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A Revision of the Species of MONOPSYLLUS Kolenati in North America

(Siphonaptera, Ceratophyllidae)

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A Revision of the Species of MONOPSYLLUS Kolenati in North America

(Siphonaptera, Ceratophyllidae)

By PHYLLIS T. JOHNSON,[1] *entomologist, Entomology Research Division, Agricultural Research Service*

Workers concerned with the classification of fleas have realized for some time that the genus *Monopsyllus* Kolenati needed to be revised. Several North American species of this genus are known to be infected with plague in nature. Consequently, it is imperative that the various species be defined and a guide for their identification be made available. Since specimens of some of the Asian species are not available for comparison, it is not possible at this time to revise the entire genus. This bulletin is therefore limited to those species that are native to North America. *Monopsyllus anisus* (Rothschild) was at one time found in San Francisco, Calif., and was recently discovered on a ship at Vancouver, British Columbia. Although *anisus* is not known to occur in North America now, it is included in the species descriptions because there is always the possibility of its reintroduction. Illustrations (pl. I) of the type species, *Monopsyllus sciurorum* Schrank, 1803, which is native to Europe and Asia, are included for purposes of comparison and to augment the generic description.

Keys to the North American species, as well as illustrations, diagnoses, and descriptions of all these species, are included. Maps show the distribution for most of the species. Canadian distribution is usually not indicated, but it may be found in Holland (1949).[2]

Jordan's (1933) definition of *Monopsyllus* is followed here. There is lack of agreement among taxonomists of the Siphonaptera as to the taxonomic hierarchy of *Ceratophyllus* Curtis and closely related genera or subgenera, including *Ceratophyllus* Curtis (*s. stricto*) and *Monopsyllus* Kolenati, *Amonopsyllus* Ioff, *Paramonopsyllus* Argyropulo, *Malaraeus* Jordan, *Amalaraeus* Ioff, *Megabothris* Jordan, and *Nosopsyllus* Jordan. American and European workers have generally followed Jordan's (1933) definition of *Ceratophyllus* and related genera, but Russian workers, following Ioff (1936), have proposed that all these genera be considered as subgenera or "sections" of *Ceratophyllus* Curtis. Smit (1957) has suggested that the *sciurorum* group of *Monopsyllus* might well be considered a subgenus of *Ceratophyllus*. Russian workers (see Ioff and Skalon 1954) have proposed in particular that all the North American forms be placed together in *Ceratophyllus*, subgenus *Monopsyllus*, "*Amonopsyllus* section." The name *Amonopsyllus* has been used both as a subgenus

[1] Resigned November 28, 1958. Now with the Gorgas Memorial Laboratory, República de Panamá.

[2] References to Literature Cited (p. 64) are herein indicated by the name of the author or authors followed by the year of publication.

under *Ceratophyllus* and as a species group or "section" under *Monopsyllus*. This grouping of American species is not satisfactory, since some forms, such as *Monopsyllus exilis* (Jordan), seem more nearly related to *sciurorum* than to some of the other North American species, such as *M. eumolpi* (Rothschild).

Except for one obviously related group, *M. eumolpi* and allies, I have not attempted to arrange the species in groups, but I have described and discussed them in the order of their diminishing likeness to the type of the genus, *M. sciurorum*.

It is hoped that these descriptions and the illustrations will be of value to other workers in determining the actual relationships of the complex assemblage of forms related to *Ceratophyllus* Curtis.

The controversy in recent years regarding the validity and the definition of subspecies makes necessary an explanation of the definition followed in this paper. I have followed the definition in Mayr et al. (1953, p. 314): "A subspecies is a geographically defined aggregate of local populations which differs taxonomically from other such subdivisions of the species." Furthermore, I consider that reasonable proof of the subspecific status of a population depends on demonstration that the characters which distinguish the subspecies are constant and not discordant, i.e., that they are consistent within a population and not a series of clinal characters that change at differing geographical points within the supposed assemblage of subspecies. Finally, the populations ideally should show a zone of intergradation, which proves that they are not physiologically reproductively isolated and hence actually different species. The amount of intergradation would not be necessarily the same for all such morphologically distinct populations. It is not good taxonomic practice to describe subspecies that do not meet the last criterion. However, if the populations have been named already, and if the examination of available material shows by induction that it is **likely** that several subspecies exist although intergrading forms are found only once, I have retained the subspecies names.

Populations that meet the definition proposed by Mayr et al. for subspecies are a reality in Siphonaptera. It is not known whether they represent incipient species, whether some or all of them will eventually evolve into full species, or whether they will be swamped by the reestablished gene flow at the periphery of the populations where two subspecies come together. Despite uncertainty on these points, I cannot agree with taxonomists who believe that the theory of the existence of subspecies and their probable importance in the process of evolution and transmuting of species has lost its usefulness. Furthermore, I do not agree that the alternate theories proposed explain all the facts any better than the subspecies concept, although certainly there is room for a belief that more than one type of variation and species formation does take place. I do agree with the critics of subspecies that such names should not be proposed until a study of variation is possible and has been made.

GENUS *MONOPSYLLUS* KOLENATI

Monopsyllus Kolenati, 1856, Wien. Ent. Monatsschr. 1 (No. 33): 65. Jordan and Rothschild, 1920, Ectoparasites 1: 64. Type of genus: *Monopsyllus sciuri* Kolenati, 1856 = *Pulex sciurorum* Shrank, 1781. (By monotypy.)

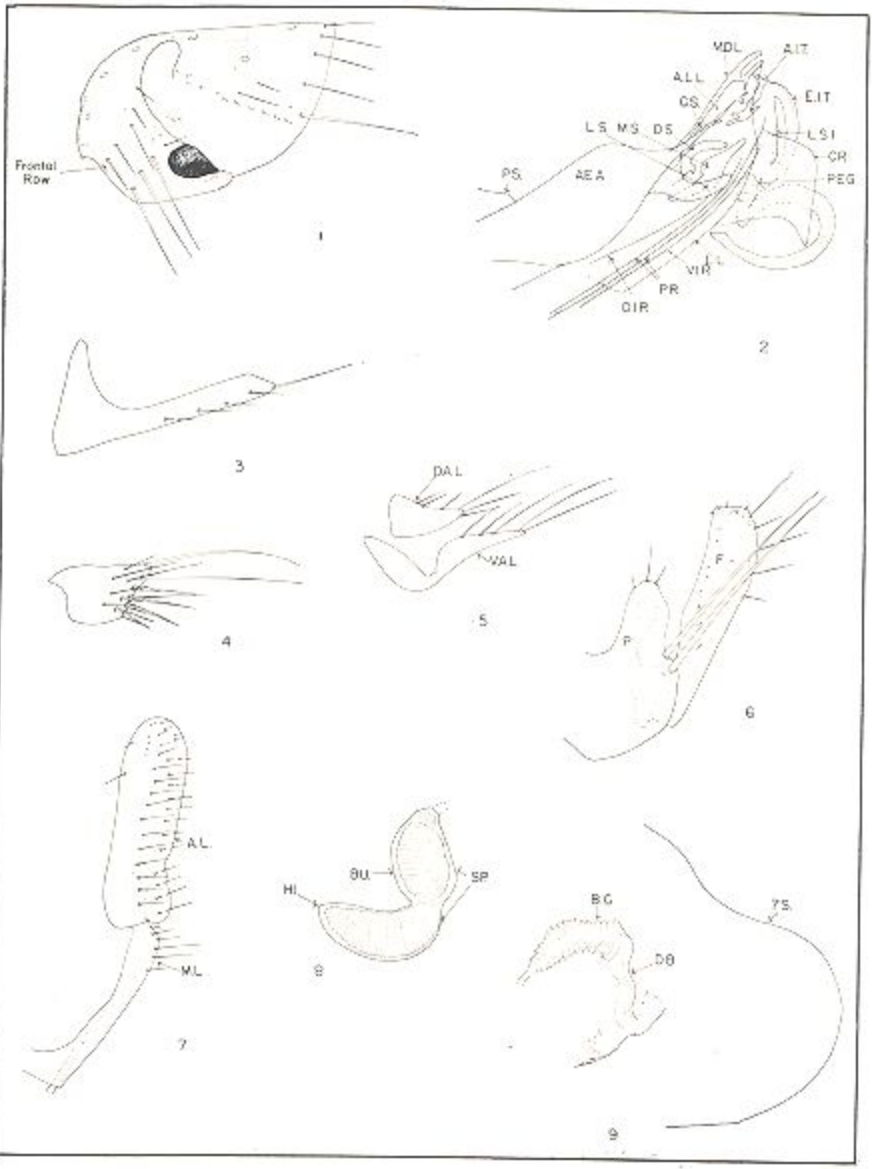
Ceratophyllus (*Amonopsyllus*) [section of *Monopsyllus*] Ioff, 1936, Ztschr. f. Parasitenk. 9: 96. Type: *Ceratophyllus ciliatus* Baker. (Subsequent designation by Argyropulo, 1946.)
Ceratophyllus (*Monopsyllus*), Ioff, 1936, loc. cit. 9: 96.
Monopsyllus (*Amonopsyllus*), Wagner, 1938, Konowia 17: 9.
Trichopsylla (*Trichopsylla*)[3] Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Pub. 500, pp. 55, 56.
Ceratophyllus (*Paramonopsyllus*) Argyropulo, 1946, *in* Ioff, Tiflov, Argyropulo, et al., Med. Parazitol. i Parazitarnye Bol. 15 (No. 4): 87. Type: *Ceratophyllus* (*Paramonopsyllus*) *desertus* Argyropulo. (By original designation.)
Monopsyllus, Hubbard, 1947, Fleas West. North Amer., p. 219. Holland, 1949, Canad. Dept. Agr. Pub. 817, Tech. Bul. 70, p. 164.
Ceratophyllus (*Monopsyllus*), Ioff and Skalon, 1954, Handb. Ident. Fleas, p. 75.
Ceratophyllus (*Amonopsyllus* section), Ioff and Skalon, 1954, loc. cit., p. 76.
Ceratophyllus (*Paramonopsyllus*), Ioff and Skalon, 1954, loc. cit., p. 76.

Description.—***Head*** (pl. I, 1): Eye large and dark except in *exilis* (Jordan); longest diameter always longer than distance of eye from angle of strongly chitinized part of genal lobe. Occiput with no more than four medium-sized to large bristles, other than posterior submarginal row, and row of minute bristles along dorsal margin of antennal groove. Second antennal segment of male with apical bristles not reaching beyond middle of club except in *eumolpi* group, where these bristles are three-fourths length of club; apical bristles of female reaching to or beyond apex of club. ***Thorax:*** Pronotal comb of no more than 24 spines, usually 18 to 20; these spines large and dark. ***Legs:*** Outer surface of fore femur with several small lateral bristles. Inner surface of hind coxa with thin long bristles, if present, confined to apical half. Fifth tarsal segment of all legs with only basal of five pairs of plantar bristles moved somewhat on to plantar surface. ***Abdomen:*** Spiracle of eighth tergum never greatly enlarged. Male with one large antesensilial bristle flanked by minute antesensilial bristle on each side. Female with three long antesensilial bristles, middle one longest.

Male: Ventral anal lobe often, but not always, longer than dorsal anal lobe (pl. I, 5). Eighth tergum not mesally spiculated apicodorsally except in one species, *thambus* (Jordan). Eighth sternum (pl. I, 3) always present, sometimes strongly reduced, often with subapical plume on each side. Distal arm of ninth sternum (pl. I, 7) always with mesal groove or bay in apical lobe (A.L.)[4] for reception of crochet peg. ***Aedeagus*** (pl. I, 2): Apodemal strut with its dorsal sclerite (D.S.) long and thin. Crescent sclerite (C.S.) usually well developed. Accessory lateral lobe (A.L.L.) usually present. (This lobe is perhaps always present, but it is often difficult to see in specimens that have the aedeagus in normal position within the body.) Sclerotized inner tube (E.I.T.) always with an extension, sometimes short and sometimes very long. Aedeagal apodeme (pl. IX, 56, AP. A.) with or without apical appendage. Penis rods (P.R.) sometimes very long and coiled. Crochets (CR.) small to large, often hooked apically but never fimbriate.

Female: Anal stylet (pl. III, 28) normally with one long apical bristle, one minute dorsal subapical hair, and one long subapical bristle both dorsally and ventrally; occasionally stylet (pl. IX, 63) has three large subapical bristles rather than two. Ventral anal lobe (pl. I, 4) often posteroventrally angulate, always with thick short

[3] See Hopkins (1948) for a discussion of the use of this name.
[4] For meaning of abbreviations, see p. 68.



M. sciurorum Schrank: 1, Head, male (Turkey ex *Sciurus*); 2, aedeagus (India ex *Callosciurus*); 3, eighth sternum, male (Turkey); 4, ventral anal lobe, female (Turkey); 5, dorsal and ventral anal lobes, male (Turkey); 6, clasper, male (Turkey); 7, distal arm of ninth sternum, male (Turkey); 8, spermatheca (Germany ex *Eliomys*); 9, seventh sternum and bursa copulatrix (Turkey).

bristles on posterior margin, some of which may be bent apically. Bursa copulatrix (pl. I, 9, B.C.) of various shapes, but apex never tightly coiled. Spermatheca (pl. I, 8) of various configurations; hilla at times longer and broader than bulga. (The term "bulga" (BU.) is used in place of head or body and "hilla" (HI.) in place of tail.) At times (in type species and some others) spermathecal duct dilated and wrinkled, and/or strongly sclerotized for part of its length. Eighth sternum present, normally developed, though at times lacking bristles.

KEY TO MALES

1. With three dark spiniform bristles along posterior margin of movable finger, upper two approximately same size, lowest one larger, none of spiniforms contiguous (pls. X, 66; XV, 92) ... 2
   No more than two spiniforms on finger (pl. VI, 35), or if three, upper two very short and contiguous (pl. IX, 61) ... 11

2 (1). Spiniforms on finger set on prominence of proximal (ventral) half of posterior margin (pl. X, 66); pair of subapical plumes (one on each side) of eighth sternum, if present, never long or bifurcate (pl. XI, 78) ... 3
   Spiniforms on finger spaced more or less evenly along entire margin (pl. XV, 92); pair of subapical plumes of eighth sternum large and bifurcate (pl. XV, 98) (illustration shows only one of two subapical plumes) ... 4

3 (2). Penis rods coiled (pl. XI, 75, P.R.); spiniforms of finger blunt apically (pl. XIII, 83); crochet apically acute (pl. XI, 79, CR.) ***wagneri***, p. 31
   Penis rods not coiled; spiniforms of finger apically acute (pl. X, 66); crochet apically blunt (pl. X, 72, CR.) ... ***thambus***, p. 29

4 (2). Distal arm of ninth sternum with apical part bent at about right angle to remainder of segment (pl. XIX, 114) ... 5
   Distal arm of ninth sternum with apical part not at all bent (pl. XV, 94), or merely curved (pl. XXI, 142) ... 7

5 (4). Apical part of movable finger above notch on anterior margin broader than high (pl. XX, 129) ... ***wallowensis***, p. 53
   Apical part of finger never broader than high ... 6

6 (5). Median dorsal lobe of aedeagus angulate along margin (pl. XX, 127, M.D.L.); armature of inner tube not craggy (pl. XX, 127, A.I.T.); apical part of distal arm of ninth sternum with posteroventral corner drawn out and acute (pl. XX, 126) ***orarius***, **n. sp.**, p. 55
   Median dorsal lobe smoothly convex (pl. XIX, 115, M.D.L.); armature of inner tube heavy and craggy (pl. XIX, 115, A.I.T.); distal arm of ninth sternum with posteroventral corner blunter and more rounded (pl. XIX, 114) ... ***cyrturus***, p. 50

7 (4). Distal arm of ninth sternum with subapical posterior projection (pl. XV, 94); (*eumolpi* subspecies) ... 8
   Distal arm of ninth sternum lacking subapical posterior projection, although margin may be incised in this area (pl. XXI, 135, 142) ... 9

8 (7). Movable finger broadest at level of lowest spiniform (pl. XVIII, 110); crochet angulate posteriorly (pl. XV, 97, CR.); aedeagal apodeme strongly humped dorsally at juncture with end chamber (pl. XV, 97, AE. A.); in Southwestern States, mainly Arizona and New Mexico ... ***eumolpi americanus***, p. 50
   Movable finger no broader at level of lowest spiniform than elsewhere (pl. XV, 92); crochet convex posteriorly (pl. XV, 100, CR.); apodeme not strongly humped; found throughout southwestern and south-central Canada and Western United States except Arizona, New Mexico, and coastal Washington, Oregon, and California ... ***eumolpi eumolpi***, p. 42

9 (7). Movable finger strongly angled at level of lowest large spiniform (pl. XXII, 145); second mesotarsal segment lacking bristles, which extend beyond apex of following segment ..... ***polumus,*** p. 61
Movable finger not angled at level of lowest spiniform (pl. XXI, 139, 143); second mesotarsal segment with long slender bristles reaching beyond apex of following segment 10

10 (9). Lowest spiniform on movable finger on or above level of acetabular bristles of fixed process (pl. XXI, 143); distal arm of ninth sternum with apical lobe curved, narrowing evenly to apex, not incised subapically on posterior margin (pl. XXI, 142) ***eutamiadis,*** p. 57
Lowest spiniform on movable finger below level of acetabular bristles (pl. XXI, 139); distal arm of ninth sternum with subapical incision in posterior margin; apical lobe of ninth sternum not curved or evenly narrowing to apex (pl. XXI, 135) ***fornacis,*** p. 60

11 (1). Movable finger lacking enlarged or darkened bristles, elongate-rectangular with sides parallel for entire length (pl. II, 21); apex of fixed process of clasper small, triangular; crochet apically hooked (pl. II, 22, CR.); found once on *Rattus* in San Francisco ..... ***anisus,*** p. 8
Movable finger often with spiniforms or enlarged dark bristles; if finger is elongate, apex is produced posteriorly or sides are not parallel (pls. II, 13; VI, 35); crochet rounded or acute apically but not hooked 12

12 (11). Apex of movable finger produced anteriorly into slender finger-like process (pl. IX, 61); apical appendage of aedeagal apodeme long (pl. IX, 56, AP. A.); penis rods coiled (P.R.) ..... ***tolli,*** p. 27
Apex of movable finger not so; apical appendage not so long; penis rods never coiled 13

13 (12). Eighth sternum with pair of subapical plumes feathered (pl. II, 16); movable finger not produced posteroapically, its posteroapical bristles not spiniform (pl. II, 13); crochet rounded apically (pl. II, 15, CR.) ..... ***vison,*** p. 11
Eighth sternum lacking plumes or with these plumes very small and simple (pl. III, 31); movable finger at least somewhat produced posteroapically (pls. V, 34; VI, 35); crochet apically acute (pls. III, 32; VI, 41, CR.) 14

14 (13). Eighth sternum with apical plumes (pl. III, 31); movable finger with or without one or two small blunt posteroapical bristles, these bristles never greatly enlarged (pl. V, 34) ..... ***exilis,*** p. 13
Eighth sternum lacking apical plumes (pl. VI, 40); movable finger with two short stout spiniforms apically on posterior margin (pl. VI, 35); (*ciliatus* subspecies) 15

15 (14). Movable finger not strongly produced posteroapically; anterior margin not strongly angled at level of notch; apex of fixed process very broad (pl. VI, 35); found south of San Francisco Bay ..... ***ciliatus ciliatus,*** p. 20
Movable finger and fixed process otherwise 16

16 (15). Movable finger strongly angulate at level of notch on anterior margin; apex of fixed process very narrow and strongly sclerotized (pl. VII, 45); found in Sierra Nevada Mountains of California ..... ***ciliatus mononis,*** p. 25
Movable finger and fixed process otherwise 17

17 (16). Movable finger short, less than twice as high as apically broad; anterior margin not at all angulate (pl. VII, 46); found mainly in Great Basin area and Rocky Mountains ..... ***ciliatus kincaidi,*** p. 26
Movable finger more than twice as high as apically broad; anterior margin angled (pl. VII, 44); found in Alaska, western Canada, western Washington, Oregon, and California north of San Francisco Bay ..... ***ciliatus protinus,*** p. 24

KEY TO FEMALES

1. Bulga (body) of spermatheca long and narrow, of vermiform appearance; hilla (tail) often longer and broader than bulga (pls. X, 69; XIII, 85) 2
Bulga never vermiform; hilla never broader than bulga and rarely longer (pls. II, 19; VI, 42; IX, 60) 3

2 (1). Bulga subapically constricted (pl. X, 69, SP.); seventh sternum with long pointed lobe above deep rounded sinus (pl. X, 69, 7S.); found in subarctic of Canada ..... ***thambus,*** p. 29
If bulga is subapically constricted (pl. XII, 80), seventh sternum is without long apical lobe or deep sinus (pl. XII, 82); if seventh sternum has deep sinus, lobe above is not narrow or pointed and bulga is not subapically constricted (pl. XIII, 84); found from southern British Columbia, Alberta, and Saskatchewan south ..... ***wagneri,*** p. 31

3 (1). Bursa copulatrix long and coiled (pl. XV, 99); seventh sternum with rounded or squared lobe and no sinus (pl. XVI, 101) 4
Bursa copulatrix of various configurations but never coiled; seventh sternum sometimes as above 6

4 (3). Ventral anal lobe strongly angled posteroventrally, almost right angle (pl. XIX, 122); seventh sternum with broad lobe (pl. XIX, 117); found in New Mexico and central to south Arizona ***cyrturus,*** p. 50
Ventral anal lobe not so strongly angled posteroventrally, angle greater than 90° (pl. XV, 95); lobe on seventh sternum large or small, but never very large and squared in specimens from southern Arizona, New Mexico, and southern Colorado 5

5 (4). Lobe of seventh sternum narrow (pl. XVI, 104); found in Colorado, New Mexico, and Arizona ..... ***eumolpi americanus,*** p. 49
Lobe of seventh sternum broad and usually squared (pl. XVI, 101); found in Western United States and southwestern Canada south and east to Colorado and Arizona ..... ***eumolpi eumolpi,*** p. 42

6 (3). Bulga of spermatheca strongly curved, 2½ to 3 times as long as broad; hilla narrow and less than half as long as bulga (pl. II, 19); seventh-sternum margin ventrally so strongly convex as to be semicircular (pl. II, 19); found once on *Rallus* in San Francisco ***anisus,*** p. 8
Bulga not so strongly curved; hilla proportionately longer (pls. VI, 42; XV, 93); seventh sternum often with dorsal lobe or sinus, never ventrally semicircular (pls. II, 10; VI, 42) 7

7 (6). Spermatheca with bulga and hilla approximately same length; bulga elongate-oval, with one margin more convex than other (pl. II, 12); seventh sternum usually with entire ventral part large squared lobe, but sometimes with dorsal projection and small sinus ventral to it (pl. II, 10) ..... ***vison,*** p. 11
Spermatheca and seventh sternum not as above 8

8 (7). With combination of following: Seventh sternum lacking sinus or dorsal projection (pl. XIX, 119); spermatheeal bulga with sides parallel; hilla no longer than bulga (pl. XV, 93) 9
Seventh sternum with dorsal projection, lobe, and/or sinus; spermatheca sometimes as above 10

9 (8). Bursa copulatrix relatively large, convex, and ridged (pl. XIX, 119); found in Siskiyou Mountains of southwestern Oregon and northwestern California ..... ***orarius,* n. sp.,** p. 55
Bursa copulatrix much smaller, not convex or heavily ridged (pl. XXII, 151, B.C.); found in Durango, Mexico ..... ***polumus,*** p. 61[5]

[5] Some specimens of *fornacis* would key here. The bursa copulatrix and its duct are at least as long as the length of the spermatheeal bulga in *fornacis*; in *polumus* they are not so long as the bulga.

