male with pseudopenis distally extending slightly beyond tips of parameres and parameres with distinct median processes ventrally embracing the endotheca (Fig. 42). Female with median genital plate lacking and area between gonopods wide (WBG) (Fig. 54).

*Remarks.* This species was rediscovered from *R. tarandus grantis* Allen from Alaska (Weisser & Kim, 1973). *S. tarandi* is considered to be the species parasitic upon *Rangifer tarandus* (Linnaeus, 1758) in the Arctic and northern Holarctic region.

*Specimens examined.* Ex *R. tarandus granti* Allen, ALASKA: Anaktuvuk Pass, Brooks Range, June 1971, 21 females, 8 males and 7 nymphs (Host Coll. no. 45029); Utukok River, Barrow, June 1971, 22 females, 18 males and 34 nymphs (Host Coll. no. 45037); both collections were made by K. Neiland, Alaska Department of Fish and Game, Fairbanks, Alaska. These specimens are in the FEM and CFW Collections; representative specimens also in the BM (NH) USNM, and University of Lund, Sweden.

*Species previously assigned to Solenopotes*

*Linognathus panamensis* Ewing, 1927 (Figs. 55–57)

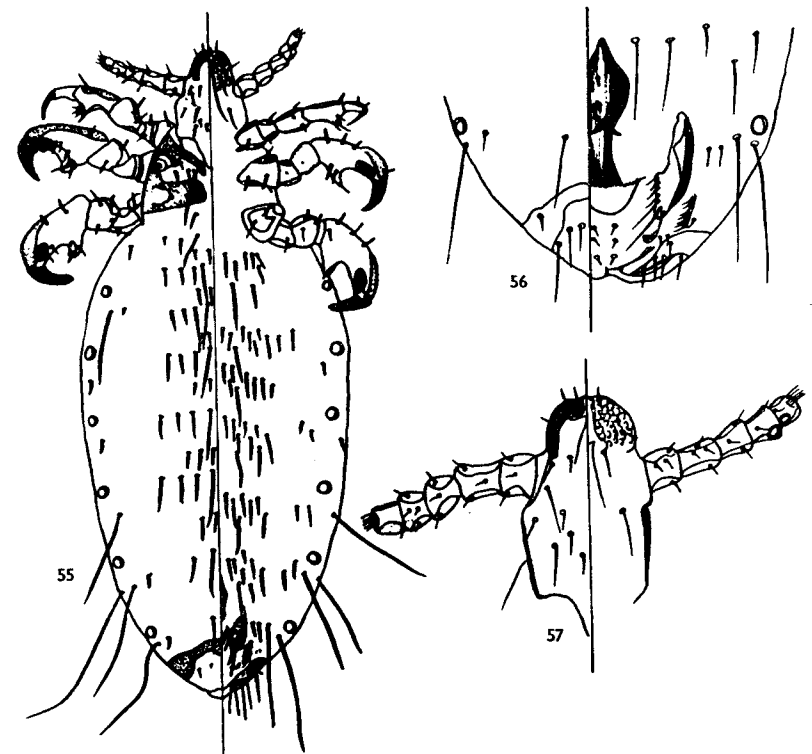
*Linognathus panamensis.* Ewing (1927), 119 (type host: '*Odocoileus chiriquensis*').

*Solenopotes panamensis.* Hopkins (1949), 524; Johnson (1958), 49; Wenzel & Johnson (1966), 276.

*Solenopotes binipilosus* (partim): Ferris (1932), 401 (sunk *S. panamensis*); Ferris (1951), 253.

*Type data.* *L. panamensis* was originally described from 6 females taken from a deer, *Odocoileus chiriquensis* J. A. Allen, 1910 (= *O. virginianus chiriquensis*) (Origin, Panama), which died at National Zoological Park on 28 Jan. 1925 (USNM type no. 40160; host USNM no. 240843). Johnson (1958) designated one female (circled with a diamond pencil) as the lectotype from the lot of 6 females on a slide. We have cleared and remounted all 6 females on separate slides. One slide is Johnson's lectotype and the other five slides are labelled paralectotypes. They are deposited in the collection of the National Museum of Natural History, Smithsonian Institution.