10 (8). Spermathecal bulga oval or round (pls. III, 30; VI, 42)..... 11
Spermathecal bulga not oval or round (pl. IX, 60)..... 15

11 (10). Hilla of spermatheca no longer than bulga; seventh sternum never darkened just anterior to sinus (pl. III, 30); on *Onychomys* ***exilis,*** p. 13
Hilla longer than bulga; seventh sternum darkened anterior to sinus (pl. VI, 42); found on chipmunks and squirrels; (*ciliatus* subspecies)..... 12

12 (11). Seventh-sternum sinus very narrow; lower lobe broad and squared (pls. VI, 42; VIII, 52); found in California south of San Francisco Bay..... ***ciliatus ciliatus,*** p. 20
Sinus much broader (pl. VIII, 49, 51, 54); lower lobe usually not at all squared..... 13

13 (12). Seventh sternum with upper lobe long, apically rounded, or square, projecting beyond lower lobe which slants smoothly to ventral margin (pl. VIII, 54); found mainly in Great Basin area and Rocky Mountains..... ***ciliatus kincaidi,*** p. 26
Upper lobe not projecting so far; lower lobe more rounded (pl. VIII, 49, 51)..... 14

14 (13). Seventh sternum with sinus very broad; lower lobe narrow (pl. VIII, 51); found in Sierra Nevada Mountains of California ***ciliatus mononis,*** p. 25
Sinus not so broad; lower lobe larger (pl. VIII, 49); found in Alaska, western Canada, western Washington, Oregon, and California north of San Francisco Bay..... ***ciliatus protinus,*** p. 24

15 (10). Seventh sternum with rounded upper lobe surmounting deep rounded sinus (pl. IX, 59); ventral anal lobe not at all angulate posteriorly, with posterior bristles along entire posterior-ventral margin (pl. IX, 63); on *Ochotona* in northern Canada ***tolli,*** p. 27
Seventh sternum not as above (pls. XIX, 120; XXI, 134, 137); ventral anal lobe angulate posteriorly, with bristles only on posterior margin above angle (pls. XIX, 123; XXI, 141); on chipmunks in Western United States..... 16

16 (15). Bursa copulatrix very large, convex, and ridged (pl. XIX, 121); seventh sternum with squared dorsal lobe (pl. XIX, 120); found in Wallowa Mountains of Oregon and Washington and vicinity..... ***wallowensis,*** p. 53
Bursa copulatrix not as above (pl. XXI, 130, 140, B.C.); seventh-sternum lobe never large and squared (pl. XXI, 134, 137)..... 17

17 (16). Seventh sternum with long acute to sharply rounded upper lobe surmounting deep rounded sinus (pl. XXI, 137)..... ***eutamiadis,*** p. 57
Seventh sternum with short dorsal projection or sometimes with this projection almost lacking; no sinus below projection (pl. XXI, 134)..... ***fornacis,*** p. 60

DESCRIPTIONS OF THE SPECIES

Monopsyllus anisus (Rothschild)

(Pl. II, 19–24)

Ceratophyllus anisus Rothschild, 1907, Novitates Zool. 14: 332, figs. 6, 7. Mitzmain, 1909, Canad. Ent. 41: 201. Rothschild, 1910, Bul. Ent. Res. 1: 94, fig. 23. Jordan, 1929, Novitates Zool. 35: 164, pl. 8, figs. 11, 12. Wagner, 1930, Kat. Aphanipt., p. 7.

Monopsyllus anisus, Jordan, 1933, Novitates Zool. 39: 78. Wagner, 1934, Konowia 13: 262. Wagner, 1936, loc. cit. 15: 92, fig. 8.

Ceratophyllus (Monopsyllus) anisus, Ioff, 1936, Ztschr. f. Parasitenk. 9: 96, fig. 23.

Monopsyllus anisus, Jordan, 1937, Novitates Zool. 40: 206.

Ceratophyllus (*Monopsyllus*) *anisus*, Marikovski, 1937, Akad. Nauk S.S.S.R., Dal. Fil. Vest. 27: 148–156 (page number not available). Liu, 1939, Philippine Jour. Sci. 70: 20, figs. 7, 8.

Monopsyllus anisus, Jellison and Good, 1942, U.S. Natl. Inst. Health Bul. 178: 88. Jordan, 1943, *in* Smart, Handb. Ident. Insects Med. Importance, fig. 143A, B. Chow and Huang, 1950, Taiwan Mus. Quart. Jour. 3: 115, figs. 13, 14. Smit, 1952, World Health Organ. Bul. 7: 328, figs. 30–32. Fujisaki, 1953, Nagasaki Med. Soc. Jour. 28: 1045, 1047. Jameson, 1953, Fleas of Japan and Korea, p. 9, figs. 1–4. Nagahana, 1954, Jap. Jour. Sanit. Zool. 4 (spec. No.): 264, 266, figs. 1–3. Smit, 1954, World Health Organ. Monog. Ser. 22: 653, figs. 28, 29.

Ceratophyllus (*Monopsyllus*) *anisus*, Ioff and Skalon, 1954, Handb. Ident. Fleas, p. 76, figs. 144A, B.

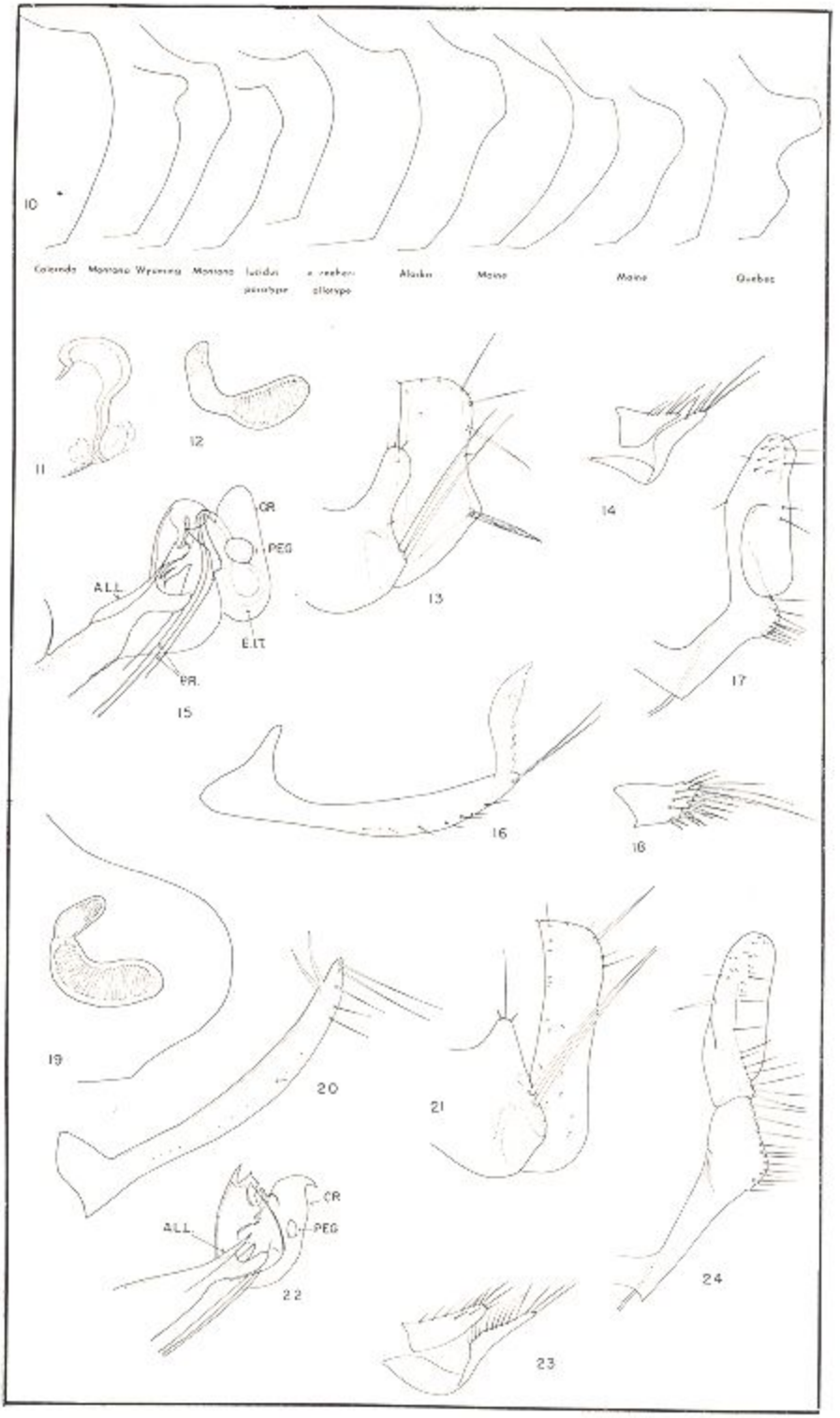
Diagnosis.—The male lacks spiniforms on the movable finger (pl. II, 21), which is armed with one large bristle on the posteroapical angle plus a few smaller bristles on the dorsal margin and below the large bristle. The finger itself is long and narrow, with parallel anterior and posterior margins; the fixed process of the clasper is short and bluntly triangular apically. The seventh sternum (pl. II, 19) of the female has a large rounded ventral lobe. The spermathecal bulga (pl. II, 19) is long, curved, and more than two times as broad and as long as the hilla.

Description.—***Head:*** Eye large and dark. Frontal row of six to seven bristles in male, two to three in female. Occiput with one row of two bristles in male and one or two bristles in female, other than posterior submarginal row. Dorsal margin of antennal groove lined with 10 to 15 small bristles. ***Thorax:*** Pronotal comb of 19 to 20 broad but sharply pointed spines. ***Legs:*** Mesotarsal segments one and two of male lacking long slender bristles on posterior margin.

Male: Ventral anal lobe much longer than dorsal anal lobe (pl. II, 23). Eighth sternum (pl. II, 20) with four to five long apical and subapical bristles plus one or more small bristles along ventral (posterior) margin; one small subapical plume inserted on each side, plume small, simple, apically acute. Fixed process of clasper (pl. II, 21) apically a broad short triangle. Movable finger long, narrowly rectangular, armed with one long posteroapical bristle plus varying numbers of medium-sized to small bristles dorsal to large bristle and on apical half of posterior margin. Distal arm of ninth sternum (pl. II, 24) rounded apically, anterior subapical margin with one large bristle; row of median bristles extending length of apical lobe; median lobe flattened, with row of large marginal bristles. ***Aedeagus*** (pl. II, 22): Accessory lateral lobe (A.L.L.) present. Median dorsal lobe excised posteriorly, strongly sclerotized marginally. Extension of inner tube very short; crochet (CR.) small, hooked posteroapically; peg (PEG) small, oval. Penis rods not coiled.

Female: Seventh-sternum margin (pl. II, 19) with large rounded ventral lobe; spermathecal bulga (pl. II, 19) long, bent; hilla short, half width of bulga and less than half as long.

U.S. distribution.—This species, which occurs on *Rattus* species in temperate northeast Asia, was reported once (Mitzmain 1909) from rats collected in San Francisco. It has not been established in North America, but it might possibly be introduced with rats escaping from ships that have come from Asian ports. Holland informed me that he has one specimen picked up on a ship from Vladivostok that docked at Vancouver, British Columbia.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Monopsyllus vison (Baker)

(Pl. II, 10–18)

Ceratophyllus vison Baker, 1904, U.S. Natl. Mus. Proc. 27: 388, 408.
Ceratophyllus lucidus Baker, 1904, loc. cit. 27: 388, 410, pl. 20, figs. 5–9. Baker, 1905, loc. cit. 29: 132.
Ceratophyllus vison, Baker, 1905, loc. cit. 29: 133.
Ceratophyllus lucidus, Dunn, *in* Dunn and Parker, 1923, U.S. Pub. Health Rpts. 38: 2773, 2775.
Ceratophyllus vison, Jordan, 1929, Novitates Zool. 35: 35 (synonymizes *lucidus*), 170. Wagner, 1929, Konowia 8: 315.
Monopsyllus vison, Jordan, 1933, Novitates Zool. 39: 78.
Ceratophyllus (*Monopsyllus*) *vison* [*Amonopsyllus* section], Ioff, 1936, Ztschr. f. Parasitenk. 9: 97.
Monopsyllus vison, Wagner, 1936, Konowia 15: 91. Wagner, 1936, Canad. Ent. 68: 199. Jellison, 1939, U.S. Pub. Health Rpts. 54: 2022.
Megabothris vison, I. Fox, 1940, Fleas East. United States, p. 72, pl. 19, figs. 95, 98, 99.
Monopsyllus vison, Jellison and Good, 1942, U.S. Natl. Inst. Health Bul. 178: 91.
Megabothris vison, Fuller, 1943, N.Y. Ent. Soc. Jour. 51: 8.
Trichopsylla (*Trichopsylla*) *vison*, Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Pub. 500, p. 64. Costa Lima and Hathaway, 1946, Inst. Oswaldo Cruz Monog. 4: 300.
Monopsyllus vison, Hubbard, 1947, Fleas West. North Amer., p. 234, fig. 121. Holland, 1949, Canad. Dept. Agr. Pub. 817, Tech. Bul. 70, p. 168, figs. 301, 302.
Monopsyllus vison recheri Hubbard, 1954, Ent. News 65: 174. NEW SYNONYMY.
Monopsyllus visan, Morlan, 1955, Tex. Rpts. Biol. and Med. 13: 110. Holdenried and Morlan, 1956, Amer. Midland Nat. 55: 374.

Diagnosis.—*M. vison* is easily distinguished in the male by the shape and armature of the movable finger of the clasper (pl. II, 13). The finger is roughly rectangular and lacks spiniforms. There are four large bristles on the posterior margin of the finger; the lowest one is large and dark but pointed. This dark bristle is set on a broadly angled protuberance of the posterior margin. The female is distinguished by the shape of the spermatheca (pl. II, 12), which has the bulga oval, about 1½ times as long as broad, and the hilla about as long as the bulga, narrower than the bulga, and with its area of greatest width medially. The seventh sternum (pl. II, 10) usually has a large truncate lobe with a convex margin, but at times the dorsal angle of the lobe is produced into a rounded or squared process, and the margin below this process may be so sinuate as to have an actual sinus.

Description.—***Head:*** Eye large and dark. Male with five to six and female with four to five small to medium-sized bristles in frontal row. Occiput with two rows of one and two bristles each, other than posterior submarginal row. Dorsal margin of antennal groove lined with about 15 small bristles. ***Thorax:*** Pronotal comb of 19 to 20 sharply pointed spines. ***Legs:*** Male lacking long slender bristles on mesotarsal segments one and two.

Male: Ventral anal lobe longer than dorsal anal lobe (pl. II, 14). Fixed process of clasper (pl. II, 13) long and narrow, extending half length of movable finger. Movable finger apically truncate; posteroapical angle rounded and bearing two long bristles; third long bristle

M. vison (Baker), male lectotype, Quebec female: 10, Seventh sternum, female, variations; 11, bursa copulatrix; 12, spermatheca; 13, clasper, male; 14, dorsal and ventral anal lobes, male; 15, aedeagus; 16, eighth sternum, male; 17, distal arm of ninth sternum, male; 18, ventral anal lobe, female.
M. anisus (Rothschild), Japan ex *Rattus*: 19, Spermatheca and seventh sternum; 20, eighth sternum, male; 21, clasper, male; 22, aedeagus; 23, dorsal and ventral anal lobes, male; 24, distal arm of ninth sternum, male.

below these on slightly concave posterior margin (in most western males this bristle is almost midway between the second bristle from the apex and the large dark ventral bristle, and most eastern males are as shown in the illustration; however, this difference does not hold with all specimens); below concavity of margin there is one large dark pointed bristle set on broad angle of margin. Eighth sternum (pl. II, 16) with one simple subapical plume on each side; two long apical bristles plus few small ventromarginal bristles along apical two-thirds. Distal arm of ninth sternum (pl. II, 17) subtruncate apically; apex with several thin subapical bristles plus group of smaller lateral bristles; median lobe rounded, with many medium-sized slender marginal bristles. ***Aedeagus*** (pl. II, 15): Penis rods not long or coiled. Apical appendage of aedeagal apodeme very short. Accessory lateral lobe (A.L.L.) present, dorsal for most of its length. Extension of inner tube (E.I.T.) very long, sinuate, and well sclerotized. Crochet (CR.) small, rounded apically, not projecting from apex of aedeagus; peg (PEG) relatively very large.

Female: Ventral anal lobe (pl. II, 18) with none of posteromarginal bristles bent down apically. Seventh sternum (pl. II, 10) varying from having large truncate lobe with slightly convex or undulate margin to having narrow upper lobe with definite sinus ventral to it. Spermathecal bulga 2 to 2½ times as long as broad, ovoid; hilla only somewhat shorter than bulga, half as broad as bulga, and broadest in middle. Bursa copulatrix and ductus bursae (pl. II, 11) not strongly sclerotized.

Types.—Baker described *vison* from an unstated number of syntypes from *Putorius vison*, Peterboro, N.Y., collected by Gerrit S. Miller. In the U.S. National Museum collections are two males labeled as above, one slide has the date "7–13–1900," and has been marked "type 6914 USNM" in handwriting other than that of Baker. The other male is dated "Aug. 8, 1900," and has been labeled subsequently "co-type 6914 USNM." I have selected and labeled as lectotype the specimen dated "7–13–1900."

Ceratophyllus lucidus was also described from an unstated number of specimens taken from spruce squirrels and collected by Baker near Pagosa Peak, Colo., in 1899. Of three specimens bearing data as above, one is a female, *Orchopeas caedens* (Jordan). The remaining male and female are *Monopsyllus vison* (Baker). The male of the pair is labeled "type" in Baker's handwriting. This male is selected as lectotype of *Ceratophyllus lucidus* Baker.

Monopsyllus vison reeheri was described by Hubbard from males and females from *Tamiasciurus hudsonicus richardsoni*, "Hepner [Heppner], Oregon, 15 June 1950, number 2760" in the U.S. National Museum collections. Hubbard did not designate a holotype in his original description of *reeheri*. The male of a pair bearing data as above and labeled "holotype ♂, allotype ♀" is selected as lectotype and has been so labeled. A study of the types of *M. v. reeheri* Hubbard has made it evident that *reeheri* is a synonym of *vison* Baker.

Hosts and distribution.—*M. vison* occurs over the range of *Tamiasciurus hudsonicus* and is a normal parasite of this squirrel. In addition to the localities shown in figure 2, page 19, this species is also found in Alaska at Takotna River and Skilak Lake. In Canada it has been taken at Rampart House, Yukon; Goose Bay, Labrador; and other scattered localities (see Holland 1949). Morlan (1955) has reported this species from *Tamiasciurus*, Santa Fe, N. Mex. I have examined 144 specimens of *vison*.

Monopsyllus exilis (Jordan)

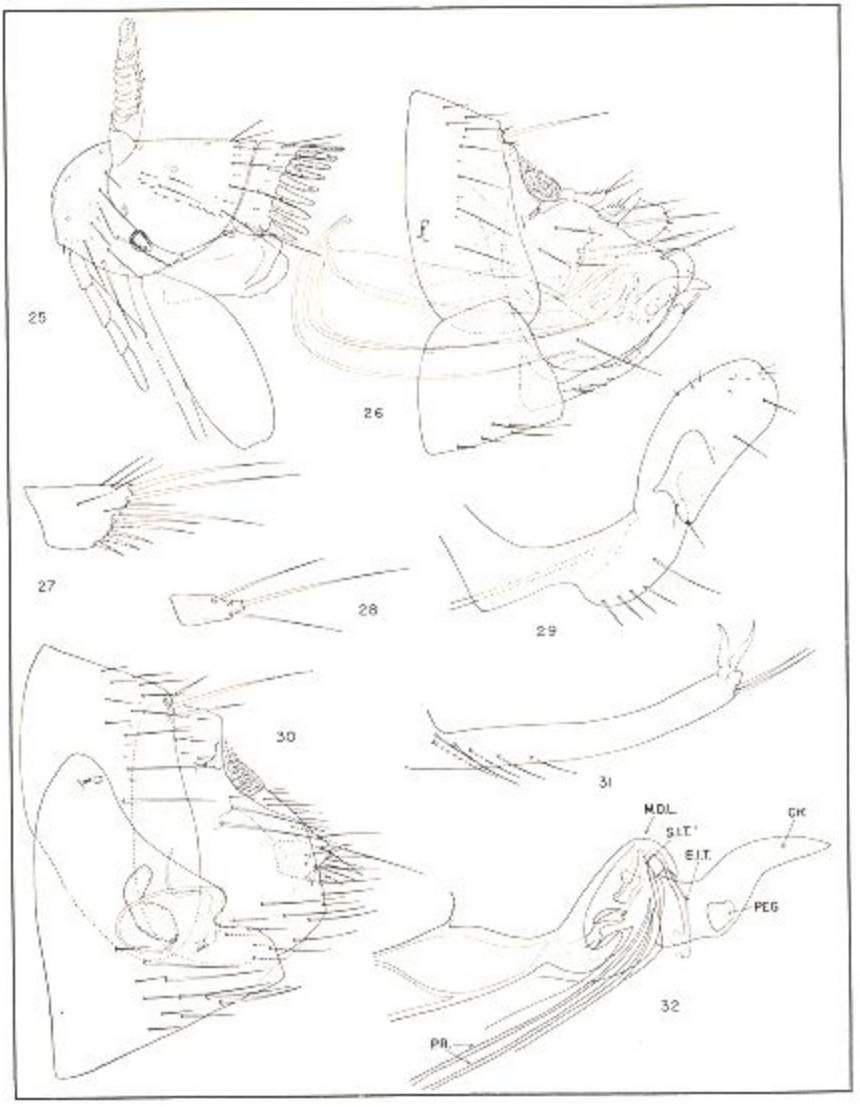
(Pls. III, 25–32; IV, 33; V, 34)

Megabothris exilis Jordan, 1937, Novitates Zool. 40: 264, fig. 46.
Monopsyllus exilis exilis, Jordan, 1938, loc. cit. 41: 120, figs. 68, 69.
Monopsyllus exilis opadus Jordan, 1938, loc. cit. 41: 121, figs. 70d, e. NEW SYNONYMY.
Monopsyllus exilis triptus Jordan, 1938, loc. cit. 41: 122, figs. 71f, g. NEW SYNONYMY.
Monopsyllus exilis exilis, Jellison and Good, 1942, U.S. Natl. Inst. Health Bul. 178: 90.
Monopsyllus exilis opadus, Jellison and Good, 1942, loc. cit. 178: 90.
Monopsyllus exilis triptus, Jellison and Good, 1942, loc. cit. 178: 90.
Trichopsylla (Trichopsylla) exilis exilis, Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Pub. 500, p. 60.
Trichopsylla (Trichopsylla) exilis opada, Ewing and Fox, 1943, loc. cit. 500, p. 61.
Trichopsylla (Trichopsylla) exilis tripta, Ewing and Fox, 1943, loc. cit. 500, p. 61.
Monopsyllus exilis kansensis Hubbard, 1943, Pacific Univ. Bul. 39: 1, fig. NEW SYNONYMY.
Trichopsylla (Trichopsylla) exilis exilis, Costa Lima and Hathaway, 1946, Inst. Oswaldo Cruz Monog. 4: 305.
Trichopsylla (Trichopsylla) exilis opada, Costa Lima and Hathaway, 1946, loc. cit. 4: 305.
Trichopsylla (Trichopsylla) exilis tripta, Costa Lima and Hathaway, 1946, loc. cit. 4: 305.
Monopsyllus exilis exilis, Hubbard, 1947, Fleas West. North Amer., p. 243, fig. 126.
Monopsyllus exilis opadus, Hubbard, 1947, loc. cit., p. 245, fig. 127.
Monopsyllus exilis triptus, Hubbard, 1947, loc. cit., p. 245, fig. 128.
Monopsyllus exilis kansensis, Hubbard, 1947, loc. cit., p. 245, fig. 129.
Monopsyllus exilis, Eads, 1950, Fleas of Texas, p. 41.
Monopsyllus exilis, Morlan, 1955, Tex. Rpts. Biol. and Med. 13: 109.

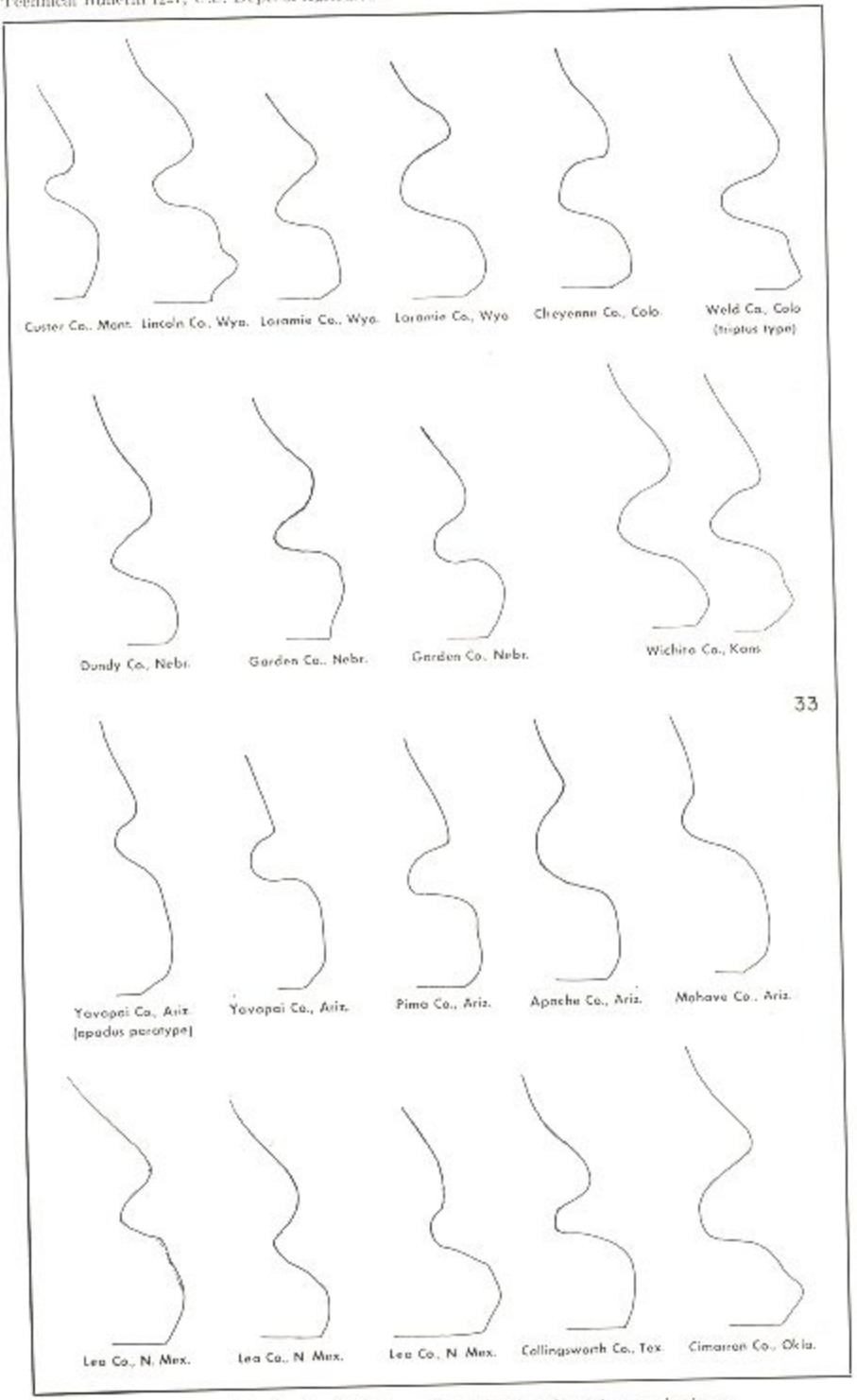
Diagnosis.—*M. exilis* is similar to *ciliatus*. It may be distinguished from other *Monopsyllus* species, because it has a smaller eye (pl. III, 25) than is usual in the genus. In the male the shape of the movable finger (pl. V, 34) is distinctive. The finger is long and narrow, extending far above the apex of the fixed process, and only slightly expanded apically; the posterior margin has two small bristles (often but not always spiniform) set near the apex. The penis rods (pl. III, 26) are thick and not coiled. The ventral anal lobe (pl. III, 27) does not extend much farther posteriad than the dorsal anal lobe. The female of *exilis* is distinguished by the shape of the spermatheca, which has the bulga oval and the hilla narrower and shorter than the bulga and only slightly expanded apically. The seventh-sternum outline (pl. IV, 33) is variable, but a sinus is always present.

Description.—***Head*** (pl. III, 25): Frontal row of five to seven medium-sized bristles. Eye much smaller than usual in genus. ***Thorax:*** Pronotal comb of about 20 rather narrow spines. ***Legs:*** Male lacking long thin bristles on mesotarsal segments one and two.

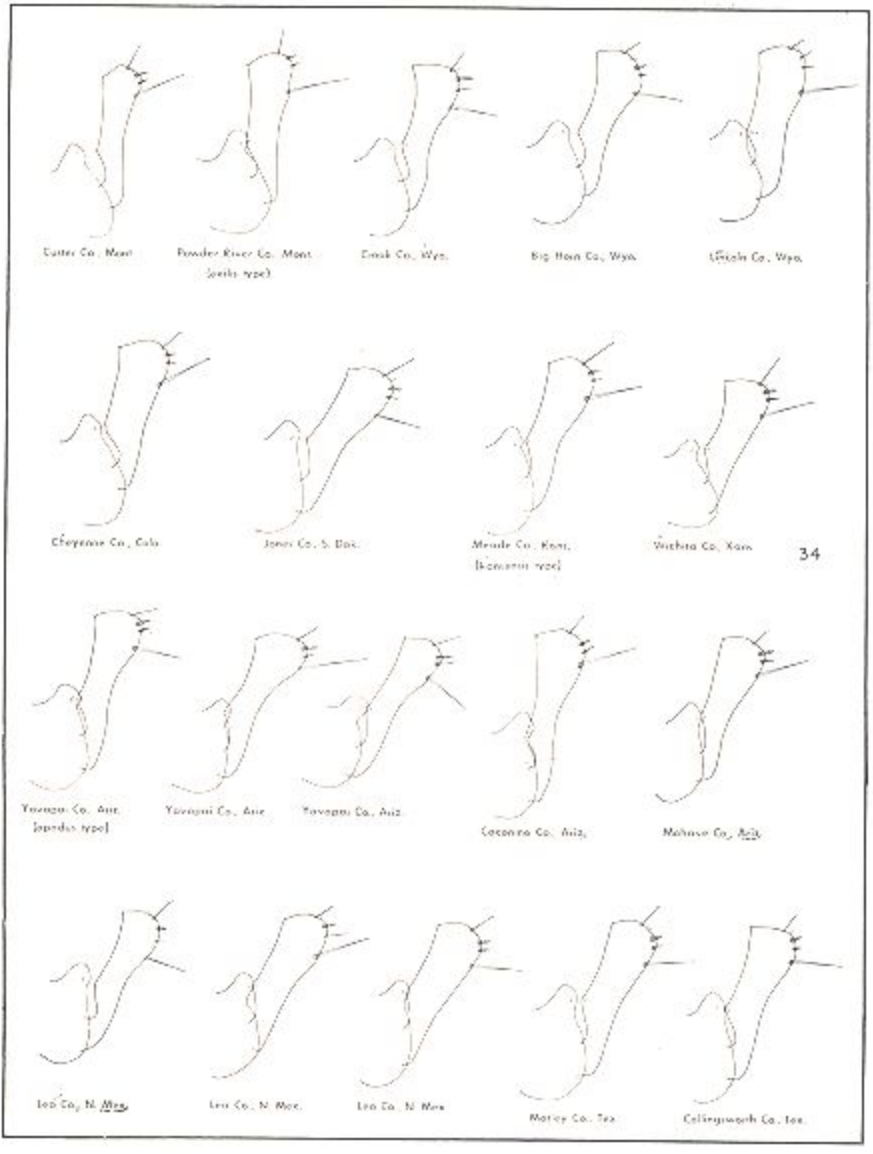
Male (pl. III, 26): Dorsal and ventral anal lobes of about same length. Fixed process of clasper short, rounded, or rounded-truncate apically; acetabular bristles set closer to its apex than its base. Movable finger of variable shape but always long and narrow, extending at least half its length above apex of fixed process; anteroapical corner definitely an angle; posteroapical corner usually rounded; medium-sized to large bristle at or just ventral to posterior angle, followed by two short bristles, which may be spiniform, with large bristle below these. Eighth sternum (pl. III, 31) with one simple subapical plume on each side; two long apical bristles; row of three to



M. exilis (Jordan), male holotype, Custer County, Mont., female: 25, Head, male; 26, modified segments, male; 27, ventral anal lobe, female; 28, anal stylet, female; 29, distal arm of ninth sternum, male; 30, modified segments, female; 31, eighth sternum, male; 32, aedeagus.



M. exilis (Jordan): 33, Seventh sternum, female, variations.



M. exilis (Jordan): 34, Clasper, male, variations.

four small bristles on basal third on each side. Distal arm of ninth sternum (pl. III, 29) rounded apically, with few thin small bristles; median lobe with six to seven thin medium-sized bristles. ***Aedeagus*** (pl. III, 32): Crochets (CR.) large, apically acute, and somewhat hooked; peg (PEG) (which fits into a slit on the ninth sternum) large and squared apically. Inner tube (S.I.T.) with extension of inner tube (E.I.T.) very long. Apical appendage of aedeagal apodeme short. Penis rods not coiled or especially long.

Female (pl. III, 30): Seventh-sternum outline (pl. IV, 33) variously shaped, always with median sinus. Spermathecal bulga ovoid, cribriform area large; hilla shorter and narrower than bulga, somewhat expanded apically. Bursa copulatrix not heavily sclerotized or abnormally shaped. Ventral anal lobe (pl. III, 27) posteroventrally angulate; posteromarginal bristles heavy but not at all bent apically.

Types.—The description of *exilis* was based on two males collected from *Onychomys leucogaster*, Powderville, Powder River County, Mont. The holotype is in the collections of the Rocky Mountain Laboratory, Hamilton, Mont. Although Jordan did not designate one of the two males available to him as holotype, he did state that holotypes of fleas described in the paper naming *exilis* had been returned to the Rocky Mountain Laboratory. Therefore the single male labeled "*Megabothris exilis* Jordan—type" that is in this laboratory is the holotype.

M. exilis opadus was based on one male and three females from *Dipodomys ordii* and one female from *Onychomys leucogaster capitulatus*, Yavapai County, Ariz. In this case it is necessary to select a lectotype, since Jordan did not designate a holotype and both sexes plus several specimens are involved. The male in the Rocky Mountain Laboratory collections that is from *Dipodomys ordii* and labeled "*Monopsyllus exilis opadus* Jordan—type" is selected as lectotype.

M. exilis triptus was described from two females taken from *Dipodomys* or *Onychomys*, Rugger [apparently Roggen, Weld County], Colo., June 1937. One of the two females is in the Rocky Mountain Laboratory collections, and as with *exilis* this is considered the holotype. Through a **lapsus** this specimen had been labeled "*Monopsyllus exilis opadus* Jordan—type." I have placed a notation on the label that the specimen is the holotype of *triptus* Jordan.

Hubbard based the name *M. exilis kansensis* on two males from *Onychomys leucogaster arriceps* (Rhoads), Meade County, Kans., July 1940, Hill and Crowe collectors. The holotype is in the collections of the U.S. National Museum.

Hosts and distribution.—*M. exilis* is a characteristic flea of *Onychomys* species and is rarely found on other species of animals. There are occasional collections from *Dipodomys* spp., and I have seen two specimens supposedly collected from *Baiomys* in Oklahoma.

The distribution of *exilis* (fig. 1) follows that of its hosts. It is found chiefly in the lower elevation arid regions of the Western United States and probably extends into like habitats in Mexico, although no collections have been reported from there. Of interest is the fact that *exilis* has not been reported from Nevada, although *Onychomys* species occur there. Holland informed me that the same situation exists in Canada.

The morphological variation of *exilis* is relatively great, but in my opinion retaining formal names for the populations is not warranted. My study of this variation is based on examination of 370 specimens.

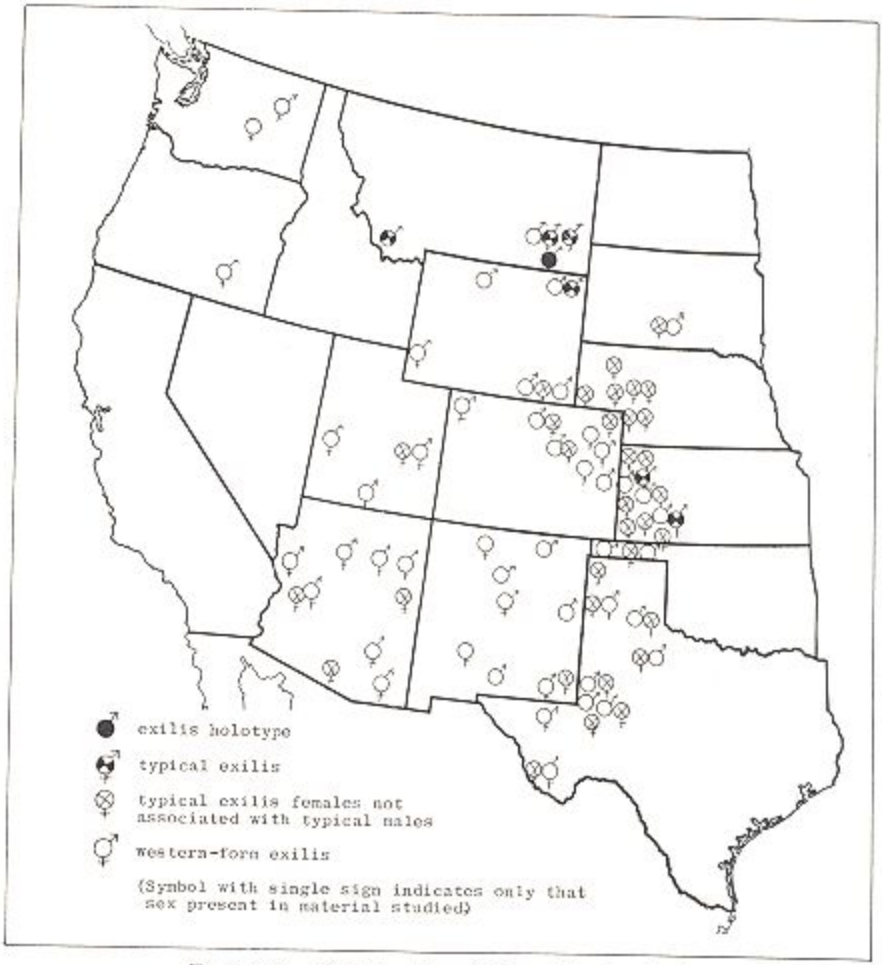


FIGURE 1.—Distribution of *M. exilis* (Jordan).

Discordance between male and female characters is marked. In the western form (see fig. 1), females have the seventh-sternum sinus broad, the dorsal lobe recessed, and the ventral lobe usually, but not always, broad (as in pl. IV, 33, Mohave County, Ariz.). The males associated with such females usually have the two spiniforms of the movable finger set equidistant from the upper and lower long bristles on the posterior margin (pl. V, 34, Motley County, Tex.). (See below the discussion of these spiniforms.) Some males have the lower of the two spiniforms equidistant from the two long bristles (pl. V, 34, Wichita County, Kans.) and thus approach the condition found in the holotype of *exilis* from Powder River County, Mont. (pl. V, 34, *exilis* type). Western-form males occur over the entire range of *exilis*, even in the type locality, as may be seen in figure 1. The few males exhibiting the characteristic spiniform placement of *exilis* holotype apparently are distributed only on the northeastern periphery of *exilis*' range. (Further collections in the center of the range may prove this statement incorrect.) Females with the seventh sternum like or near topotypic *exilis* (pl. IV, 33, Montana, Colorado, Nebraska, Kansas, Oklahoma, etc.) occur throughout the eastern part of *exilis*'

range in company with males of both the *exilis* holotype form and the western form.

The shape of the male movable finger is highly variable in any area. There is no indication that this variation follows a geographical pattern. The two small spiniforms on the posterior margin of the movable finger are also exceedingly variable in both form and coloration, and at times one or both are simple light-colored bristles (pl. V, 34, Lincoln County, Wyo.). It is possible that *exilis* is in the process either of gaining the spiniforms or of losing them. Ordinarily one would presume that *exilis* was gaining spiniforms, since this would be a new departure from the ancestral condition of possessing only normal bristles. The phylogeny of the subfamily Ceratophyllinae and more particularly the relationships of those species currently placed in *Monopsyllus* are uncertain and obscure, and an intelligent guess is impossible as to whether *exilis* is losing or gaining spiniforms on the movable finger.

Monopsyllus ciliatus (Baker)

M. ciliatus is subdivided into four easily defined allopatric populations. Each population maintains its morphological integrity over its respective range. Little is known of the distribution of the nominate form. The type of variation encountered within each subspecies is random and not found on a geographical basis. Only three females from Lassen and Plumas Counties, Calif., show characters that indicate there are probably intergrade forms of two subspecies, *mononis* and *protinus*. However, reasoning from the character and degree of variation between *mononis* and *protinus* and relating it to the type of variation seen in *c. ciliatus* and *c. kincaidi*, the only conclusion I can reach, based on the study of approximately 300 specimens, is that the other populations also represent subspecies of *ciliatus*.

The general distribution of *ciliatus* subspecies (fig. 2) corresponds

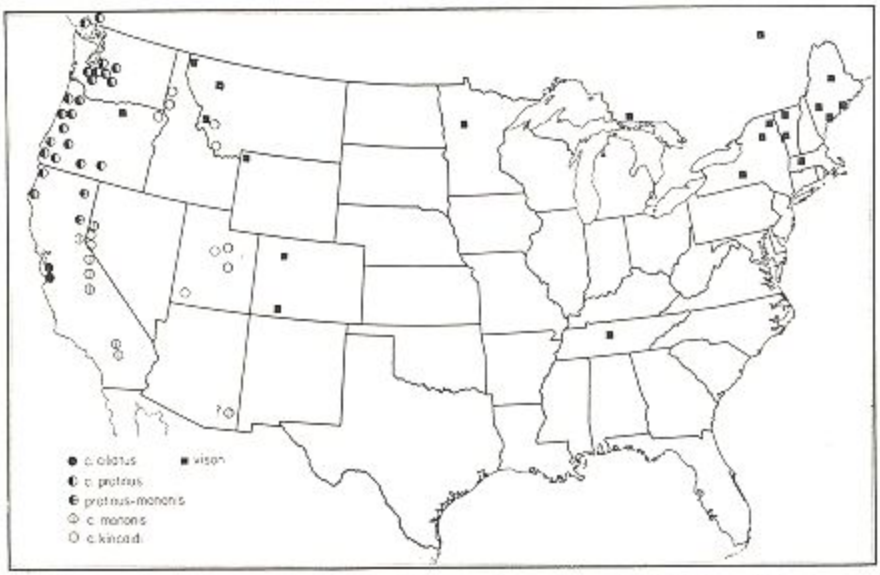


FIGURE 2.—Distribution of *M. ciliatus* subspecies and *M. vison* (Baker).

roughly to the distribution of *Tamiasciurus douglasii* and the western distribution of *T. hudsonicus*. Holland (1949) has pointed out that *ciliatus* occurs on *Tamiasciurus* on Vancouver Island, British Columbia, where *Eutamias* does not occur. At the present time *ciliatus* also occurs normally on *Eutamias* species and is often collected from species of *Citellus*.

M. ciliatus replaces *vison* on *Tamiasciurus* species to the west, although the two species of fleas may occur together over a broad area from the northern Rockies to the Cascades. Since the distribution of *ciliatus* is broader than that of *Tamiasciurus* species, probably *ciliatus* has extended its range via its secondary hosts, the western chipmunks of the genus *Eutamias*.

Monopsyllus ciliatus ciliatus (Baker)

(Pls. VI, 35–43; VII, 48; VIII, 52)

Ceratophyllus ciliatus Baker, 1904, U.S. Natl. Mus. Proc. 27: 387, 397, pl. 16, figs. 1–6. Baker, 1905, loc. cit. 29: 133. Mitzmain, 1909, Canad. Ent. 41: 201. C. Fox, 1914, U.S. Pub. Health Serv. Hyg. Lab. Bul. 97: 25, pl. 18, fig. 41.

Ceratophyllus ciliatus ciliatus, Jordan, 1929, Novitates Zool. 35: 34. Jordan, 1929, 4th Internatl. Cong. Ent. Trans. 2: 497, fig. 5.

Monopsyllus ciliatus, Jordan, 1933, Novitates Zool. 39: 78. Wagner, 1936, Konowia 15: 93, fig. 10.

Ceratophyllus (Monopsyllus) ciliatus [*Amonopsyllus* section], Ioff, 1936, Ztschr. f. Parasitenk. 9: 96, figs. 12, 33, 43.

Monopsyllus ciliatus ciliatus, Wagner, 1936, Canad. Ent. 68: 200. Jellison and Good, 1942, U.S. Natl. Inst. Health Bul. 178: 88.

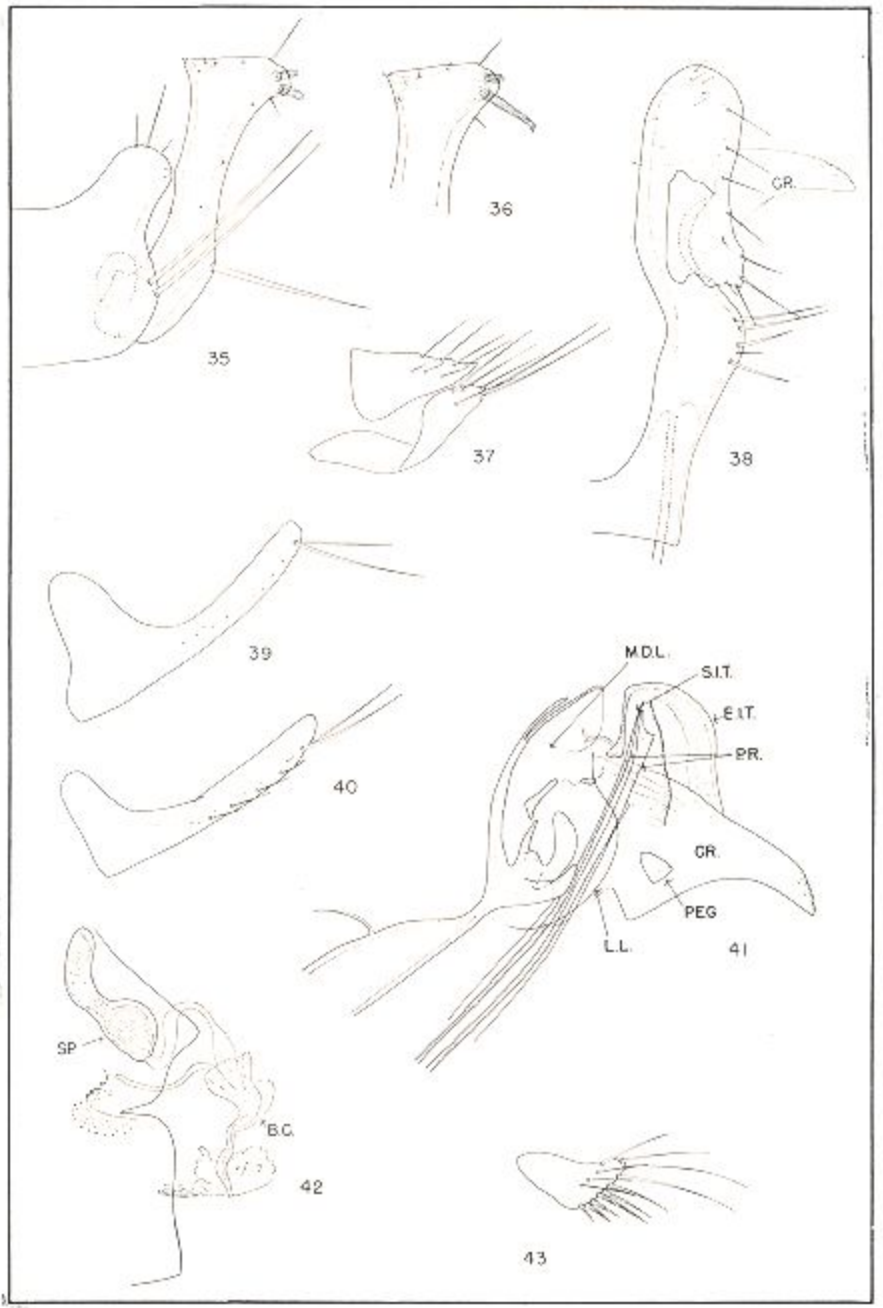
Trichopsylla (Trichopsylla) ciliata ciliata, Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Pub. 500, p. 59. Costa Lima and Hathaway, 1946, Inst. Oswaldo Cruz Monog. 4: 298.

Monopsyllus ciliatus ciliatus, Hubbard, 1947, Fleas West. North Amer., p. 229, fig. 118.