*Description.* FEMALE (Fig. 55): total body length 1.98 mm ( $\bar{X}$ ). A rather slender species. *Head* (Fig. 57) quite deeply retracted into the thorax, lateral margins straight; posterolateral angles pronounced and angulate; post-antennal angles not pronounced; forehead rounded and heavily sclerotized, and ventrally with distinct tubercles; marginal head setae placed off the lateral margin; dorsal principal head setae small; one posterior central head seta distinct; ventral principle head setae distinct; antennae 5-segmented, with segment 4 and 5 each bearing a large sensorium (Fig. 57). *Thorax* short and broad; sternal plate lacking; mesothoracic phragmata mesally separated abruptly; mesothoracic spiracle large, prothoracic phragmata elongated posteromesally; dorsal prothoracic setae distinct; 3 dorsal



Figs. 55–57. *Linognathus panamensis* Ewing, female. 55. Body. 56. Terminalia and genitalia. 57. Head; left side – dorsal view, right side – ventral view.

mesothoracic setae placed mesad to spiracle; dorsal principal thoracic setae long. *Legs* as in other members of *Linognathus*. *Abdomen* long, elliptical and membranous, with 6 large spiracles; segments 3–8 dorsally each with 2 transversal rows of setae, posterior row with one short DLAS on segments 2–8 and an additional long DLAS on segments 3 and 6–8, and 3 short DMdAS on each side; centrally segments 2 with 2 long and 7 short DCAS; segments 7 and 8 each with a very long MAS and segments 4 and 5 with minute MAS; ventrally with 2 irregular transverse rows of setae arranged in clusters, comprising VMdAS and ACAS; segments 5–7 each with 2 small VLAS. *Genitalia* (Fig. 56): median genital plate anteriorly ovate with its anterior end tapering and posteriorly narrowed; gonopods slender with their lateral margins heavily sclerotized and mesal margins bearing 8 setae arranged in a vertical line; genital lobe mesally prolonged, with 3 distinct setae and 1 small seta at apex; ventral vaginal wall forming a hemispherical plate. MALE: Unknown.

*Remarks.* Ferris (1932) considered this species as a junior synonym of *Solenopotes binipilosus*. However, Hopkins (1949) and Johnson (1958) considered *S. panamensis*

distinct from other species, and Johnson (1958) designated a lectotype for this species from the lot of six females. A careful examination of the types showed that this species is not *Solenopotes* but *Linognathus* close to *L. breviceps* (Piaget) and *L. limnotragi* Cummings.

The *breviceps* group is common on South African bovids of the genus *Cephalopus*, and the type host record of *L. panamensis*, *Odocoileus chiriquensis*, must have been accidental, due to contamination during the captivity of the deer in the zoo. Here, this species is considered distinct.

*Specimens examined.* Type series.

#### Species of *Solenopotes* and their hosts

##### On Bovidae:

*S. capillatus* Enderlein, 1904 Ex cattle (*Bos taurus*) of palearctic origin; world wide.  
*S. natalensis* Ledger, 1970 Ex *Raphicerus campestris*, *R. melanotis*; Southern Africa.

##### On Cervidae:

*S. binipilosus* (Fahrenheit, 1916a) Ex *Mazama gouazoubira* (= *M. simplicicornis*); *Odocoileus virginianus chiriquensis*; *O. v. couesi*; *O. v. osceola*; Southern U.S., Central and South America.  
*S. burmeisteri* (Fahrenheit, 1919) Ex *Cervus elaphus*, *C. nippon*; Europe and (?) Palearctic Asia  
*S. capreoli* Freund, 1935 Ex *Capreolus capreolus*; Europe and Palearctic Asia  
*S. ferrisi* (Fahrenheit, 1919) Ex *Odocoileus virginianus*, *O. hemionus*; North America  
*S. muntiacus* Thompson, 1938 Ex *Muntiacus muntjak*; East, Central and Southeast Asia  
*S. tarandi* (Mjöberg, 1915) Ex *Rangifer tarandus*; Arctic region

#### Taxonomic relationships among cervid-infesting *Solenopotes*

Six species of *Solenopotes* have been described from six genera of Cervidae: *S. muntiacus* on *Muntiacus muntjak* (Muntiacinae); *S. burmeisteri* on *Cervus elaphus* and *C. nippon* (Cervinae); *S. binipilosus* on *Mazama gouazoubira* and *Odocoileus virginianus*; *S. capreoli* on *Capreolus capreolus*; *S. ferrisi* on *Odocoileus hemionus* and *O. virginianus*; and *S. tarandi* on *Rangifer tarandus* (all Odocoileinae) (Whitehead, 1972).