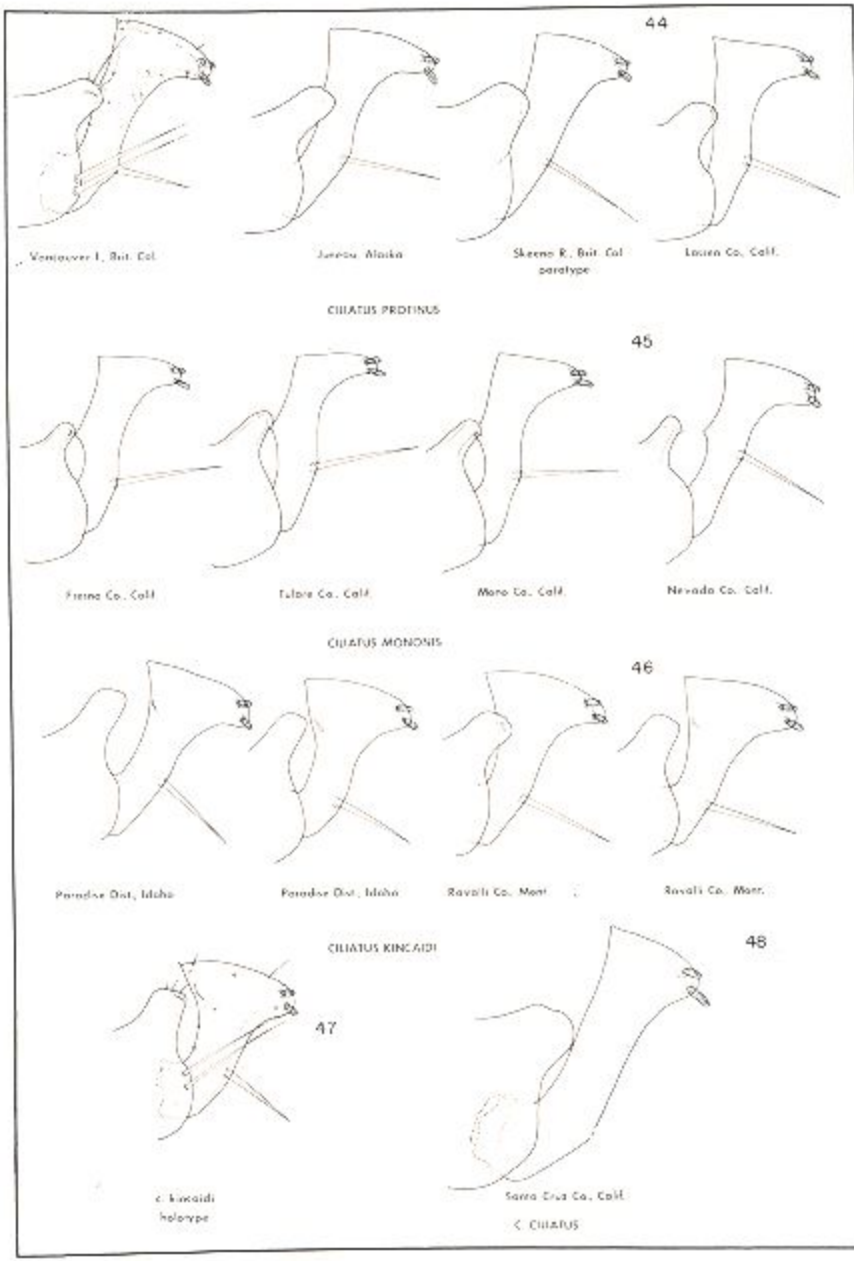
Diagnosis.—The male is easily separated from that of other North American species, because the movable finger (pl. VI, 35) has two very short blunt spiniforms on the posteroapical angle and lacks a long fingerlike projection anteroapically. The eighth sternum lacks an apical plume. The penis rods are not coiled. The female differs from that of other species in having the spermathecal bulga round or ovoid and the hilla longer and much narrower than the bulga (pl. VI, 42, SP.). The seventh sternum (pl. VI, 42) always has a definite sinus. *M. c. ciliatus* may be distinguished in the male from other subspecies of *ciliatus*, because the fixed process of the clasper (pl. VI, 35) is always broad and the movable finger is never sharply angled on the anterior margin, or much expanded posteroapically. The female differs from that of other subspecies of *ciliatus* in having the seventh-sternum sinus (pl. VI, 42) more or less median in position and narrow.

Description.—***Head:*** Eye large and dark. Frontal row of five to seven bristles in male, three in female. Occiput with antennal groove margin lined with approximately 10 small bristles; other than posterior submarginal row, occiput with only 2 large bristles. ***Thorax:*** Pronotal comb of 19 to 20 stout spines. ***Legs:*** Mesotarsal segments one and two of male lacking long slender bristles.

Male: Dorsal and ventral anal lobes (pl. VI, 37) same length. Fixed process of clasper (pl. VI, 35) very broad and short. Movable finger (pl. VII, 48) normally with two posteroapical short blunt spiniforms (the lectotype has one of these spiniforms long and apically bent down and acute on one side (pl. VI, 36), but this is obviously abnormal and is not present in any of the other specimens of this species examined). Finger somewhat expanded posteroapically;

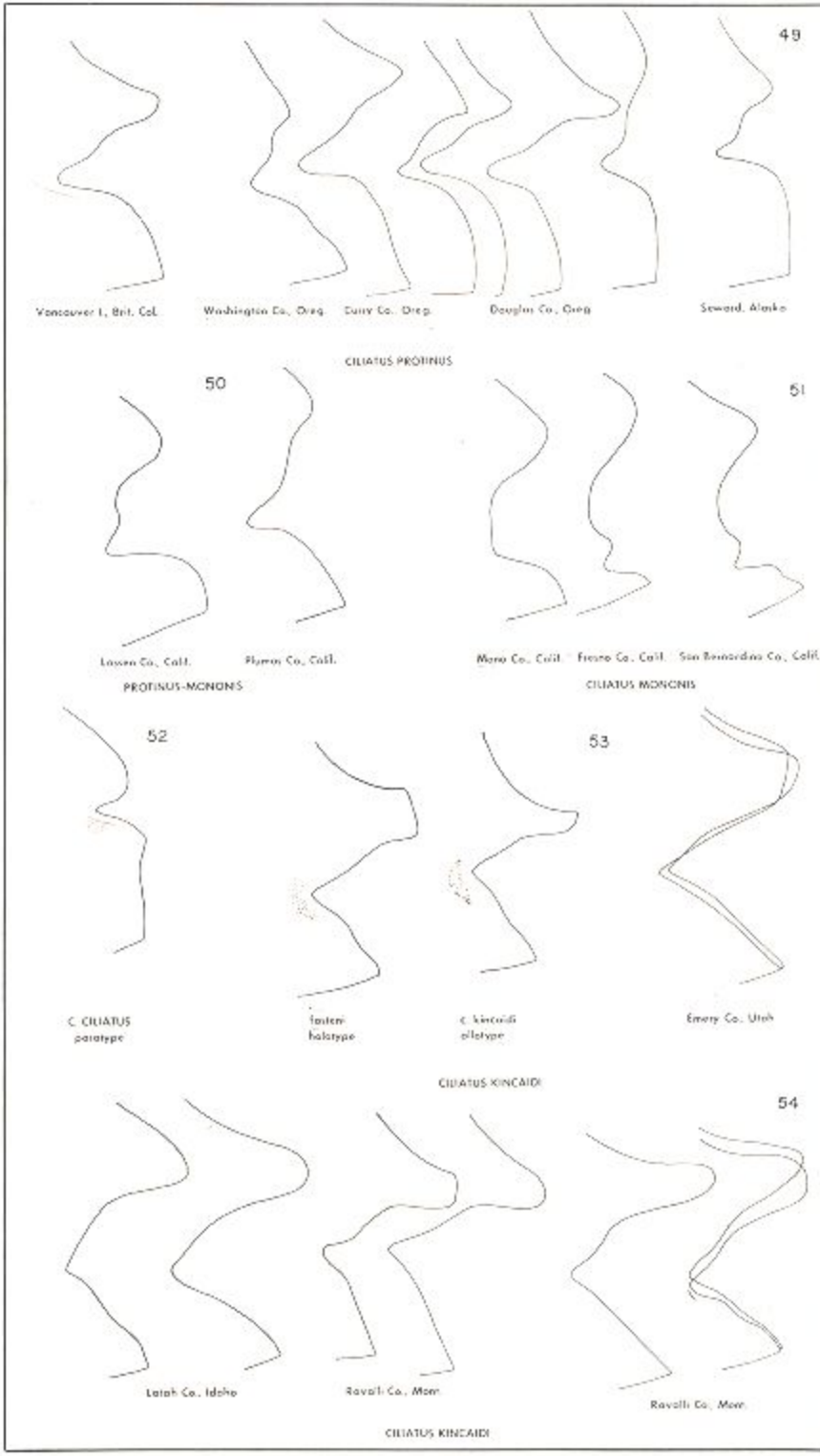


M. ciliatus ciliatus (Baker): 35, Clasper, male (lectotype); 36, apex of movable finger, male, other side (lectotype); 37, dorsal and ventral anal lobes, male (Santa Clara County, Calif.); 38, distal arm of ninth sternum and crochet, male (lectotype); 39, eighth sternum, male (lectotype); 40, ibid. (Santa Cruz County, Calif.); 41, aedeagus (lectotype); 42, seventh sternum, bursa copulatrix, and spermatheca (Santa Cruz County); 43, ventral anal lobe, female (Santa Cruz County).



M. ciliatus subspecies: 44, *M. c. protinus*, clasper, male, variations; 45, *M. c. mononis*, ibid.; 46, *M. c. kincaidi*, ibid.; 47, *M. c. kincaidi*, ibid.; 48, *M. c. ciliatus*, ibid.

M. ciliatus subspecies: 49, *M. c. protinus*, seventh sternum, female, variations; 50, *M. c. protinus-mononis*, intergrading forms, ibid.; 51, *M. c. mononis*, ibid.; 52, *M. c. ciliatus*, ibid.; 53, *M. c. kincaidi*, ibid.; 54, *M. c. kincaidi*, ibid.


49
Vancouver I., Brit. Col.
Washington Co., Oreg.
Curry Co., Oreg.
Douglas Co., Oreg.
Seward, Alaska
CILIATUS PROFINUS
50
Lassen Co., Calif.
Plumas Co., Calif.
PROFINUS-MONONIS
51
Mono Co., Calif.
Fresno Co., Calif.
San Bernardino Co., Calif.
CILIATUS MONONIS
52
C. CILIATUS
paratype
fauteri
holotype
c. kincaidi
allotype
53
Emery Co., Utah
CILIATUS KINCAIDI
54
Latah Co., Idaho
Ravalli Co., Mont.
Ravalli Co., Mont.
CILIATUS KINCAIDI

anterior margin essentially straight, with only slight angle at level of notch, which articulates with similar notch on fixed process. Eighth sternum (pl. VI, 40) with varying number of small bristles along ventral margin; these bristles interspersed with alveoli (the lectotype (pl. VI, 39) apparently has no small bristles along this margin, but they may have been knocked off during mounting); apically with two long bristles; apical plume lacking. Distal arm of ninth sternum (pl. VI, 38) apically rounded; with posterior submarginal row of medium-sized bristles; median lobe with four to five various-sized bristles. ***Aedeagus*** (pl. VI, 41): Extension of inner tube (E.I.T.) long and thick, sclerotized only along one margin; crochet (CR.) apically narrowed, slightly hook shaped; peg (PEG) of normal rounded shape. Aedeagal apodeme with short apical appendage. Penis rods long, but not coiled. (Pl. VI, 41, shows how the peg fits into the ninth sternum so that the crochets and ninth sternum are firmly interlocked.)

Female: Seventh sternum (pls. VI, 42; VIII, 52) with narrow short sinus; lobe below sinus as broad or broader than upper lobe; upper lobe rounded or angulate, darkened area present just anterior to sinus. Spermatheca (pl. VI, 42, SP.) with bulga oval or round; hilla longer and narrower than bulga. Bursa copulatrix (B.C.) not particularly enlarged, somewhat expanded apically. Ventral anal lobe (pl. VI, 43) with bristles on posterior margin thick and dark but not apically bent.

Types.—*M. c. ciliatus* was described from one male and one female collected from a chipmunk (*Eutamias*), Mountain View, [Santa Clara County], Calif. These specimens are in the U.S. National Museum collections. They are labeled as being from Santa Cruz County, not Mountain View, but bear the type catalog No. 6906, as given by Baker in his original description. The male was selected as lectotype by Jordan (1929, p. 34).

Hosts and distribution.—Other than the type male and female, I have seen one female from *Sciurus griseus*, Santa Cruz County, and one male from *Eutamias lateralis*, Santa Clara County, near Mountain View. Anything more than conjectures as to normal hosts and distribution of *c. ciliatus* cannot be made, since the sample is so small. However, it is likely that this subspecies is limited to areas in the California coastal mountains south of San Francisco Bay. The principal hosts may well be chipmunks.

Monopsyllus ciliatus protinus (Jordan)

(Pls. VII, 44; VIII, 49)

Ceratophyllus ciliatus protinus Jordan, 1929, Novitates Zool. 35: 34, pl. 1, figs. 15, 16.

Monopsyllus ciliatus protinus, Wagner, 1936, Canad. Ent. 68: 200. Jellison, 1939, U.S. Pub. Health Rpts. 54: 2022. Jellison and Good, 1942, U.S. Natl. Inst. Health Bul. 178: 89.

Trichopsylla (Trichopsylla) ciliata protina, Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Pub. 500, p. 59. Costa Lima and Hathaway, 1946, Inst. Oswaldo Cruz Monog. 4: 298.

Monopsyllus ciliatus protinus, Hubbard, 1947, Fleas West. North Amer., p. 230, fig. 119. Holland, 1949, Canad. Dept. Agr. Pub. 817, Tech. Bul. 70, p. 165, figs. 295, 296.

Diagnosis.—This subspecies of *ciliatus* differs from *c. ciliatus* in the male only in the shape of the fixed process and movable finger of the clasper. Although these parts show considerable variation, the

process seldom approaches that of *c. ciliatus* in width, although one specimen (a paratype) from Skeena River, British Columbia, (pl. VII, 44) has the process almost as broad as in *c. ciliatus*. Except for the Skeena River specimen, the finger is always expanded markedly posteroapically, and the notch on the posterior margin is at about the middle and the margin is only very slightly angled here. *M. c. protinus* differs from *c. mononis* in the male, in that the fixed process is not so narrow apically and the anterior margin of the finger does not have a definite angle medially. It is easily separable from *c. kincaidi*, because the finger is not evenly concave anteriorly, nor is the notch on this margin set in from the margin. The female differs from that of all the other subspecies, in that the sinus of the seventh sternum (pl. VIII, 49) is large, usually deep, the lower lobe is broad and rounded, and the upper lobe is usually pointed and does not extend far beyond the lower lobe.

Types.—Jordan based his description of *c. protinus* on a series of males and females from various localities in British Columbia. The specimens were taken from "*Sciurus* sp.," and *Sciurus hudsonicus* (*Tamiasciurus hudsonicus*). The male holotype is from "*Sciurus*" sp., Sumas, "British Columbia" [Washington State], and is in the collections of the British Museum (Natural History). The type host is *Eutamias townsendi* according to Holland (1949).

Hosts and distribution.—This subspecies of *ciliatus* has been collected in numbers from both *Tamiasciurus* and *Eutamias* species, and now normally it occurs on both these genera, although it may have been originally a parasite of *Tamiasciurus*.

M. c. protinus occurs in a north-south direction from Alaska (Seward, Juneau, and Salmon Creek), through British Columbia (probably mainly along the coast), and through the western half of Washington, Oregon, and northern California. Two females from Plumas County and one female from Lassen County, Calif., show intermediate characteristics between *c. protinus* and *c. mononis* and probably represent an intergrading population (pl. VIII, 50). I have examined about 150 specimens of this subspecies.

Monopsyllus ciliatus mononis (Jordan)

(Pls. VII, 45; VIII, 51)

Ceratophyllus ciliatus mononis Jordan, 1929, Novitates Zool. 35: 35, pl. 1, figs. 1 7 18. Jordan, 1929, 4th Internatl. Cong. Ent. Trans. 2: 497, fig. 6.

Monopsyllus ciliatus mononis, Augustson, 1941, South. Calif. Acad. Sci. Bul. 40: 152. Jellison and Good, 1942, U.S. Natl. Inst. Health Bul. 178: 89. Augustson, 1943, South. Calif. Acad. Sci. Bul. 42: 78.

Trichopsylla (*Trichopsylla*) *ciliata mononis*, Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Pub. 500, p. 59. Costa Lima and Hathaway, 1946, Inst. Oswaldo Cruz Monog. 4: 298.

Monopsyllus ciliatus mononis, Hubbard, 1947, Fleas West. North Amer., p. 233, fig. 120.

Diagnosis.—This subspecies is closest in the male to *c. protinus* but is easily separated, because the fixed process of the clasper (pl. VII, 45) is always very narrow and more heavily sclerotized and the anterior margin of the movable finger is always markedly angulate at the level of the notch. Like *c. protinus*, *c. mononis* has the finger much expanded posteroapically. In the female of *c. mononis* (pl. VIII, 51), the sinus of the seventh-sternum margin is very broad, the upper lobe is rounded and not salient, and the lower lobe is narrow and at times sinuate.

Types.—*M. c. mononis* was described from one male and two females taken from *Mustela arizonensis* and *Eutamias frater*, "Pine City," Mono County, Calif., July 1922, A. B. Howell collector. The type series is in the collections of the British Museum (Natural History).

Hosts and distribution.—*M. c. mononis* occurs on both *Tamiasciurus* and *Eutamias* species, and it is occasionally taken from *Citellus*. Its range includes the Sierra Nevada Mountains south of the range of *c. protinus* and also the San Bernardino Mountains to the south. One male specimen examined supposedly was taken from the Chiricahua Mountains in southeastern Arizona, but the collection data may be incorrect. As stated under *c. protinus*, three females from the Sierras at the southern end of *protinus*' range seem to be intergrades with *c. mononis*. I have examined approximately 50 specimens of this subspecies.

Monopsyllus ciliatus kincaidi Hubbard

(Pls. VII, 46, 47; VIII, 53, 54)

Ceratophyllus ciliatus, Dunn and Parker, 1923, U.S. Pub. Health Rpts. 38: 2772, 2775 (record specimens from Montana).

Monopsyllus ciliatus kincaidi Hubbard, 1947, Fleas West. North Amer., p. 232, fig. 119a.

Monopsyllus ciliatus fasteni Hubbard, 1954, Ent. News 65: 174. NEW SYNONYMY.

Diagnosis.—This subspecies of *ciliatus* differs in the male from all the other species in the shape of the movable finger (pl. VII, 46, 47). The anterior margin of the finger is evenly concave and the notch is set in from the margin and is usually above the middle. The finger is shorter in relation to its apical width than is true of the other subspecies and is considerably produced posteroapically as in *c. protinus* and *c. mononis*. The fixed process of the clasper is about as broad as in *c. protinus*. In the female of *c. kincaidi* the sinus in the seventh-sternum margin (pl. VIII, 53, 54) is very large; the lower lobe, which slants down to the ventral body margin, is usually as broad from the deepest part of the sinus as the upper lobe, which extends farther posteriad than the lower lobe and may be either apically squared or narrowly rounded.

M. c. fasteni Hubbard (described from females only) is a synonym of *c. kincaidi*. Specimens similar to the holotype of *c. fasteni*—with the upper lobe of the seventh sternum (pl. VIII, 53) squared—may be found throughout the range of *c. kincaidi*, and the degree of squareness or roundness of the lobe may differ on the two sides of a single specimen.

Types.—*M. c. kincaidi* was described from the male holotype, female allotype, and two male and two female paratypes from *Eutamias amoenus luteiventris*, Wallowa Lake, Wallowa County, Oreg. One male paratype was taken from *Tamiasciurus hudsonicus richardsoni*, Utah. The holotype is in the collections of the U.S. National Museum.

M. c. fasteni was described from the female holotype and an unstated number of female paratypes from a chipmunk (*Eutamias*) 10 miles north of Potlatch, Latah County, Idaho, July 22, 1945. The holotype is in the collections of the U.S. National Museum.

Hosts and distribution.—*M. c. kincaidi* probably will be found in all the areas of the northern U.S. Rockies and Great Basin area inhabited by *Tamiasciurus* and in some of the adjoining areas inhabited by various species of *Eutamias*. I have examined approximately 90 specimens of *c. kincaidi*.

Monopsyllus tolli (Wagner)

(Pl. IX, 55–65)

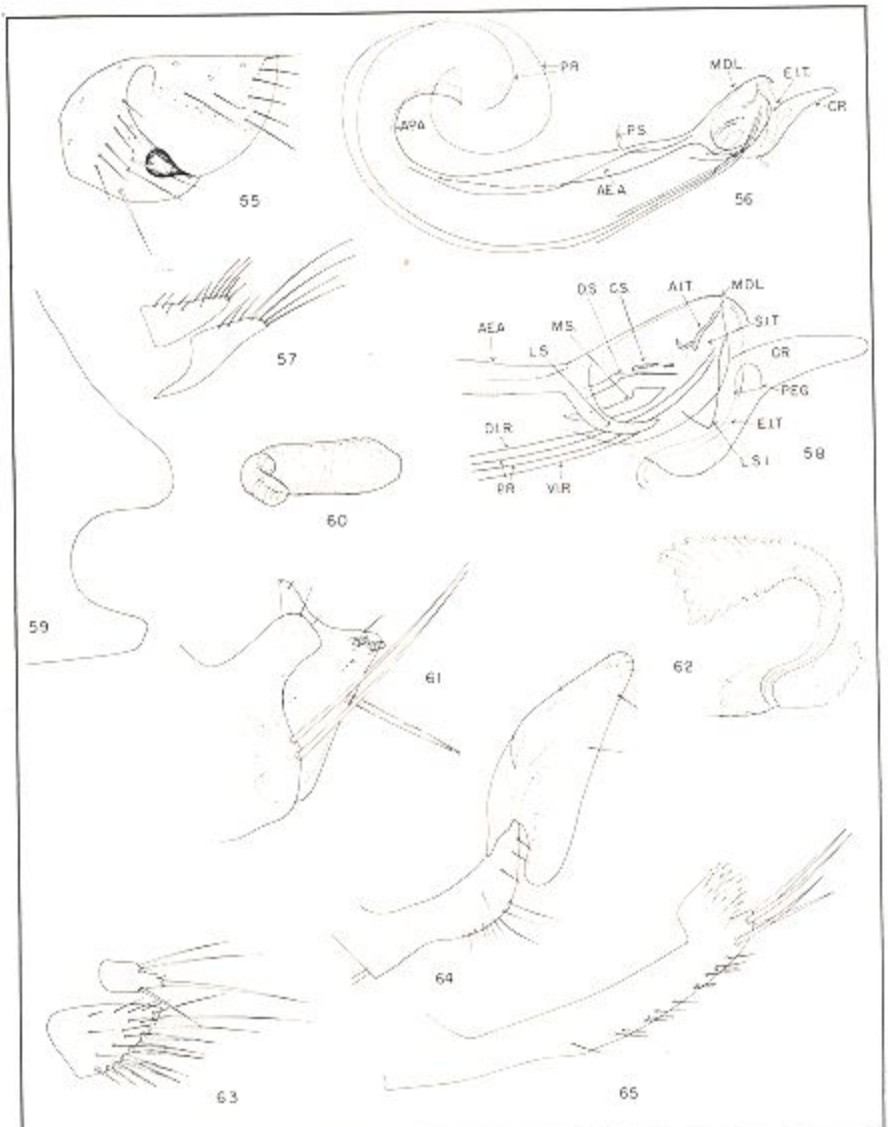
Ceratophyllus tolli Wagner, 1901, Soc. Ent. Rossica Horae 35: 19, pl. 1, fig. 8.
Ceratophyllus tollii [sic], Baker, 1904, U.S. Natl. Mus. Proc. 27: 447.
Ceratophyllus toli [sic], Wagner, 1930, Kat. Aphanipt., p. 9.
Megabothris toli [sic], Wagner, 1934, Konowia 13: 262.
Ceratophyllus (*Monopsyllus*) *toli* [sic] [*Amonopsyllus* section], Ioff, 1936, Ztschr. f. Parasitenk. 9: 96, figs. 3, 13, 34, 44.
Monopsyllus anadyrus Jordan, 1937, Novitates Zool. 40: 288, figs. 72, 73.
Monopsyllus (*Amonopsyllus*) *toli* [sic], Wagner, 1938, Konowia 17: 9.
Monopsyllus (*Amonopsyllus*) *anadyrus*, Wagner, 1938, loc. cit. 17: 9 (= *M.* (*A.*) *toli* (?)).
Trichopsylla (*Trichopsylla*) *toli* [sic], Costa Lima and Hathaway, 1946, Inst. Oswaldo Cruz Monog. 4: 296.
Trichopsylla (*Trichopsylla*) *andyra* [sic], Costa Lima and Hathaway, 1946, loc. cit. 4: 305.
Monopsyllus tolli, Holland, 1952, Canad. Ent. 84: 305, figs. 20–25 (synonymizes *anadyrus* Jordan).
Ceratophyllus (*Monopsyllus*) *toli* [sic], Ioff and Skalon, 1954, Handb. Ident. Fleas, p. 76, figs. 148A, B.

Diagnosis.—In many respects *tolli* resembles *ciliatus* but differs as follows: The male is easily distinguished from that of other North American species by the shape of the movable finger (pl. IX, 61), which has the anteroapical angle extended into a narrow fingerlike process, and the apical margin of the finger is markedly concave. At the posteroapical angle of the finger are two short blunt spiniforms. The penis rods (pl. IX, 56, P.R.) are coiled and an apical appendage (AP. A.) is present. The female is separable in having a deep rounded sinus in the seventh-sternum margin (pl. IX, 59), surmounted by a rounded lobe. The spermathecal bulga is about three times as long as broad, with the sides parallel, and the hilla is much narrower and less than half the length of the bulga.

Description.—***Head:*** Eye (pl. IX, 55) large but not deeply pigmented. Frontal row of five to seven medium-sized bristles; in male uppermost bristles smaller than others. Occiput with two rows of one and two bristles each, other than posterior submarginal row. ***Thorax:*** Pronotal comb of 24 rather narrow blunt spines. ***Legs:*** Mesotarsal segments one and two of male lacking long slender bristles.

Male: Ventral anal lobe slightly longer than dorsal anal lobe (pl. IX, 57). Eighth sternum (pl. IX, 65) with small feathered plume on each side of apex; with four long apical bristles and row of six to seven small bristles on each side along posterior (ventral) margin. Fixed process of clasper (pl. IX, 61) with apex about two times as long as broad, rounded or truncate apically. Movable finger with anteroapical angle extended into fingerlike process, which extends well beyond apex of fixed process; apical margin concave and slanting ventrad to rounded protuberant posteroapical angle, which bears two short blunt spiniforms; below spiniforms on posterior margin, large dark marginal bristle. Distal arm of ninth sternum (pl. IX, 64) with apex narrowly rounded; apical lobe with few small pale bristles; median lobe with convex posterior margin bearing several small to medium-sized bristles. ***Aedeagus*** (pl. IX, 56, 58): Apodeme (AE. A.) very long and narrow with long apical appendage (AP. A.). Penis rods (P.R.) coiled. Extension of inner tube (E.I.T.) very long and sclerotized. Crochets (CR.) large, apically narrowed, and sharply rounded. Accessory lateral lobe not visible in only specimen examined.

Female: Seventh-sternum margin (pl. IX, 59) with rounded upper lobe, deep rounded sinus, and short somewhat truncate lower lobe.



M. tolli (Wagner), Yukon Territory ex *Ochotona:* 55, Head, male; 56, aedeagus; 57, dorsal and ventral anal lobes, male; 58, apex of aedeagus, male; 59, seventh sternum, female; 60, spermatheca; 61, clasper, male; 62, bursa copulatrix; 63, anal stylet and ventral anal lobe, female; 64, distal arm of ninth sternum, male; 65, eighth sternum, male.

Spermatheca (pl. IX, 60) with bulga three times as long as broad, sides parallel; hilla much narrower than bulga and less than half its length. Bursa copulatrix (pl. IX, 62) rather large, apically expanded. Ventral anal lobe (pl. IX, 63) triangular, no posteroventral angle; posteromarginal bristles not at all bent apically. Anal stylet (pl. IX, 63) of female examined had three large subapical bristles rather than two such bristles.

Types.—The unique male holotype was from an unknown host in Siberia. (Wagner presumed the host might be *Pteromys volans*.)

Jordan described *anadyrus* from two females collected from *Ochotona hyperborea*, Emma Harbor, East Siberia. The type series is in the British Musem (Natural History).

Hosts and distribution. Holland (1952) reported *tolli* from *Ochotona collaris*, Yukon Territory, Canada. It is probable that the northern species of *Ochotona* serve as normal hosts and that *tolli* ranges from northeastern Asia through extreme northwestern North America. I have examined a pair from *Ochotona collaris*, Yukon Territory. Holland also has specimens of *tolli* from ptarmigan, Worthington Glacier, Alaska.

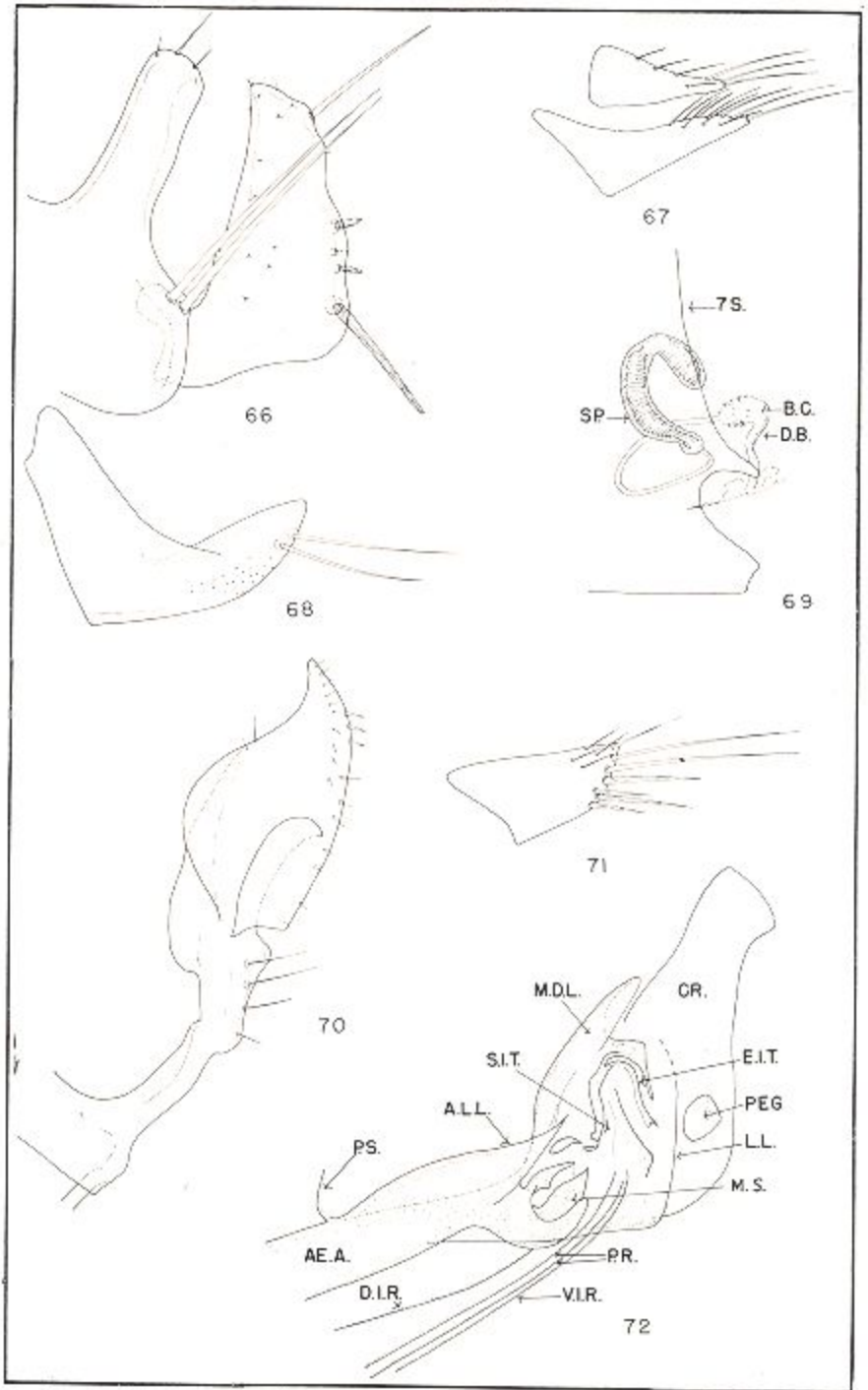
Monopsyllus thambus (Jordan)

(Pl. X, 66–72)

Ceratophyllus thambus Jordan, 1929, Novitates Zool. 35: 36, pl. 2, fig. 21.
Monopsyllus thambus, Jordan, 1933, loc. cit. 39: 78.
Ceratophyllus bakeri Wagner, 1933, Berlin Zool. Mus. Mitt. 18: 352, fig. 13.
Monopsyllus enderleini Jordan, 1933, Novitates Zool. 39: 78 (lapsus for *bakeri* Wagner).
Ceratophyllus (*Monopsyllus*) *thambus* [*Amonopsyllus* section], Ioff, 1936, Ztschr. f. Parasitenk. 9: 96.
Ceratophyllus (*Monopsyllus*) *bakeri* [*Amonopsyllus* section], Ioff, 1936, loc. cit. 9: 96.
Monopsyllus thambus, Wagner, 1936, Konowia 15: 91. Jellison and Good, 1942, U.S. Natl. Inst. Health Bul. 178: 91.
Monopsyllus bakeri, Jellison and Good, 1942, loc. cit. 178: 88.
Trichopsylla (*Trichopsylla*) *thamba*, Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Pub. 500, p. 64.
Trichopsylla (*Trichopsylla*) *bakeri*, Ewing and Fox, 1943, loc. cit. 500, p. 58. Costa Lima and Hathaway, 1946, Inst. Oswaldo Cruz Monog. 4: 304.
Monopsyllus thambus, Holland, 1944, Canad. Ent. 76: 244, figs. 4, 5.
Trichopsylla (*Trichopsylla*) *thamba*, Costa Lima and Hathaway, 1946, Inst. Oswaldo Cruz Monog. 4: 304.
Monopsyllus thambus, Hubbard, 1947, Fleas West. North Amer., p. 227, fig. 117. Holland, 1949, Canad. Dept. Agr. Pub. 817, Tech. Bul. 70, p. 168, figs. 299, 300 (synonymizes *bakeri* Wagner).

Diagnosis. This species is very similar to *wagneri*. The male of *thambus* has the movable finger (pl. X, 66) shaped much as in *wagneri*, but the three spiniforms on the posterior margin are pointed, not blunt. The male is also distinctive in that the penis rods are not coiled. The female is distinctive in that the seventh sternum has a pronounced dorsal lobe and a sinus ventral to the lobe and the spermathecal bulga is constricted subapically. In *wagneri* if the bulga is so constricted, the seventh sternum does not have a large sinus and vice versa.

Description.—***Head:*** Frontal row of about seven bristles in male, five in female. Occiput with two rows of one and two bristles, respectively, other than posterior submarginal row. Dorsal margin of antennal groove lined with more than 20 small bristles in male, 15 in female. ***Thorax:*** Pronotal comb of 20 to 22 relatively narrow



M. thambus (Jordan), Northwest Territories ex *Peromyscus:* 66, Clasper, male; 67, dorsal and ventral anal lobe, male; 68, eighth sternum, male; 69, seventh sternum, spermatheca, and bursa copulatrix; 70, distal arm of ninth sternum, male; 71, ventral anal lobe, female; 72, aedeagus.

sharply pointed spines. ***Legs:*** Mesotarsal segments one and two of male lacking long slender bristles.

Male: Ventral anal lobe slightly longer than dorsal anal lobe (pl. X, 67). Eighth tergum mesally spiculated near free dorsal margin. Eighth sternum (pl. X, 68) short, less than three times as long as broad, with two to three long subapical bristles; apical plume missing. Fixed process of clasper (pl. X, 66) long and narrow apically; movable finger extending about to apex of fixed process; anteroapical angle of finger acute and highest point of finger; posterior margin broadening ventrally, with two small and one large marginal sharply pointed spiniforms. Distal arm of ninth sternum (pl. X, 70) apically acute; apical lobe with posteromarginal row of short bristles; median lobe angulate, with four to five medium-sized marginal and submarginal bristles. ***Aedeagus*** (pl. X, 72): Median dorsal lobe (M.D.L.) narrow, ventral margin not sclerotized. Accessory lateral lobe (A.L.L.) large, occurring dorsally above aedeagal apodeme proper (AE. A.). Extension of inner tube (E.I.T.) relatively short, heavily sclerotized. Lateral lobes (L.L.) angulate ventrally and pigmented in this area. Crochet (CR.) large, truncate, and slightly expanded apically; peg (PEG) oval. Penis rods short, not coiled.

Female: Ventral anal lobe (pl. X, 71) with posterior margin slanted; angle with ventral margin very broad; bristles on posterior margin thick, heavy, but not bent apically. Seventh-sternum margin (pl. X, 69, 7S.) with narrow dorsal lobe; large rounded median sinus below lobe. Spermatheca (pl. X, 69, SP.) with bulga long, narrow, curved, and subapically constricted; hilla as broad as bulga but only half as long. Ductus bursae (pl. X, 69, D.B.) with margin partly sclerotized.

Types.—The unique male holotype of *thambus* was taken from *Lynx* sp., Red Deer, Alberta, A. D. Gregson collector. It is in the collections of the British Museum (Natural History).

Wagner described *bakeri* from the unique female holotype taken from a "house mouse," Killinek [Killinek Island], Labrador, O. Heller collector.

Hosts and distribution.—I have seen eight specimens from *Peromyscus* from northern Alberta and Northwest Territories, Canada. Holland (1958) has shown that *thambus* has a disjunct distribution. It occurs in northwestern Canada, including the Rocky Mountains, and in northern Labrador, but apparently not between. Within its range *thambus* is a common parasite of mice, particularly *Peromyscus*.

Monopsyllus wagneri (Baker)

(Pls. XI, 73–79; XII, 80–82; XIII, 83–85; XIV, 86–89)

Ceratophyllus wagneri Baker, 1904, U.S. Natl. Mus. Proc. 27: 387, 405, pl. 15, figs. 3–7. Baker, 1905, loc. cit. 29: 133. Mitzmain, 1909, Canad. Ent. 41: 201. McCoy and Mitzmain, 1909, U.S. Pub. Health Rpts. 24: 1017, 1019. C. Fox, 1914, U.S. Pub. Health Serv. Hyg. Lab. Bul. 97, pls. 10, 19, figs. 11, 48. Dunn and Parker, 1923, U.S. Pub. Health Rpts. 38: 2774, 2775.

Ceratophyllus peromysci Stewart, 1928, Canad. Ent. 60: 148, pl. 13, figs. 1, 2.

Ceratophyllus wagneri wagneri Jordan, 1929, Novitates Zool. 35: 35.

Ceratophyllus wagneri systallus Jordan, 1929, loc. cit. 35: 35, pl. 2, fig. 19. NEW SYNONYMY.

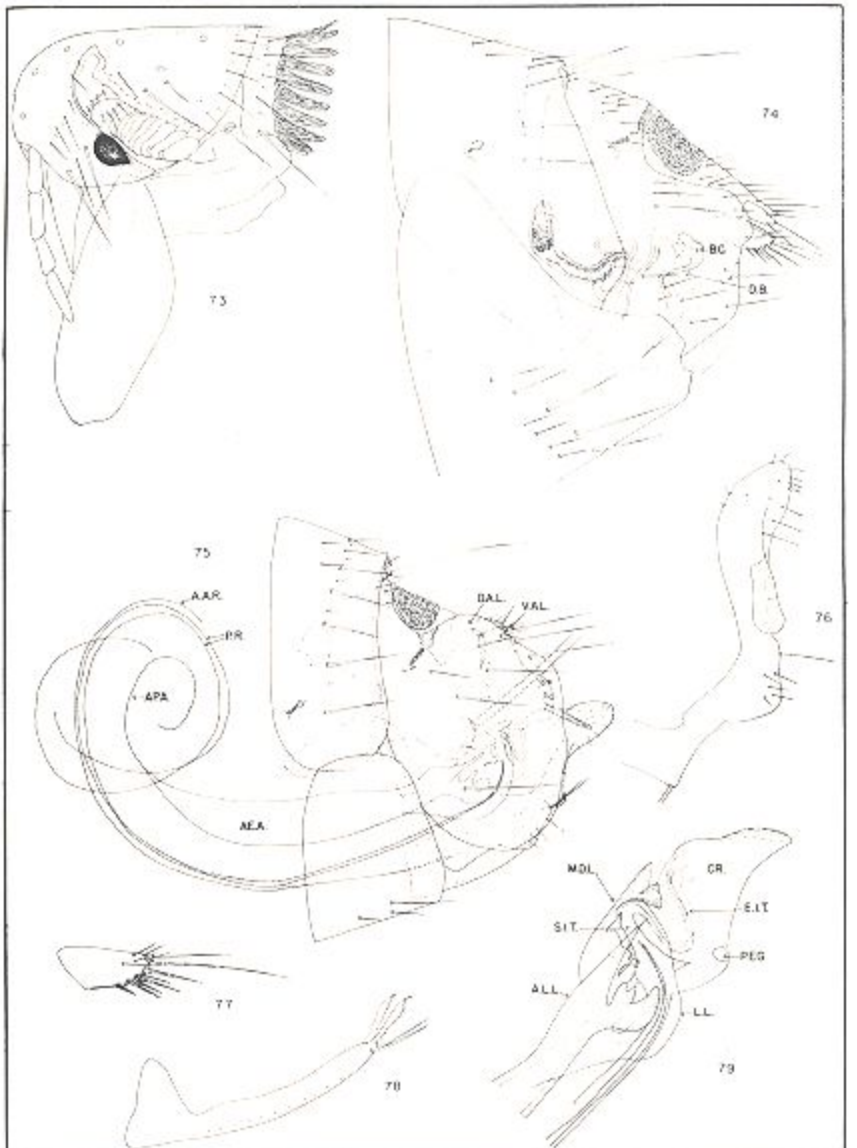
Ceratophyllus wagneri ophidius Jordan, 1929, loc. cit. 35: 36, pl. 2, fig. 20. NEW SYNONYMY.

Ceratophyllus wagneri Jordan, 1929, 4th Internatl. Cong. Ent. Trans. 2: 498, figs. 7–9. Stewart, 1930, Canad. Ent. 62: 152 (synonymizes *peromysci*). Stanford, 1931, Utah Acad. Sci. Proc. 8: 153.

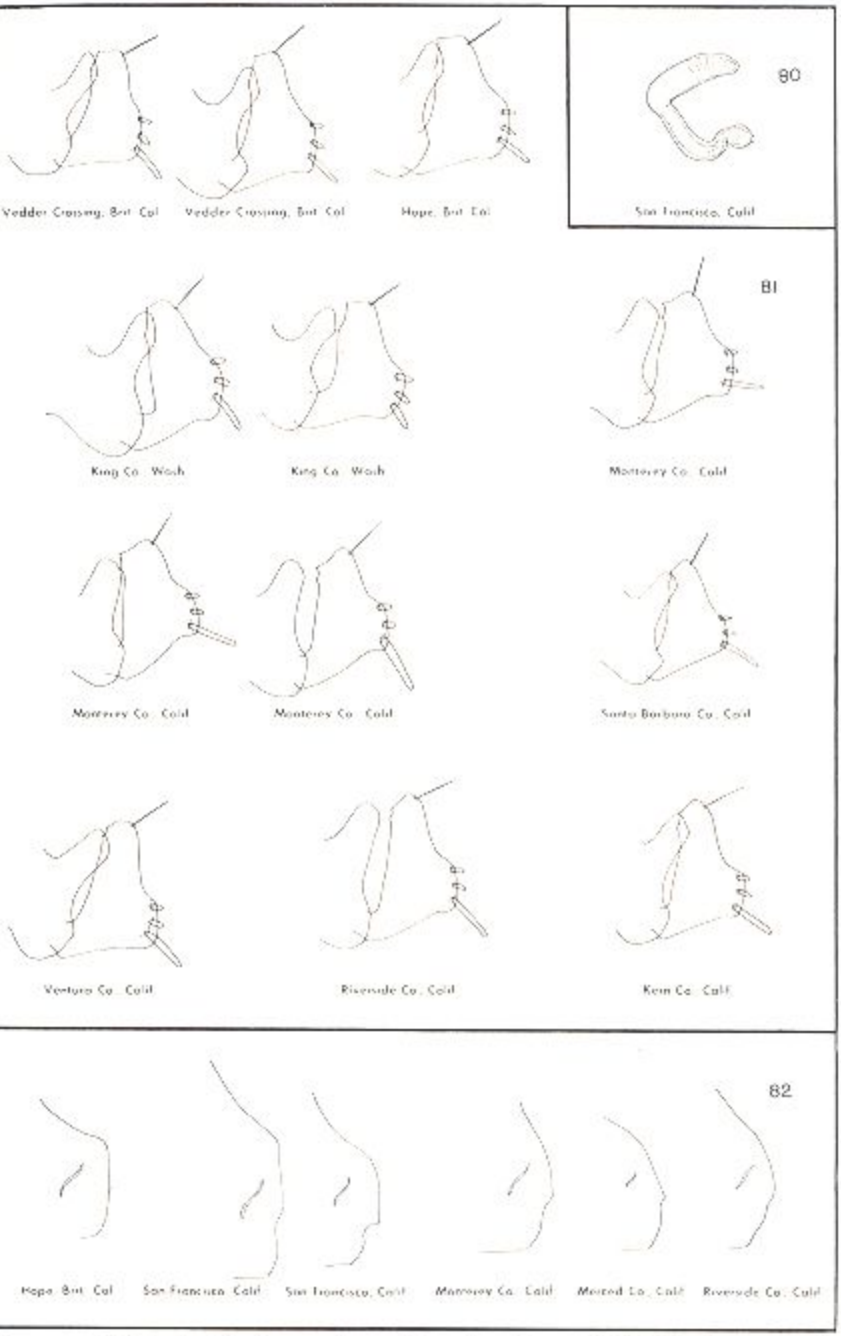
Monopsyllus wagneri, Jordan, 1933, Novitates Zool. 39: 78.
Ceratophyllus wagneri, Sassuchin and Tiflov, 1936, Vest. Mikrobiol., Epidemiol. i Parazitol. 15: 272, 273.
Ceratophyllus (*Monopsyllus*) *wagneri* [*Amonopsyllus* section], Ioff, 1936, Ztschr. f. Parasitenk. 9: 96, figs. 32, 67.
Ceratophyllus (*Amonopsyllus*) *wagneri*, Ioff, 1936, loc. cit. 9: 115, fig. 45.
Monopsyllus wagneri wagneri, Wagner, 1936, Canad. Ent. 68: 200.
Monopsyllus wagneri systolus [sic], Wagner, 1936, loc. cit. 68: 200.
Monopsyllus wagneri, Wagner, 1936, Konowia 15: 91. Erickson, 1938, Jour. Mammal. 19: 252. Wagner, 1939, Aphanipt., *in* Bronn, Klassen und Ordnungen des Tierreichs, v. 5, Arthropoda, pt. 3, Insecta, v. 13, No. 1, p. 34, fig. 42.
Megabothris wagneri (subsp. *wagneri* (?)), I. Fox, 1940, Fleas East. United States, p. 71, pl. 19, figs. 96, 97.
Monopsyllus wagneri wagneri, Augustson, 1941, South. Calif. Acad. Sci. Bul. 40: 153. Jellison and Good, 1942, U.S. Natl. Inst. Health Bul. 178: 92.
Monopsyllus wagneri systaltus, Jellison and Good, 1942, loc. cit. 178: 91.
Monopsyllus wagneri ophidius, Jellison and Good, 1942, loc. cit. 178: 91. Augustson, 1943, South. Calif. Acad. Sci. Bul. 42: 79.
Trichopsylla (*Trichopsylla*) *wagneri wagneri*, Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Pub. 500, p. 65.
Trichopsylla (*Trichopsylla*) *wagneri systalta*, Ewing and Fox, 1943, loc. cit. 500, p. 64.
Trichopsylla (*Trichopsylla*) *wagneri ophidius*, Ewing and Fox, 1943, loc. cit. 500, p. 64.
Trichopsylla (*Trichopsylla*) *wagneri wagneri*, Costa Lima and Hathaway, 1946, Inst. Oswaldo Cruz Monog. 4: 298.
Trichopsylla (*Trichopsylla*) *wagneri systalta*, Costa Lima and Hathaway, 1946, loc. cit. 4: 299.
Trichopsylla (*Trichopsylla*) *wagneri ophidius*, Costa Lima and Hathaway, 1946, loc. cit. 4: 299.
Monopsyllus wagneri wagneri, Hubbard, 1947, Fleas West. North Amer., p. 221, fig. 114.
Monopsyllus wagneri systaltus, Hubbard, 1947, loc. cit., p. 226, fig. 115.
Monopsyllus wagneri ophidius, Hubbard, 1947, loc. cit., p. 226, fig. 116.
Monopsyllus wagneri wagneri, Holland, 1949, Canad. Dept. Agr. Pub. 817, Tech. Bul. 70, p. 170, figs. 303, 304.
Monopsyllus wagneri ophidius, Holland, 1949, loc. cit., p. 171, figs. 305, 306.
Monopsyllus wagneri systaltus, Holland, 1949, loc. cit., p.171, figs. 307, 308.
Monopsyllus wagneri kylei Hubbard, 1949, South. Calif. Acad. Sci. Bul. 48: 52, pl. 8. NEW SYNONYMY.
Monopsyllus wagneri (subsp. *ophidius* (?)), Eads, 1950, Fleas of Texas, p. 41.
Megabothris wagneri, Knipping, Morgan, and Dicke, 1950, Wis. Acad. Sci., Arts, Letters, Trans. 40: 202 (report *wagneri* from Wisconsin).
Monopsyllus wagneri wagneri, Traub and Hoff, 1951, Amer. Mus. Novitates 1530: 3, 5. Allred, 1952, Great Basin Nat. 12: 70.
Monopsyllus wagneri, Morlan, 1955, Tex. Rpts. Biol. and Med. 13: 110.
Monopsyllus wagneri ophidius, Linsdale and Davis, 1956, Calif. Univ. Pubs., Zool. 54: 314.
Monopsyllus wagneri wagneri, Rapp and Gates, 1957, Kans. Ent. Soc. Jour. 30: 53.
Monopsyllus wagneri systaltus, Rapp and Gates, 1957, loc. cit. 30: 52.