Of these, four species, *S. binipilosus*, *S. burmeisteri*, *S. ferrisi* and *S. tarandi*, were studied for their taxonomic relationship. Initially, two closely related species, *S. ferrisi* and *S. tarandi*, were compared on the basis of nearly 300 specimens representing 15 different collections. Subsequently, this study was extended to *S. binipilosus* and *S. burmeisteri*. Eighteen taxonomic characters were compared for their diagnostic value. The measurements were made for 11 of these characters following the general procedure described by Kim, Brown & Cook (1966). The characters used in this study were: total body length (TBL), head length (HL), head width (HW), antennal length (AnL), width between gonopods (WBG), width of gonopods (WG), length of parameres (Pa), length of basal apodeme (Ba), diameter of spiracle (Sp), length of claw (C) and width of tibia (WTi). The mensuration system used in this study had already been described and illustrated by

Table 1. Means and standard deviations of four species of *Solenopotes*

(*n* = number of specimens examined;  $\bar{X}$  = mean; *S* = standard deviation; F = female; M = male; all measurements in mm.)

Characters	Sex	<i>S. ferrisi</i>									
		<i>S. tarandi</i> ( <i>n</i> = 11 F, 8 M)		Population 1 ( <i>n</i> = 16 F, 7 M)		Population 2 ( <i>n</i> = 52 F, 36 M)		<i>S. binipilosus</i> ( <i>n</i> = 26 F, 9 M)		<i>S. burmeisteri</i> ( <i>n</i> = 23 F, 8 M)	
		$\bar{X}$	<i>S</i>	$\bar{X}$	<i>S</i>	$\bar{X}$	<i>S</i>	$\bar{X}$	<i>S</i>	$\bar{X}$	<i>S</i>
TBL	F	2.191	0.094	1.725	0.105	1.688	0.133	1.720	0.142	1.990	0.112
	M	2.126	0.079	1.390	0.075	1.358	0.050	1.446	0.059	1.620	0.032
HL	F, M	0.498	0.010	0.409	0.017	0.374	0.014	0.347*	0.028	0.411	0.014
HW	F, M	0.326	0.014	0.244	0.014	0.235	0.010	0.209	0.014	0.237	0.010
AnL	F, M	0.279	0.017	0.275	0.025	0.242	0.008	0.259	0.010	0.284	0.010
WBG	F	0.144	0.010	0.090	0.005	0.065	0.009	0.030	0.006	0.081	0.010
WG	F	0.104	0.001	0.080	0.007	0.070	0.004	0.092	0.007	0.069	0.005
Pa	M	0.164	0.010	0.129	0.007	0.107	0.005	0.224	0.010	0.166	0.010
Ba	M	0.361	0.014	0.271	0.013	0.233	0.010	0.289	0.010	0.304	0.010
Sp	F, M	0.050	0.002	0.030	0.002	0.030	0.002	0.031	0.003	0.042	0.003
C	F, M	0.061	0.004	0.099	0.010	0.078	0.003	0.093	0.008	0.092	0.004
WTi	F, M	0.085	0.002	0.078	0.002	0.076	0.002	0.088	0.005	0.083	0.005

\* Means of two populations. Population A (ex *Odocoileus virginianus couesi*, Arizona):  $\bar{X}$  = 0.390; *S* = 0.002; and population B (ex *Odocoileus virginianus osceola*, Florida):  $\bar{X}$  = 0.335; *S* = 0.025.

Weisser & Kim (1973). The means and standard deviations for 11 characters of five taxa are summarized in Table 1.

Of the 11 characters Ba, Pa, WBG and TBL seem to give definitive discrimination among four species. The three characters Ba, Pa and WBG are subject to little variation, and are less likely to be affected by measurement errors and individual developmental conditions. However, TBL can vary considerably within one population and can be affected by nutrition during the postembryonic development and feeding conditions. In order to minimize this variation the ratio between TBL and WBG was used for comparison. The two characters Pa and Ba were used for males, and TBL/WBG and WBG were used for females to compare different populations. The scatter diagram for females is presented in Fig. 58, and for males in Fig. 59.