Diagnosis.—*M. wagneri* is most closely related to *thambus*. The male is easily separable from that of all species except *thambus* in having on the movable finger three spiniforms, which are set on a posteroventral protuberance; unlike *thambus* these spiniforms are blunt, and also the penis rods are coiled, not short and merely curved. The female has the spermathecal hilla as long and as broad as or broader than the bulga. The seventh sternum may or may not have a sinus in the posterior margin. If a noticeable sinus is present, the bulga is not constricted subapically, except in very rare specimens in the Cascade Mountains of British Columbia.

Description.—***Head*** (pl. XI, 73): Frontal row of five to seven bristles. Eye large and dark. ***Thorax:*** Pronotal comb of about 18 spines. ***Legs:*** Mesotarsal segments one and two of male lacking long thin bristles on posterior margin.



M. wagneri (Baker), male lectotype, female topotype: 73, Head, male; 74, modified segments, female; 75, modified segments, male; 76, distal arm of ninth sternum, male; 77, ventral anal lobe, female; 78, eighth sternum, male; 79, aedeagus.



M. wagneri (Baker): 80, Spermatheca (San Francisco, Calif.); 81, clasper, male, variations of "ophidius"; 82, seventh sternum and ductus bursae, female, ibid.

Male (pl. XI, 75): Ventral anal lobe extending farther posteriad than dorsal anal lobe. Fixed process of clasper long, apically bluntly rounded; acetabular bristles set at ventral third. Movable finger extending about to apex of fixed process, truncate or rounded apically; posterior margin with marked posteroventral protuberance bearing three blunt spiniforms, lower one much longer than others. Eighth sternum (pl. XI, 78) with bifurcate feathered subapical plume on each side plus two long apical bristles. Distal arm of ninth sternum (pl. XI, 76) with apex rounded, row of smallish bristles along posterior subapical margin; median lobe angulate, with six to seven various-sized bristles. ***Aedeagus*** (pl. XI, 79): Crochets (CR.) large, pale, apically sharply rounded and somewhat hooked. Extension of inner tube (E.I.T.) very long but lightly sclerotized and difficult to see. Long apical appendage present. Penis rods making complete turn. Lateral lobes (L.L.) very large.

Female (pl. XI, 74): Seventh sternum either with undulate margin with large truncate ventral lobe or with small or large sinus (pls. XII, 82; XIII, 84, 85; XIV, 88, 89). Bursa copulatrix with its duct strongly sclerotized; sclerotization of various lengths. Spermatheca (pl. XIII, 85) with hilla as broad as or broader than bulga and usually as long as or longer than bulga. Ventral anal lobe (pl. XI, 77) not angulate posteroventrally; posteromarginal bristles heavy and dark, not at all bent apically.

Types.—Baker based his description of *wagneri* on two male syntypes, one from *Peromyscus leucopus* and one from a house mouse, Moscow, [Latah County], Idaho, Aldrich collector. There is in the U.S. National Museum collections a single male labeled on the right-hand side "Ceratophyllus wagneri Baker" in Baker's handwriting, with a notation below in different handwriting "Type 6911 USNM." On the left side is a label: "Flea from nest of Dormouse (Calomys americanus Kerr) Moscow Ida., May 7, .95." *Calomys americanus* refers to a species of *Peromyscus*,[6] and it is assumed Baker merely did not correct the host name. This male specimen is selected as lectotype and has been so labeled.

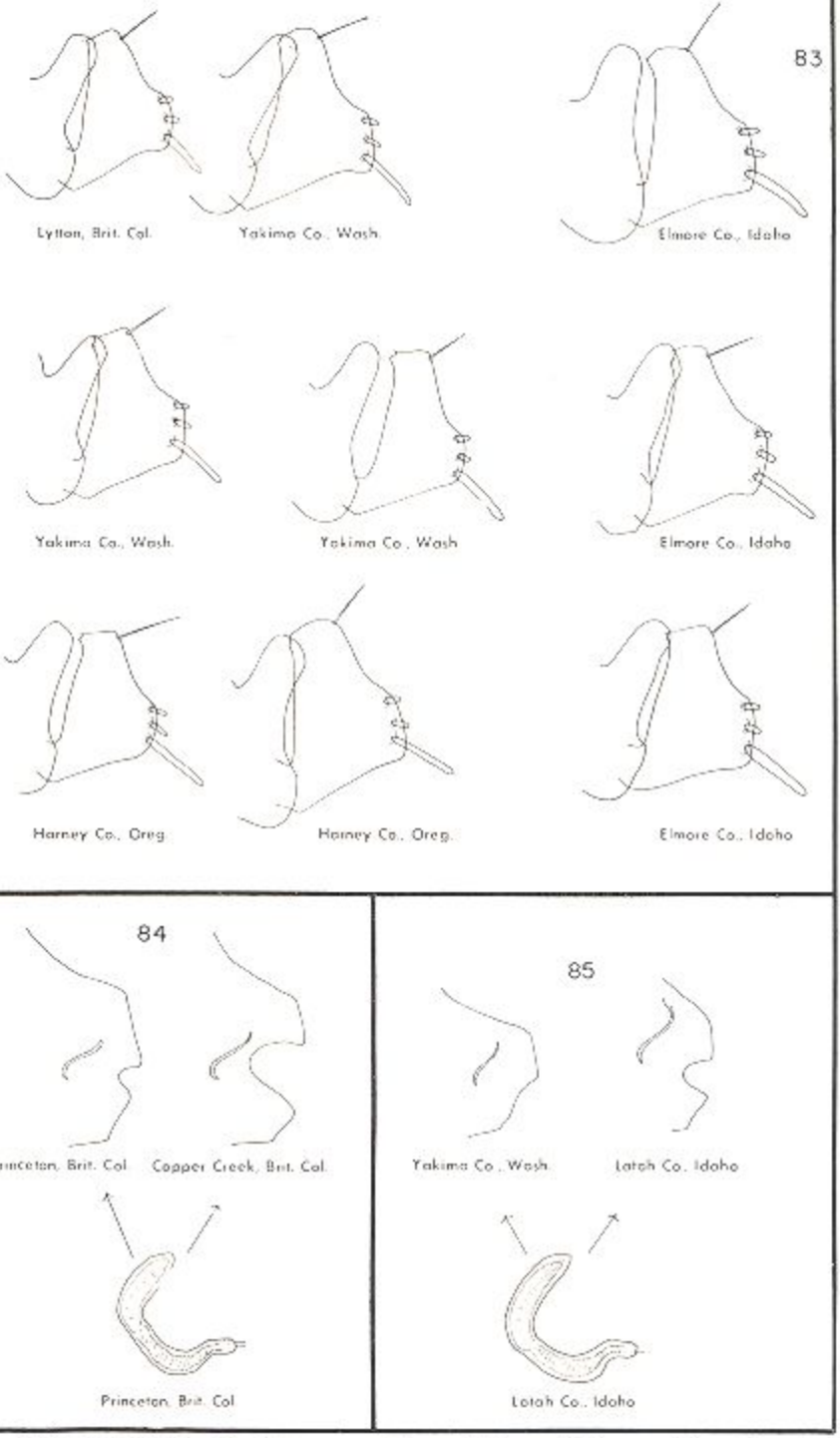
Stewart described *peromysci* from two females found on *Peromyscus* sp., Cortez, [Montezuma County], Colo. The holotype and paratype are apparently lost. Neither is in the U.S. National Museum collections, although Stewart stated that the holotype was to be sent there. Inquiries at both the University of California and Colorado A. and M., which submitted the specimens to Stewart for identification, gave negative results.

The name *w. systaltus* was based on the "type" from a mouse (probably *Peromyscus*), Blackfalds, Alberta, A. D. Gregson collector, and a series from *Peromyscus arcticus* (*Peromyscus m. maniculatus*), Red Deer, Alberta, May 1901, F. G. Dippie collector. The type series is in the British Museum (Natural History) collections.

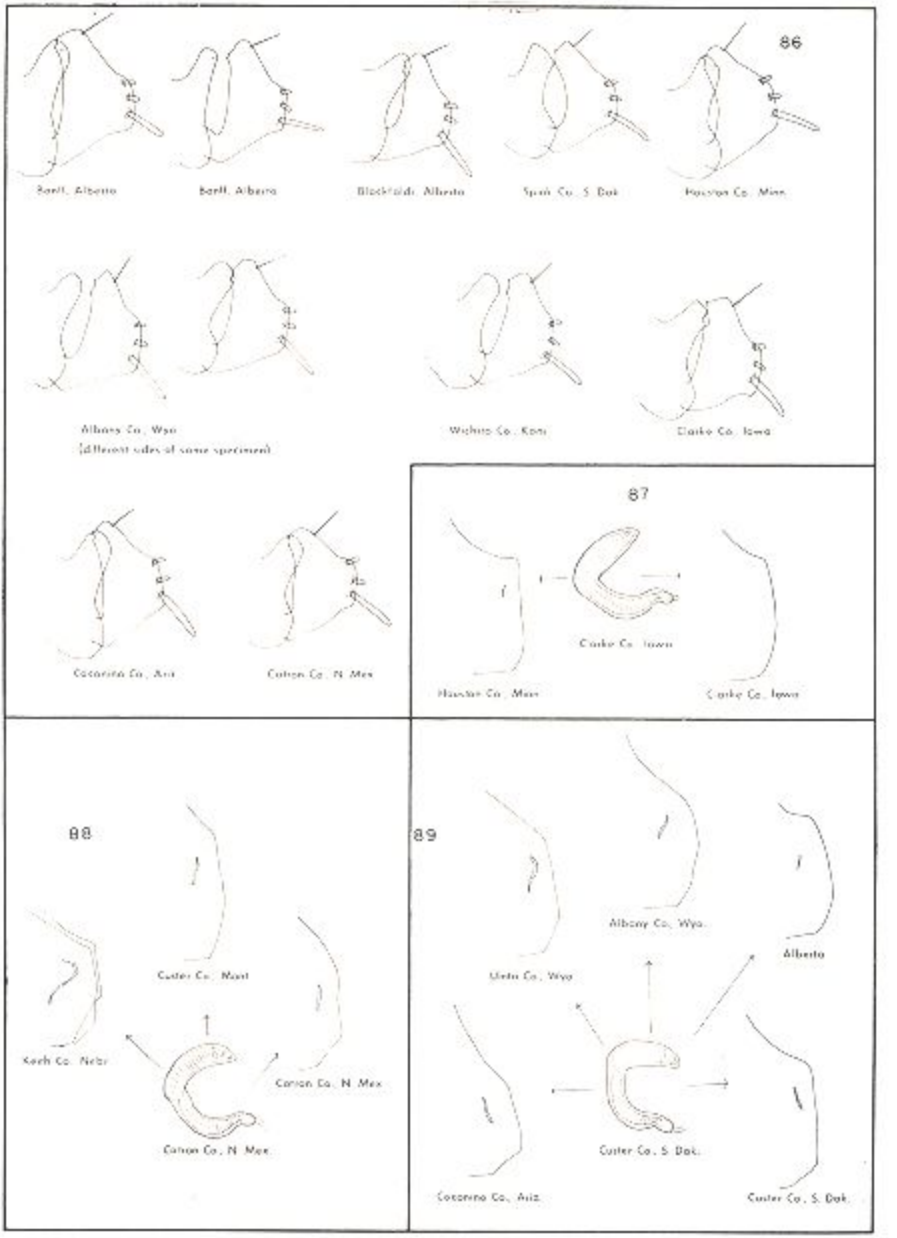
Jordan described *w. ophidius* from the "type" collected from *Putorius xanthogenys* (*Mustela frenata*), San Francisco, Calif., C. Fox collector, and a series from the same host, San Mateo, Calif., M. B. Mitzmain collector. The type series is in the British Museum (Natural History) collections.

M. w. kylei was described from the male holotype, female allotype, and a series of male and female paratypes collected from *Peromyscus maniculatus sonoriensis*, Kyle Canyon, Clark County, Nev. The

[6] Setzer, H. W., personal communication.



M. wagneri (Baker): 83, Clasper, male, variations of "wagneri" and central population; 84, seventh sternum, ductus bursae, and spermatheca, female, ibid.; 85, ibid.



M. wagneri (Baker): 86, Clasper, male, variations of "systaltus" and central population; 87, seventh sternum, ductus bursae, and spermatheca, female, variations of "systaltus," eastern form; 88, seventh sternum, ductus bursae, and spermatheca, female, variations of "systaltus" and central population; 89, seventh sternum, ductus bursae, and spermatheca, female, variations of "systaltus," western form.

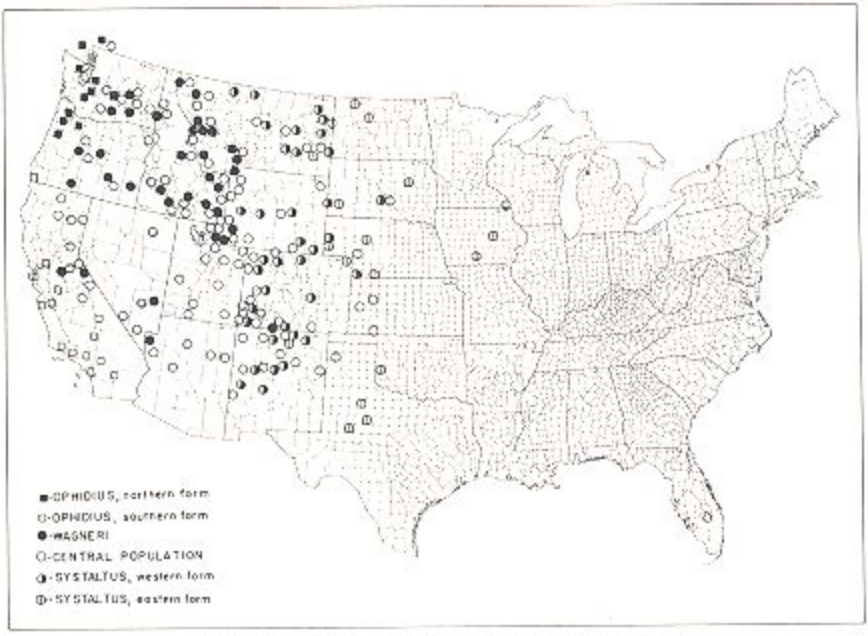


FIGURE 3.—Distribution of *M. wagneri* (Baker).

holotype and allotype are in the collections of the U.S. National Museum.

Hosts and distribution.—The principal hosts of *wagneri* are the various western species of *Peromyscus*. *M. wagneri* is also found on species of *Citellus*, *Neotoma*, *Cynomys*, *Dipodomys*, and occasionally on *Phenacomys*, *Microtus*, *Eutamias*, *Rattus*, *Mus*, *Onychomys*, *Zapus*, *Ochotona*, *Lagurus*, and *Clethrionomys*. The carnivore *Mustela* often picks up individuals of *wagneri* from its prey.

M. wagneri is found from the coast of California in the south to southern British Columbia in the north and extends eastward into Texas and Oklahoma in the south and into Iowa, Minnesota, and Manitoba in the north (fig. 3). Knipping et al. (1950) have reported *wagneri* from eastern and south-central Wisconsin.

A study of the geographical variation of *wagneri*, based on the examination of over 1,300 specimens, has led me to the conclusion that subspecies are not present but that a series of clines exist, which radiate out from a central "typical," or original, population.

Four populations have been given subspecific names, and it is convenient to use three of these names in discussing the various populations. This procedure makes unnecessary the introduction of further names to replace familiar ones but does pose the problem of the use of scientific nomenclatorially available names in the vernacular. To emphasize the fact that the names are being used in the vernacular, they are placed within quotation marks and are not italicized.

Since it would be both confusing and impractical to subdivide further the populations of *wagneri* on the map (fig. 3), only the four basic populations—the eastern and western populations of "systaltus" and the northern and southern populations of "ophidius" have been charted. When using this distributional map, it should be remembered

that some specimens have been placed rather arbitrarily in a particular group, especially some of the specimens intermediate between "systaltus" and the central population and between "wagneri" and the central population. Only specimens I have examined have been charted on the map. The illustrations showing variation (pls. XII, 80–82; XIII, 83–85; XIV, 86–89) are necessarily limited by available space. A particular shape of the female seventh sternum or male movable finger in the illustrations does not indicate that only this type will be found in the same locality.

The first population of *wagneri* to be described (the nominate form in the literature) is "wagneri." The type specimens were collected in Latah County, northwestern Idaho. Most *wagneri* specimens have the following characteristics in Idaho, Washington, and British Columbia east of the Cascades, east to the Continental Divide in Montana and Wyoming, and scattered east of the Cascades and Sierras in Oregon and California:

In the male the movable finger (pl. XIII, 83) is truncate apically, with both apical angles approximately right angles; the posteroapical long bristle is at or near the posterior dorsal angle; the anteroapical point (a small projection with a minute marginal hair) is either just mesad of the anterior apical angle of the finger or just posteriad of it, so that the anteroapical point does not break the smooth straight apical margin of the finger. Usually the finger is broad apically, the ventral spiniform on its posterior margin is at least three times as long as the other two, and the finger does not extend beyond the stout apex of the fixed process. In the female the seventh sternum (pl. XIII, 84, 85) has a definite sinus in the posterior margin, the sclerotized part of the ductus bursae is longer than the width of the spermathecal bulga, and the bulga is the same width and almost the same length as the hilla. However, not all specimens found within the geographical limits outlined meet this diagnosis, and specimens referable to "wagneri" also occur east of the Continental Divide and west of the Sierras in northern and central California.

Proceeding south and west from Idaho, the population changes to become an intermediate, variable, central population, which is probably the typical, or original, form, which centers in the Great Basin area. The males generally have the movable finger (pl. XIV, 86, Alberta) narrower apically than in "wagneri"; the anteroapical point is farther removed from the anterior apical angle of the finger (this angle is located at the knob, which articulates with a corresponding depression on the mesal side of the apex of the fixed process); and the apex itself is definitely slanted or rounded, with the posteroapical long bristle below the posterior angle. In the female the seventh sternum (pl. XIV, 88) becomes undulate and lacks a definite sinus. The spermathecal hilla is broader than the bulga (pl. XIV, 88) and somewhat shorter, and the sclerotized part of the ductus bursae is often shorter than the width of the bulga. These characteristics become more pronounced in the southern populations found in Arizona, New Mexico, and western Colorado. The population given the name *kylei* Hubbard from Clark County, Nev., is a part of the central typical population, and possibly *peromysci* Stewart from Montezuma County, Colo., is also a member of the typical population. However, *peromysci* may be a part of the population called "systaltus."

Proceeding eastward from the Continental Divide in the north and from the western parts of Colorado and New Mexico, the population becomes like the form known as "systaltus," which was described from

specimens taken in Alberta. In "systaltus" males the anteroapical point is far removed dorsally and posteriorly from the anterior angle of the finger (pl. XIV, 86, South Dakota, Kansas, Iowa, Minnesota), and the finger has a narrow strongly slanted apex, with the posteroapical long bristle well below the posterior angle. Females lack an undulation or a sinus in the seventh-sternum margin, the spermathecal hilla is broader and shorter than the bulga, and the sclerotized part of the ductus bursae is shorter than the width of the bulga. In Canada, Montana, and Wyoming the cline is not so gradual as it is in Colorado, Arizona, and New Mexico, and it might be said to be stepped. In the female, characteristics typical of "systaltus" become more and more pronounced as one progresses eastward, until at the most eastward extension of *wagneri's* range in Iowa and Minnesota the seventh-sternum margin (pl. XIV, 87) has a truncate lobe, the ductus bursae has a very short sclerotization, and the spermathecal hilla (pl. XIV, 87) is very broad.

The fourth and most distinct population of the species is "ophidius," which occurs along the Pacific slope, extending from southern British Columbia in the north to the Los Angeles area of California in the south. The Cascade Range and, in California, the coastal mountains and the Central Valley provide efficient obstacles to free gene exchange with the more easterly populations of *wagneri*, but in southern California the Tehachapi Mountains, which enclose the San Joaquin Valley to the south, and the San Bernardino Mountains, still farther to the south, provide a corridor of free access to the eastern populations of *wagneri*.

The effective northern isolation and relatively limited southern link may be the factors that allowed the development of a very definite step in the cline based on a single character. The only character that commences abruptly in "ophidius" and without intergrading is the shape of the apex of the spermathecal bulga (pl. XII, 80), which is strongly constricted subapically. This character occurs in undiminished form in females associated with definitely intermediate males from Riverside, San Bernardino, Kern, Inyo, and Merced Counties in California. In the northern part of the range of "ophidius," males have the movable finger extending beyond the narrow apical part of the fixed process, the anterior angle of the finger is not at the dorsalmost point, so that the anteroapical point forms the true anterior apex, the apex of the finger is more or less truncate, and the posteroapical long bristle is near or at the posterior angle (pl. XII, 81, British Columbia; King County, Wash.). Often, but not always, the lowest spiniform of the finger is less than twice as long as the upper two. As well as having the spermathecal bulga strongly constricted subapically, the northern female specimens have the seventh-sternum margin entire and almost never undulate. I have seen only two females (from Skagit Valley, British Columbia) with a sinus in the seventh sternum that is as marked as that found in "wagneri." These females presumably represent intergrades with "wagneri."

In southern Oregon (Curry County) and in California males have the apex of the movable finger slanted, the anteroapical point is closer to the anterior apical angle, and the finger may not extend beyond the fixed process, which is stouter than in northern specimens (pl. XII, 81, California). Females have the seventh-sternum margin undulate.

Finally, in southern and southeastern California males and females are similar to those of the typical intermediate population, except that in the females the spermathecal bulga is constricted subapically.

In conclusion, the pattern of geographical variation found in *wagneri* seems to represent a cline, with a central and variable population occurring mainly in the Great Basin area. To the north, between the Sierras and Cascades on the west, and the summits of the Rockies on the east, the central population takes on the characteristics of the population called "wagneri." East of the Rockies and southeast of the Great Basin, the population gradually changes in a clinal fashion to the form known as "systaltus," whose most easterly representatives are markedly different from both "wagneri" and the central population. From the southwest, populations of *wagneri* swing around the central valleys of California through the Tehachapi and San Bernardino Mountains to the Pacific coastal plain and form, by means of a step in the cline, the population known as "ophidius," which becomes less like the central population the farther north one goes. The peripheral populations, "ophidius" and "systaltus," have several characteristics in common. At the center of each of their ranges females have the seventh-sternum margin smooth, the spermathecal hilla is obviously broader than the bulga, and in the male the anteroapical point occurs well above the anterior angle of the movable finger.

If one were to deal only with populations found north of the 45th parallel, it would seem that three readily distinguishable subspecies were present, with a limited amount of intergradation and gene exchange between "systaltus" and "wagneri" in the Rocky Mountain region and practically no intergradation between "wagneri" and "ophidius." However, it seems evident to me that these northern populations merely represent the extremes of three populations, which are well isolated to the north, but which, in the southern parts of their respective ranges, receive a fuller complement of the available genes to be found in the central typical population and thus approach each other in morphology.

Monopsyllus eumolpi (Rothschild)

M. eumolpi has several close relatives, which form what Traub and Johnson (1952) called the *eumolpi* group. They are dark medium-sized to large fleas, and the eye is always large and dark. In the male several of the apical bristles on the second antennal segment extend three-fourths the length of the club, except in *M. polumus* Traub and Johnson. Mesotarsal segment one or segments one and two of the male have long slender bristles, which extend to or beyond the apex of the following segment. The ventral anal lobe of the male is much longer than the dorsal anal lobe; measured along its dorsal margin the ventral lobe extends half its length beyond the dorsal lobe. The eighth sternum has the two subapical plumes large and bifurcate, not trifurcate as stated by Traub and Johnson (1952). There are three dark heavy spiniforms on the posterior margin of the movable finger. The distal arm of the ninth sternum has an elongate slit for reception of the elongate peg of the crochet, rather than having the bay or groove broader and more nearly round and the peg rounded. The crochet is also different from that of other *Monopsyllus* species, since it is narrow (i.e., it is joined to the aedeagal end chamber along its longest dimension), and it does not project posteriad from the aedeagus.

In the female the bursa copulatrix is broad, often long and coiled, and never convoluted. The bulga of the spermatheca is about twice as long as broad, with the sides parallel, and the hilla is narrow and

not longer than the bulga. The posteromarginal bristles of the female ventral anal lobe tend to be apically bent.

Included in the *eumolpi* group are the following: (1) *M. eumolpi* (Rothschild), which consists of two well-marked subspecies—*e. eumolpi* and *e. americanus* Hubbard. *M. eumolpi canadensis* Hubbard is a synonym of the nominotypical form. (2) *M. cyrturus* (Jordan). This species was originally described as a subspecies of *eumolpi*. *M. eumolpi charlestonensis* Hubbard is a synonym of *M. cyrturus*. (3) *M. wallowensis* Hubbard. This species was also considered to be a subspecies of *eumolpi* by the original describer. (4) *M. orarius*, n. sp. (5) *M. eutamiadis* Augustson. (6) *M. fornacis* Jordan. (7) *M. polumus* Traub and Johnson.

All these species typically parasitize chipmunks of the genus *Eutamias*.

Monopsyllus eumolpi eumolpi (Rothschild)

(Pls. XV, 90–94, 98–100; XVI, 101, 102, 105; XVII, 106; XVIII, 107)

Ceratophyllus eumolpi Rothschild, 1905, Novitates Zool. 12: 161, pl. 6, figs. 2–4. Baker, 1905, U.S. Natl. Mus. Proc. 29: 133, 147. Jordan and Rothschild, 1911, Novitates Zool. 18: 79. Dunn and Parker, 1923, U.S. Pub. Health Rpts. 38: 2773, 2775. Wagner, 1929, Konowia 8: 314.

Ceratophyllus eumolpi eumolpi, Jordan, 1929, Novitates Zool. 35: 34.

Ceratophyllus eumolpi, Stanford, 1931, Utah Acad. Sci. Proc. 8: 153.

Ceratophyllus eumolpi eumolpi, Jordan, 1932, Novitates Zool. 38: 253.

Monopsyllus eumolpi, Jordan, 1933, loc. cit. 39: 78. Wagner, 1936, Konowia 15: 91. Wagner, 1936, Canad. Ent. 68: 200.

Ceratophyllus (Monopsyllus) eumolpi [*Amonopsyllus* section], Ioff, 1936, Ztschr. f. Parasitenk. 9: 97.

Monopsyllus eumolpi, Jordan, 1937, Novitates Zool. 40: 263. Jellison, 1940, U.S. Pub. Health Rpts. 55: 491, fig. 2.

Monopsyllus eumolpi eumolpi, Augustson, 1941, South. Calif. Acad. Sci. Bul. 40: 152. Jellison and Good, 1942, U.S. Natl. Inst. Health Bul. 178: 89.

Trichopsylla (Trichopsylla) eumolpi eumolpi, Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Pub. 500, p. 60. Costa Lima and Hathaway, 1946, Inst. Oswaldo Cruz Monog. 4: 301.

Monopsyllus eumolpi cyrturus, Hubbard, 1947, Fleas West. North Amer., fig. 123 (err. det.).

Monopsyllus eumolpi eumolpi, Hubbard, 1947, loc. cit., p. 237 (partim). Holland, 1949, Canad. Dept. Agr. Pub. 817, Tech. Bul. 70, p. 166, figs. 297, 298. Hubbard, 1949, Canad. Ent. 81: 337. Hubbard, 1949, Ent. News 60: 258, fig. 1.

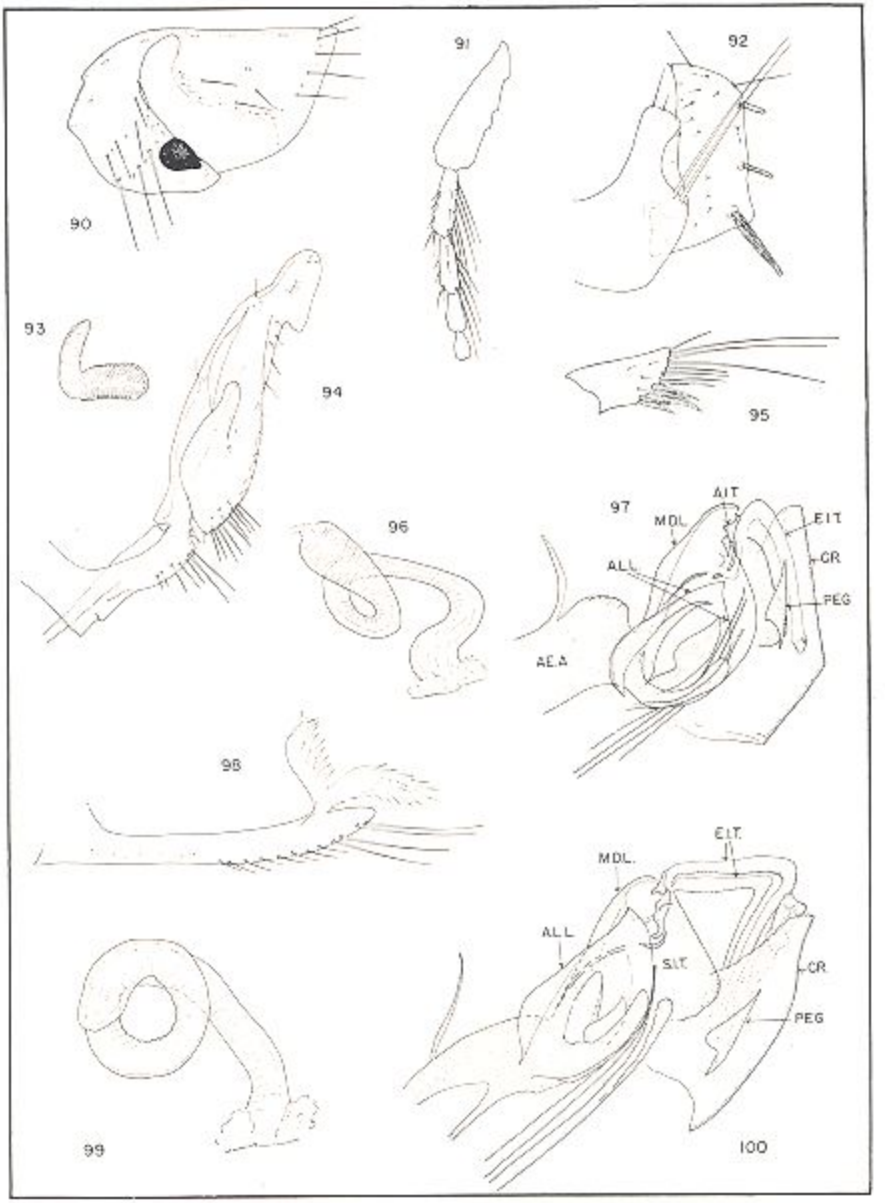
Monopsyllus eumolpi canadensis Hubbard, 1949, loc. cit. 60: 259, fig. 1. NEW SYNONYMY.

Monopsyllus eumolpi cyrturus, Tipton and Allred, 1951, Great Basin Nat. 11: 108 (the records are almost certainly of *e. eumolpi*).

Monopsyllus eumolpi eumolpi, Allred, 1952, loc. cit. 12: 70.

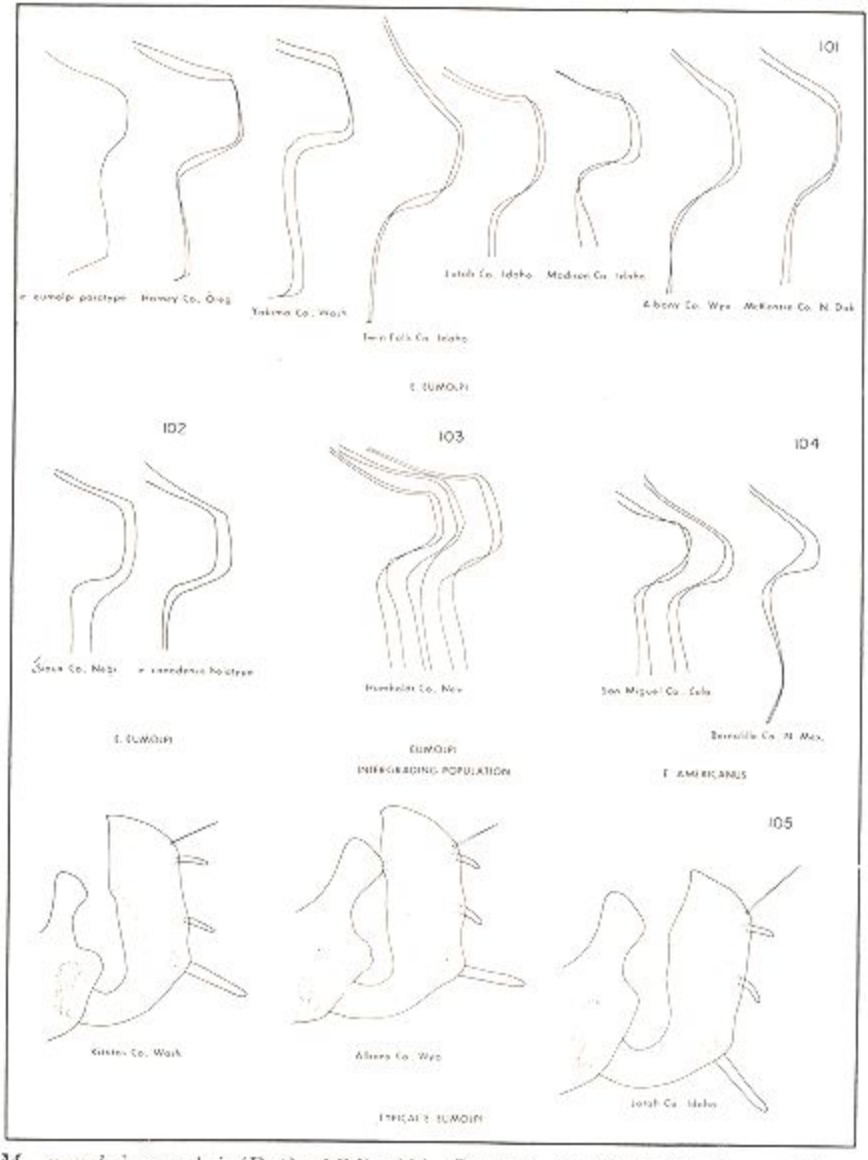
Monopsyllus eumolpi, Traub and Johnson, 1952, Amer. Mus. Novitates 1598: 18, 25, figs. 26, 28, 30, 36, 38.

Diagnosis.—This species is distinguished in the male by the shape of the ninth sternum and movable finger. The distal arm of the ninth sternum (pl. XV, 94) has a projection on the posterior subapical margin and a narrow rounded apex. The movable finger (pl. XV, 92) has three dark more or less equidistant spiniforms on its posterior margin; the finger is roughly rectangular with the sides more or less parallel, and there is always at least a slight angle in the posterior margin at the level of insertion of the lowest spiniform. In the female the bursa copulatrix (pl. XV, 99) is always long and coiled; the ventral anal lobe (pl. XV, 95, *americanus*) is never strongly angulate posteroventrally; the seventh sternum (pl. XVI, 101) has a noticeable dorsal lobe, which may be broad and squared or narrow and rounded, and the margin below always lacks a sinus. The



M. eumolpi eumolpi (Rothschild): 90, Head, male (British Columbia); 91, mesotibia and mesotarsal segments one through four, male (British Columbia); 92, clasper, male (paratype); 93, spermatheca (paratype); 94, distal arm of ninth sternum, male (Custer County, S. Dak.); 98, eighth sternum, male (paratype); 99, bursa copulatrix (McKenzie County, N. Dak.); 100, aedeagus (Custer County).

Monopsyllus eumolpi americanus Hubbard: 95, Ventral anal lobe, female (Bernalillo County, N. Mex.); 96, bursa copulatrix (Bernalillo County); 97, aedeagus (Apache County, Ariz.).



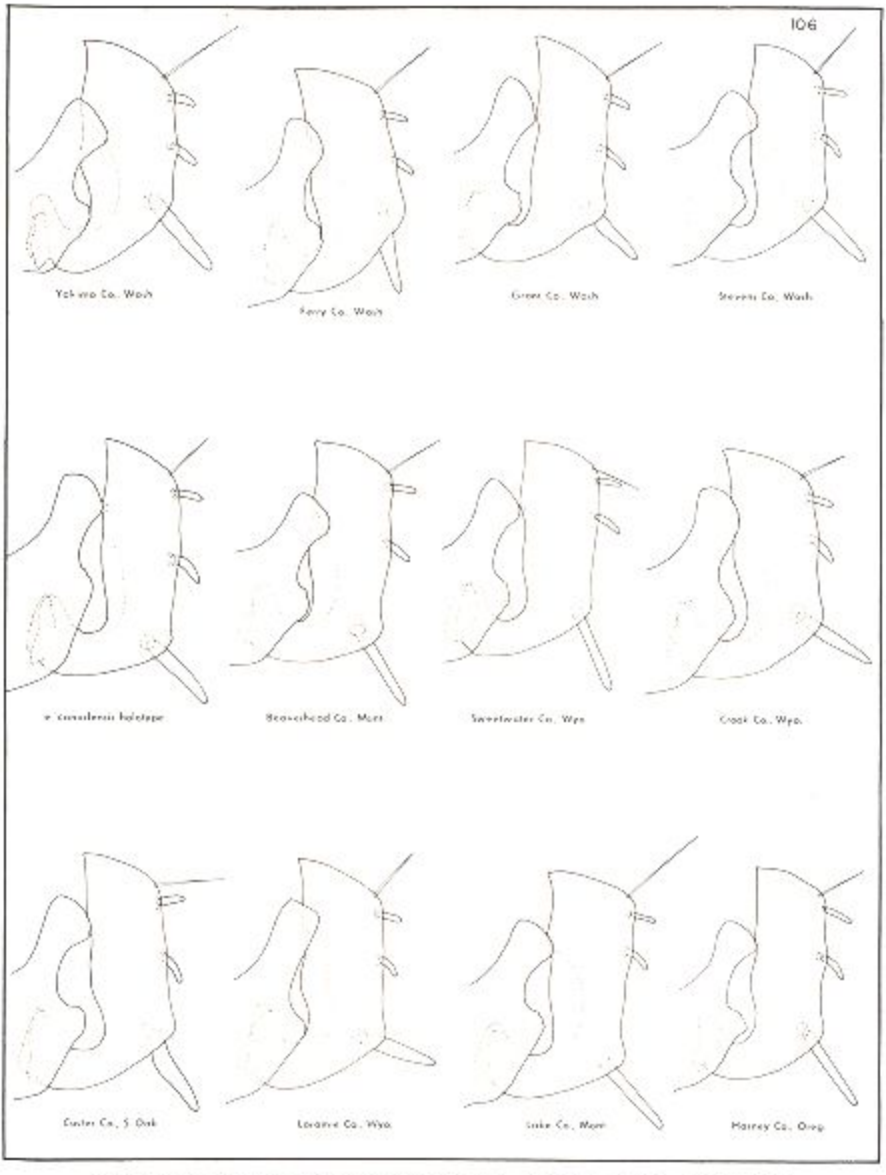
M. eumolpi eumolpi (Rothschild): 101, Seventh sternum, female, variations; 102, ibid.; 105, elasper, male, variations.
M. eumolpi, intergrading population: 103, Seventh sternum, female, variations.
M. eumolpi americanus Hubbard: 104, Seventh sternum, female, variations.

nominotypical form is distinguished from *e. americanus* in the male, because the angle at the lowest spiniform on the movable finger (pl. XVI, 105) is almost always more than a right angle and the finger is always narrowed near its articulation with the fixed process of the clasper. The crochets (pl. XV, 100, CR.) are never angulate posteriorly. The female differs from *e. americanus* in that the lobe on the posterior margin of the seventh sternum (pl. XVI, 101) is always broad and the bursa copulatrix (pl. XV, 99) is larger and thicker.

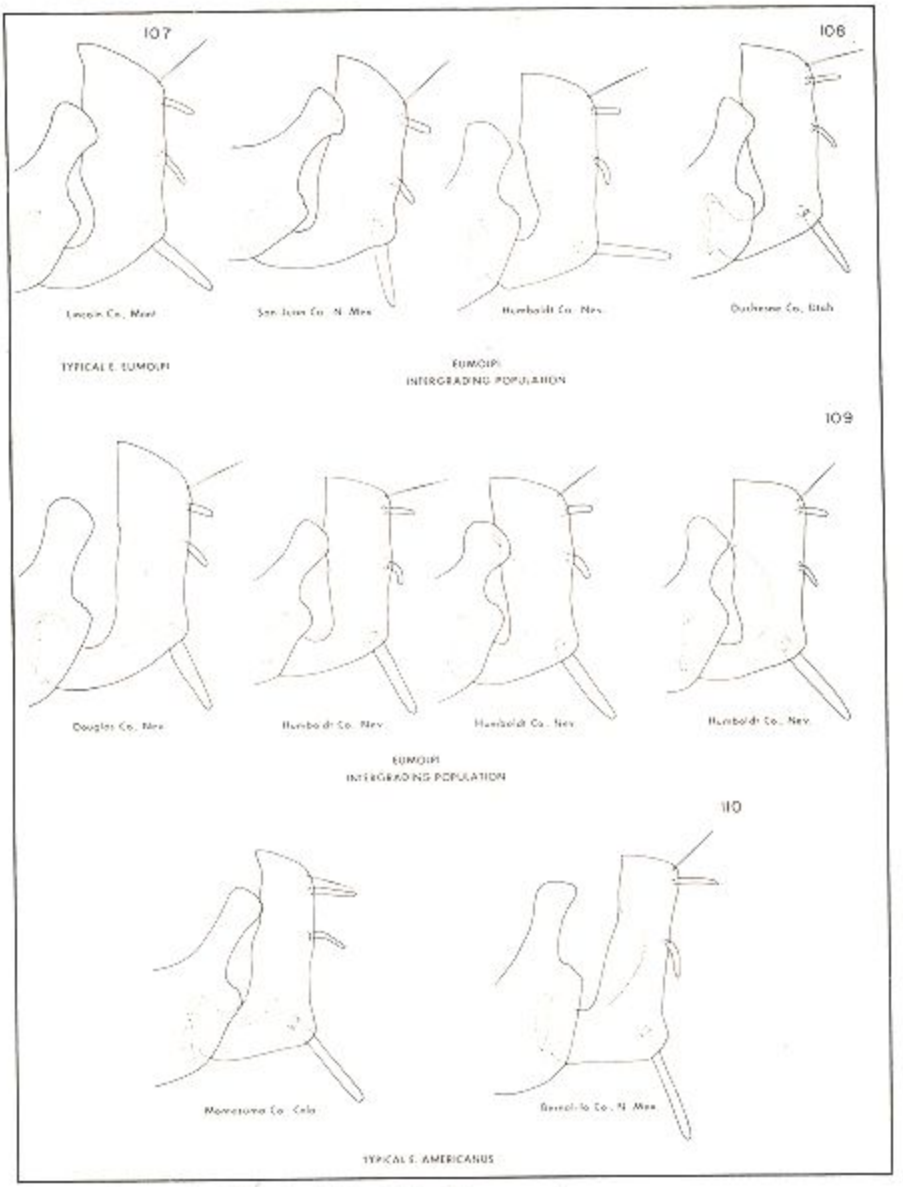
Description.—*Head* (pl. XV, 90): Eye large and dark. Ventral margin of gena strongly curved and at times angulate. Frontal row of four to five medium-sized bristles. Occiput with two rows of one and two bristles each, other than posterior submarginal row. Dorsal margin of antennal groove lined with about 10 small hairs. Apical bristles of second antennal segment extending three-fourths length of club in male. ***Thorax:*** Pronotal comb of 18 to 19 heavy dark rather bluntly pointed spines. ***Legs:*** Mesotarsal segments (pl. XV, 91) one and two of male with long slender bristles, which reach beyond apex of succeeding segments.

Male: Ventral anal lobe (pl. XXI, 136, *fornacis*) extending half its dorsal length beyond dorsal anal lobe. Eighth sternum (pl. XV, 98) with bifurcate feathered apical plumes; four long apical bristles, plus several smaller ventromarginal bristles. Fixed process of clasper (pls. XVI, 105; XVII, 106; XVIII, 107) of varying shape, but apex seldom more than two times as long as broad at broadest point. Movable finger with apex at least slightly slanted, posterior and anterior margins near apex parallel; three spiniforms of posterior margin more or less equidistant; middle spiniform may be nearer either upper or lower spiniform; lower spiniform largest and set on slight to distinct angle of posterior margin; finger strongly narrowed near articulation with fixed process. Distal arm of ninth sternum (pl. XV, 94) with apex narrowly rounded; posterior margin deeply cut subapically, so that apex looks somewhat like a crochet hook; apical lobe with bay for reception of crochet peg long and narrow; few small scattered bristles on apical lobe plus group of medium-sized bristles at ventral posterior angle; median lobe with several various-sized bristles and one short thick curved bristle at dorsal posterior angle. ***Aedeagus*** (pl. XV, 100): Aedeagal apodeme only slightly humped dorsally at juncture with median dorsal lobe (M.D.L.). Accessory lateral lobes (A.L.L.) very distinct, large. Armature of inner tube strong, dorsally (anteriorly) with craggy appearance. Lateral lobes not visible in specimen drawn, but undoubtedly present. Extension of inner tube (E.I.T.) very long, not strongly sclerotized, actually consisting of two tubes. (The aedeagus drawn had been pulled out from the body and many of its structures were more easily seen than usual. It is rather likely that more *Monopsyllus* species have the extension double.) Crochet (CR.) with posterior margin sclerotized, slightly curved, and never angulate; crochet not projecting far from remainder of aedeagus when in normal position; its peg (PEG) long and narrow. Penis rods long but not coiled. Apodeme with long apical appendage.

Female: Seventh sternum (pl. XVI, 101, 102) with broad dorsal lobe, usually lobe is as broad as or broader than long and seldom with angles rounded. Bursa copulatrix (pl. XV, 99) large and thick. Spermatheca (pl. XV, 93) with bulga twice as long as broad, sides parallel, hilla narrow and no longer than bulga. Ventral anal lobe



M. eumolpi eumolpi (Rothschild): 106, Clasper, male, variations.



M. eumolpi eumolpi (Rothschild): 107, Clasper, male.
M. eumolpi, intergrading population: 108, Clasper, male, variations; 109, ibid.
M. eumolpi americanus Hubbard: 110, Clasper, male, variations.

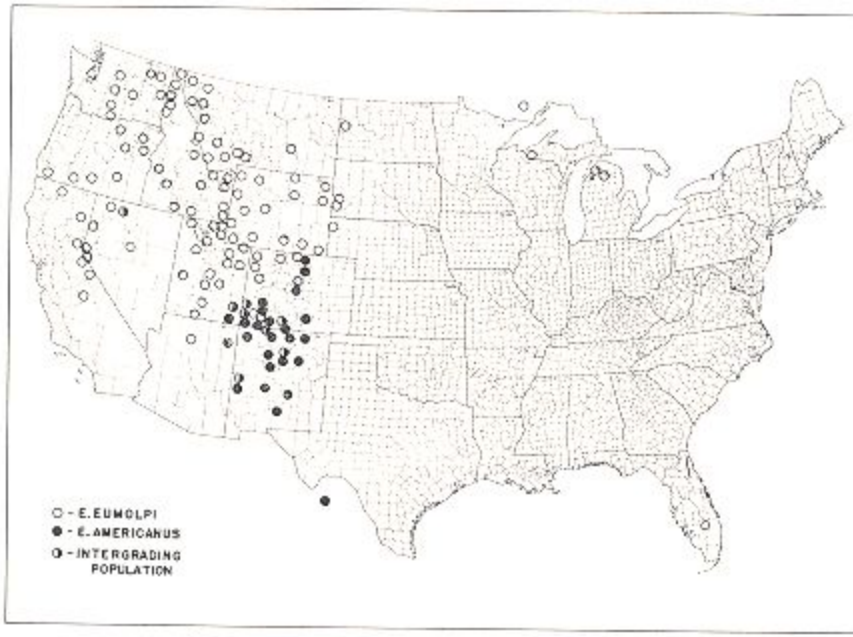


FIGURE 4.—Distribution of *M. eumolpi* subspecies.

(pl. XV, 95, *americanus*) almost never strongly angulate posteroventrally; bristles on posterior margin thick, dark, and often apically bent.

Types.—*M. eumolpi* was described from many specimens from *Tamias borealis* [*Eutamias minimus borealis*], Banff, Red Deer, and Canadian National Park in Alberta, Canada; from "chipmunk," near Golden, British Columbia; and from *Eutamias quadrivittatus affinis* [*Eutamias amoenus affinis*], Okanagan, British Columbia. The syntype series is in the collections of the British Museum (Natural History).