The three species *S. binipilosus*, *S. ferrisi* and *S. tarandi* are parasitic on deer of the subfamily Odocoileinae, and *S. burmeisteri* on the Cervinae. *S. ferrisi* is distinctly discriminated from *S. tarandi* and *S. binipilosus*, while *S. binipilosus* is also definitely separated from *tarandi* population (Figs. 58, 59). Two populations of *S. ferrisi*, one from the northeastern white-tailed deer and the other from mule deer, show some discrimination, but both populations as a group are distinctly discriminated from other species. There is no significant difference between two samples of *S. binipilosus* from *Mazama* and *Odocoileus*, although the intraspecific variation is considerable. *S. burmeisteri* is considerably different from any other species as described already. However, *S. burmeisteri* is intermediate between the

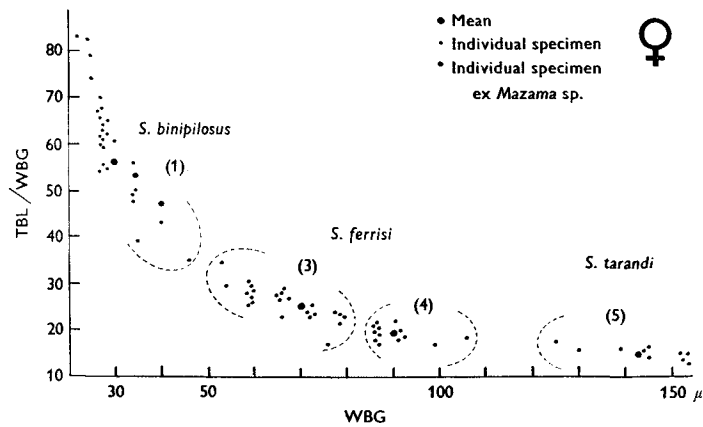


Fig. 58. Scatter diagram showing discrimination among females of three closely related species of *Solenopotes*. The number, (1), (3), (4), (5), represents the host species; two specimens taken from *Mazama* are indicated separately; individual specimens are indicated by a small dot and the mean by a large dot. TBL, Total body length; WBG, width between the gonopods.

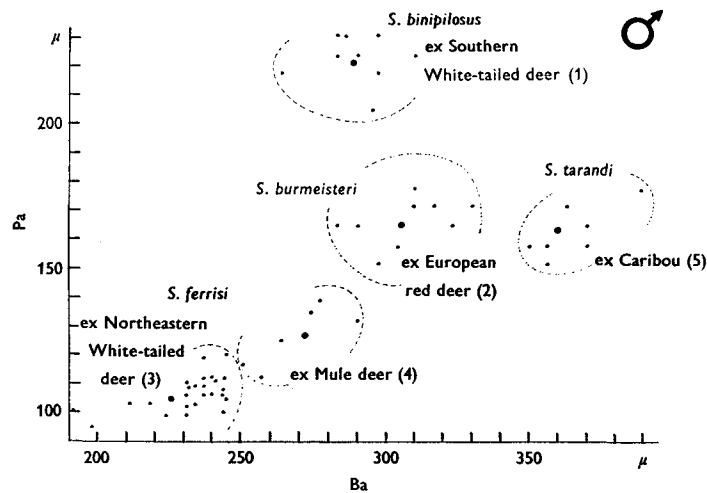


Fig. 59. Scatter diagram showing the discrimination among males of four closely related species of *Solenopotes*. Number, (1)–(5), represents the host species; individual specimens are indicated by a small dot and the mean is expressed by a larger dot. Pa, Length of parameres; Ba, length of the basal apodeme (in  $\mu$ ).

three species parasitic on the Odocoileinae when compared on the basis of Pa and Ba (Fig. 59).

From this study it is concluded that the four species studied in this paper are distinct from each other, and two populations of *S. ferrisi* from different hosts did not show enough difference to warrant any further taxonomic division of the taxon.

The sucking lice from the Odocoileinae are generally of 'ferrisi' type. As already shown, *S. tarandi* and *S. capreoli* are undoubtedly close to *S. ferrisi*. On the other hand, *S. binipilosus* is distinctly different from other Odocoileinae-infesting *Solenopotes*. On the basis of our present knowledge on the *Solenopotes* fauna, no further phylogenetic inferences can be made at this time.

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