M. e. canadensis, which is a synonym of *e. eumolpi*, was described from the male holotype, female allotype, and two male and two female paratypes from "chipmunk," Ontario, Canada, July 19, 1947, W. Watson collector. The holotype is in the collections of the U.S. National Museum. The label on the holotype slide gives the additional information: "Malachio" [Malachi], Kenora District, Ontario.

Hosts and distribution.—The normal hosts are species of western chipmunks, genus *Eutamias*. *M. e. eumolpi* is also found in large numbers on *Tamiasciurus, Sciurus, Citellus*, and occasionally on mice and lagomorphs. The range of *e. eumolpi* extends from north-central British Columbia, across southern Canada as far as the Great Lakes, and through the Northern United States to north-central British Columbia; south through the Cascades (but not west of these mountains, except in southern Oregon) and down the Sierras in California; throughout the northern Rockies and as far east as South Dakota and Nebraska in the central region and south to the northern parts of Utah and Colorado. (See fig. 4.)

In the Great Basin area and in the Rockies along the adjacent borders of Utah, Arizona, Colorado, and New Mexico, *e. eumolpi* and *e. americanus* form an intergrading population. This population can be most easily distinguished from *e. eumolpi* in the female, and

most males associated with definitely intermediate females are more like *e. eumolpi* than like *e. americanus* (pl. XVIII, 108, 109). Occasional males of this population have the movable finger like that of *e. eumolpi* and the aedeagus like that of *e. americanus*, but this is the exception rather than the rule. One collection from Humboldt County, Nev., showed characters ranging from those of true *e. eumolpi* to those of definitely intergrade males, and the females ranged from *e. eumolpi* to *e. americanus* (pl. XVI, 103).

East of the Rockies in Wyoming, east to the Black Hills of South Dakota, and north to western North Dakota there is a population in which the females have a broad and shallow lobe on the margin of the seventh sternum (pl. XVI, 101, Albany County, Wyo.; McKenzie County, N. Dak.). The males are typical *e. eumolpi*. In Yakima and Ferry Counties in eastern Washington, the males have the movable finger (pl. XVII, 106) broader than is usual. However, the females are like typical *e. eumolpi*. Although these local populations are of interest in their departure from the normal form, they are probably not important evolutionarily and are in no way effectively isolated from other *e. eumolpi* populations.

My study of variation in *eumolpi* was based on 1,175 specimens of *e. eumolpi*, 235 specimens of *e. americanus*, and 72 specimens that I consider to be part of an intermediate intergrading population.

Monopsyllus eumolpi americanus Hubbard

(Pls. XV, 95–97; XVI, 104; XVIII, 110)

Monopsyllus eumolpi americanus Hubbard, 1949, Ent. News 60: 259, fig. 1.
Monopsyllus eumolpi, Traub and Hoff, 1951, Amer. Mus. Novitates 1530: 3, 5 (err. det.). Morlan, 1955, Tex. Rpts. Biol. and Med. 13: 109 (err. det.).

Diagnosis.—In all respects the male of this subspecies is like that of the nominotypical form except for the clasper and aedeagus. The movable finger (pl. XVIII, 110) is usually squared apically, and always it is apically narrower than at the level of the lowest large spiniform; the posterior margin is straight and parallel to the anterior margin. The apex of the fixed process of the clasper is always more than twice as long as it is broad at the broadest point. The aedeagal apodeme is very strongly humped just anterior to its juncture with the median dorsal lobe (pl. XV, 97, AE. A., M.D.L.), and the crochets (CR.) are posteriorly strongly angulate. The female differs because the bursa copulatrix (pl. XV, 96) is narrower than in *e. eumolpi* and the dorsal lobe of the seventh sternum (pl. XVI, 104) is narrow and often rounded.

Types.—The male holotype and female allotype were taken from *Eutamias amoenus*, Painted Desert, Coconino County, Ariz., July 7, 1945. Four male and ten female paratypes were taken from south-central Colorado (Antonito, Conejos County), and one male and five female paratypes were taken from San Juan County, Utah. The holotype is in the collections of the U.S. National Museum. Some of the paratypes from Colorado and San Juan County are members of the intermediate population.

Hosts and distribution.—As with the nominotypical form, chipmunks of the genus *Eutamias* are the normal hosts, but *e. americanus* has also been taken from *Sciurus*, *Tamiasciurus*, *Cynomys*, *Citellus*, and occasionally mice. This subspecies occurs over most of Arizona south of the Colorado River, through mountainous New Mexico, southwestern Utah, and southwestern Colorado, with occasional

specimens from north-central Colorado (fig. 4). I have seen one male from Ocampo, Coahuila, Mexico.

Monopsyllus cyrturus (Jordan)

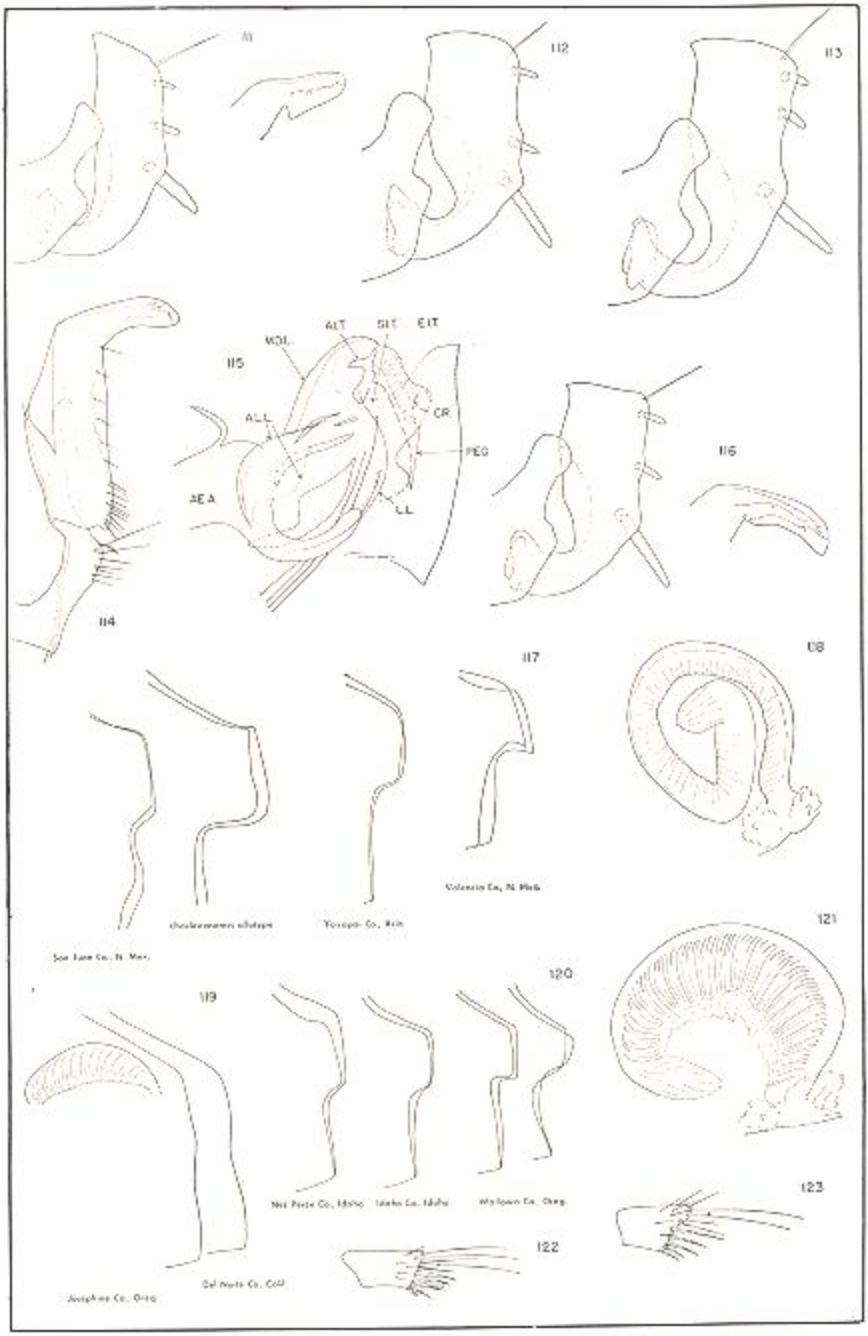
(Pl. XIX, 112–118, 122)

Ceratophyllus eumolpi cyrturus Jordan, 1929, Novitates Zool. 35: 34, pl. 1, fig. 14.
Monopsyllus eumolpi cyrturus, Jellison and Good, 1942, U.S. Natl. Inst. Health Bul. 178: 89.
Trichopsylla (Trichopsylla) eumolpi cyrtura, Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Pub. 500, p. 60. Costa Lima and Hathaway, 1946, Inst. Oswaldo Cruz Monog. 4: 301.
Monopsyllus eumolpi cyrturus, Hubbard, 1947, Fleas West. North Amer., p. 238 (partim, most of records and fig. 123 are of *eumolpi eumolpi* (Rothschild)).
Monopsyllus eumolpi eumolpi, Hubbard, 1947, loc. cit., fig. 122 (err. det.).
Monopsyllus eumolpi cyrturus, Hubbard, 1949, Ent. News 60: 256, fig. 1.
Monopsyllus eumolpi charlestonensis Hubbard, 1949, loc. cit. 60: 254, fig. 1. NEW SYNONYMY.

Diagnosis.—A member of the *eumolpi* group. *M. cyrturus* is distinguished in the male from other *eumolpi*-like species, because the movable finger (pl. XIX, 112, 113, 116) is squared apically and the area above the notch on the anterior margin is roughly square and never broader than high. The finger is broadest from the notch upward, and the area near its articulation with the fixed process is always narrow and smoothly curved. The distal arm of the ninth sternum (pl. XIX, 114) is bent subapically at about a right angle, and the apex is narrowly rounded and only slightly expanded posteroventrally; this angle is rounded so that the apical part is not noticeably broader apically than subapically. In the female the bursa copulatrix (pl. XIX, 118) is much as in *eumolpi*, but it is larger. The ventral anal lobe (pl. XIX, 122) always has a right angle posteroventrally, and bristles never occur on the ventral margin. The seventh sternum (pl. XIX, 117) has a large squared dorsal lobe and lacks a sinus below the lobe. In the area where *cyrturus* occurs, *eumolpi* always has a narrow rounded lobe and is easily distinguished from *cyrturus*.

Description.—***Head:*** Eye large and dark. Frontal row of five to six medium-sized bristles. Ventral head margin as in *eumolpi* (pl. XV, 90). Male second antennal segment with apical bristles extending three-fourths length of club. Occiput with two rows of one and two bristles each, other than posterior submarginal row. Dorsal margin of antennal groove lined with 18 to 20 small hairs. ***Thorax:*** Pronotal comb of 18 to 19 heavy dark but pointed spines. ***Legs:*** Mesotarsal segments one and two of male with long slender bristles, which reach beyond apex of following segment.

M. cyrturus-eumolpi, hybrid: 111, Clasper and apex of ninth sternum, male (Mohave County, Ariz.).
M. cyrturus (Jordan): 112, Clasper, male (Yavapai County, Ariz.); 113, ibid. (*charlestonensis* holotype); 114, distal arm of ninth sternum, male (Valencia County, N. Mex.); 115, aedeagus (Catron County, N. Mex.); 116, clasper and apex of ninth sternum, male (Valencia County, N. Mex.); 117, seventh sternum, female, variations; 118, bursa copulatrix (Valencia County); 122, ventral anal lobe, female (Valencia County).
M. ararius, n. sp.: 119, Seventh sternum, female, variations, and bursa copulatrix; 123, ventral anal lobe, female (allotype).
M. wallowensis Hubbard: 120, Seventh sternum, female, variations; 121, bursa copulatrix (Idaho County, Idaho).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Yavapai Co., Ariz.
Volusia Co., N. Mich.
Nez Perce Co., Idaho
Idaho Co., Idaho
Josephine Co., Oreg.
Del Norte Co., Calif.

Male: Ventral anal lobe extending half its dorsal length beyond dorsal anal lobe. Movable finger of clasper (pl. XIX, 112, 113, 116) squared apically, part distad to notch on anterior margin often higher than broad, never broader than high; this area broadest part of finger; middle of three spiniforms on finger occurring at varying points along margin; it may be median or nearer either upper or lower spiniforms. Eighth sternum as in *e. eumolpi* (pl. XV, 98), except that there may be as many as six long apical and subapical bristles. Distal arm of ninth sternum (pl. XIX, 114) with apical lobe with distal part bent at approximate right angles, this area about same width throughout; apex narrowly rounded and only somewhat expanded at rounded apicoventral corner; at subapical angle on posterior margin, margin may be folded (as in pl. XIX, 116); apical lobe with row of small submarginal bristles; median lobe angulate, with several bristles, most dorsal one heavy, short, and curved. ***Aedeagus*** (pl. XIX, 115): Armature of inner tube (E.I.T.) divided into two tubes, as in *eumolpi*, usually heavy and long. In the illustration the tube has been withdrawn and accordioned. Crochet (CR.) with posterior margin sclerotized and slightly convex, not extending far beyond apex of aedeagus; peg (PEG) elongate. Accessory lateral lobe (A.L.L.) small, not extending much above level of apodeme and median dorsal lobe. Aedeagal apodeme with long apical appendage. Penis rods long but not coiled.

Female: Seventh-sternum margin (pl. XIX, 117) with well-developed dorsal lobe, which is squared, though angles may be rounded and sometimes lower angle is acute. Bursa copulatrix (pl. XIX, 118) large, long, and coiled. Spermathecal bulga twice as long as broad, sides parallel; hilla narrow and shorter than bulga. Ventral anal lobe (pl. XIX, 122) posteriorly nearly square; posteromarginal bristles heavy, dark, some bent apically, never occurring on ventral margin below posteroventral angle.

Types.—The syntype series of *cyrturus* consists of one male and five females collected off *Mephitis* sp., Paradise, [Cochise County], Ariz., October 1913, O. C. Duffner collector. The type series is in the collections of the British Museum (Natural History).

Hubbard described *charlestonensis* from the male holotype, female allotype, and four male and one female paratypes from *Eutamias palmeri*, base of Charleston Peak in Kyle Canyon, Spring Mountains, 25 miles northwest of Las Vegas, Clark County, Nev., June 25, 1948. The male holotype is in the collections of the U.S. National Museum.

The name *charlestonensis* Hubbard is a synonym of *cyrturus*, and the slight differences in the movable finger of the holotype (pl. XIX, 113) are consistent with individual variation. The position of the middle spiniform is not constant in *cyrturus*, and the length of the narrow proximal part of the finger next to the fixed process varies considerably in the males I have examined.

Hosts and distribution.—All 29 specimens of *cyrturus* available to me were taken from species of *Eutamias*. As will be seen in figure 5, this species is confined to the mountainous areas of southern Nevada, Arizona, and western New Mexico. Its range probably extends into Mexico as well.

I have examined one male specimen, which appears to be a hybrid of *eumolpi* and *cyrturus* (pl. XIX, 111). This specimen is from Mohave County, Ariz. The movable finger is longer basally than is true of *eumolpi*. (The finger is very differently shaped than in *e. ameri-*

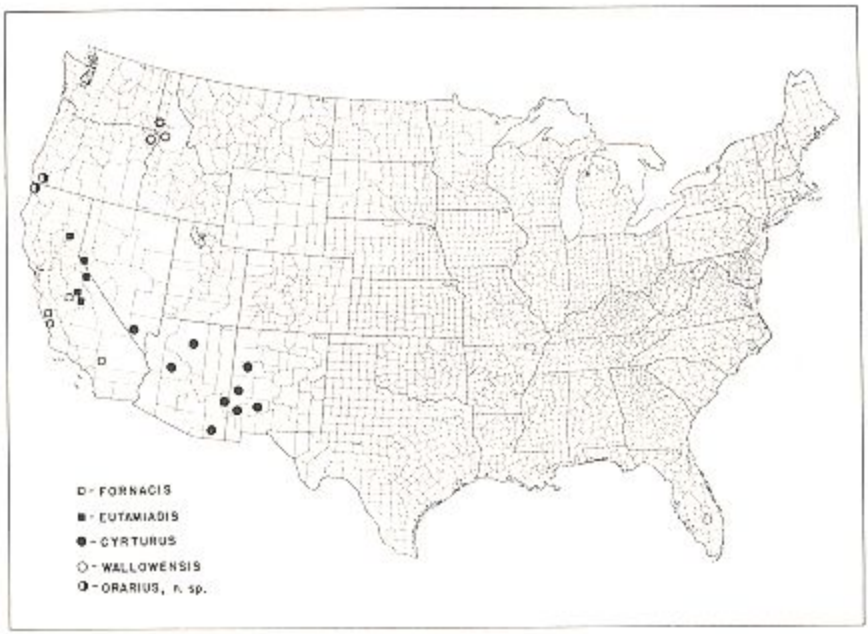


FIGURE 5.—Distribution of *M. fornacis* Jordan, *M. eutamiadis* Augustson, *M. cyrturus* (Jordan), *M. wallowensis* Hubbard, and *M. orarius*, n. sp.

canus, which occurs in this area.) The apical part of the distal arm of the ninth sternum is longer than is typical of *eumolpi*, and thus the distal arm is intermediate between *cyrturus* and *eumolpi*.

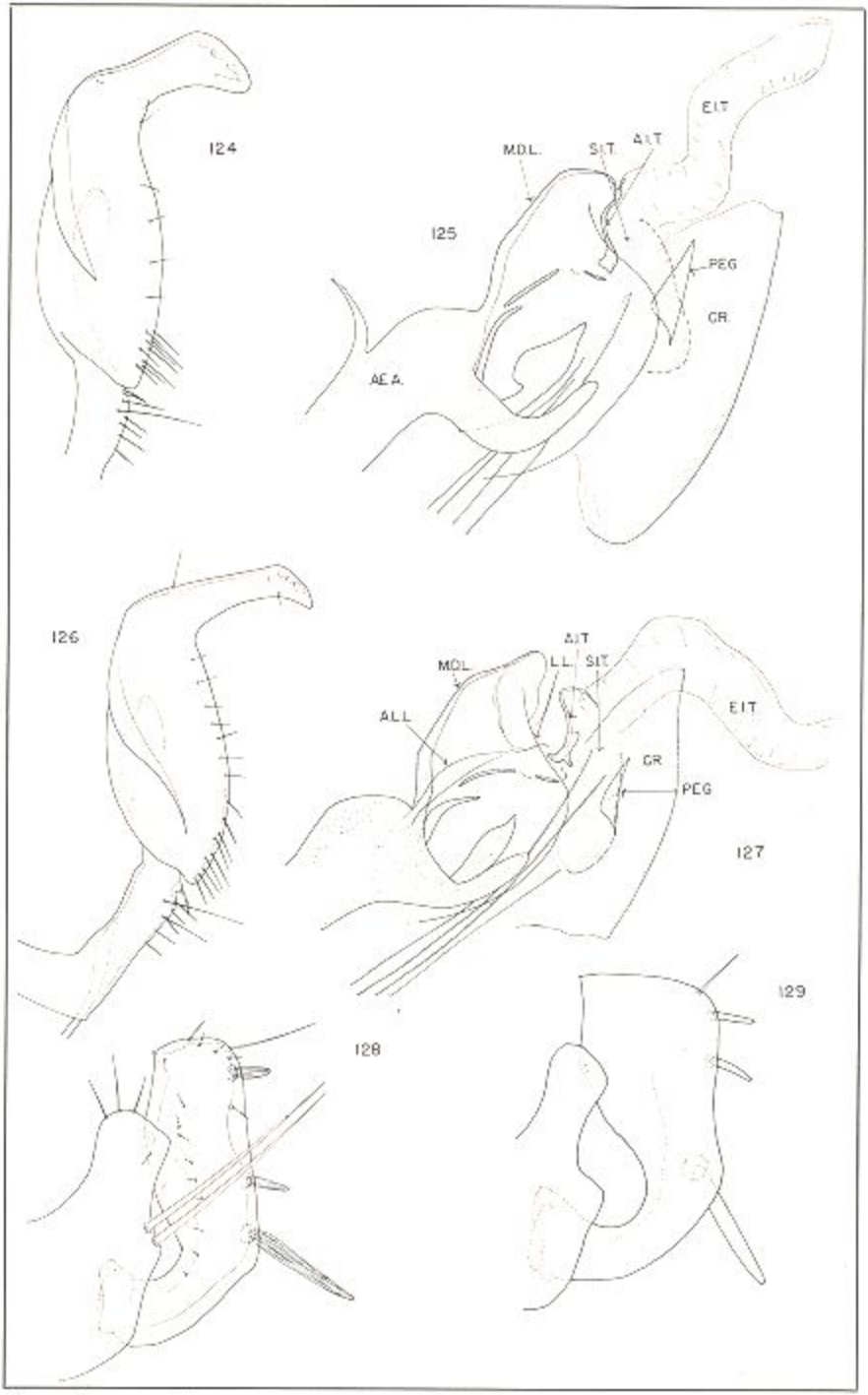
Monopsyllus wallowensis Hubbard

(Pls. XIX, 120, 121; XX, 124, 125, 129)

Monopsyllus eumolpi eumolpi, Hubbard, 1947, Fleas West. North Amer., p. 238, figs. 122–123 (partim, figure of bursa copulatrix and some of records).
Monopsyllus eumolpi wallowensis Hubbard, 1949, Ent. News 60: 255, fig. 1.

Diagnosis.—This member of the *eumolpi* group is easily distinguished in the male by the shape of the movable finger (pl. XX, 129), which is much broader apically than elsewhere. The apex is squared, and the part above the notch on the anterior margin is broader than high. The distal arm of the ninth sternum (pl. XX, 124) is bent at right angles subapically, with the distal part broadest apically. The female of *wallowensis* is immediately distinguished from that of other members of the group by the large, thick, curved, but not coiled bursa copulatrix (pl. XIX, 121) and a large dorsal lobe on the seventh-sternum margin (pl. XIX, 120).

Description.—***Head:*** Eye large and dark. Anteroventral margin as in *eumolpi* (pl. XV, 90). Frontal row of five to six bristles. Occiput with two rows of one and two bristles each, other than posterior submarginal row. Bristles on second antennal segment of male extending three-fourths length of club. ***Thorax:*** Pronotal comb of 18



M. wallowensis Hubbard, Nez Perce County, Idaho: 124, Distal arm of ninth sternum, male; 125, aedeagus; 129, clasper, male.

M. orarius, n. sp., holotype: 126, Distal arm of ninth sternum, male; 127, aedeagus; 128, clasper, male.

to 19 heavy dark spines. ***Legs:*** Mesotarsal segments one and two of male with long slender bristles extending beyond apex of following segment.

Male: Ventral anal lobe extending half its dorsal length beyond dorsal anal lobe. Movable finger of clasper (pl. XX, 129) squared apically, part above notch on anterior margin much broader than remainder of finger and this distal part broader than high; second of three spiniforms on posterior margin nearest upper spiniform in all males examined (total of six), but this character is probably not reliable. Eighth sternum as in *eumolpi*. Distal arm of ninth sternum (pl. XX, 124) with distal part of apical lobe bent at right angles to remainder; this distal part broadest apically; posteroventral corner produced and rounded; apical lobe with row of small submarginal bristles; median lobe not projecting at all, with several marginal bristles, most dorsal of these thick, short, and curved. ***Aedeagus*** (pl. XX, 125): Median dorsal lobe (M.D.L.) often angulate along dorsal margin. Armature of inner tube (A.I.T.) simple, not heavy and craggy. Extension of inner tube (E.I.T.) long and very thick, apparently not divided into two tubes as in *cyrturus* and *eumolpi*. Crochet (CR.) with sclerotized posterior margin evenly convex; peg (PEG) elongate. Penis rods long but not coiled. Aedeagal apodeme with long apical appendage. Accessory lateral lobes not visible in specimens at hand.

Female: Ventral anal lobe broadest posteriorly and posteroventrally sharply angled; bristles on posterior margin heavy, dark, some apically bent (see pl. XIX, 123, *orarius*, n. sp.). Seventh-sternum margin (pl. XIX, 120) with large dorsal lobe, which is usually squared; no sinus below lobe. Bursa copulatrix (pl. XIX, 121) very large, thick, and ridged; entire structure convex. Spermathecal bulga twice as long as broad, sides parallel; hilla narrow and shorter than bulga.

Types.—The male holotype, female allotype, and a series of male and female paratypes were taken from *Eutamias a. luteiventris* [*Eutamias amoenus albiventris*], Wallowa Lake, Wallowa County, Oreg., July 13, 1939. The holotype is in the collections of the U.S. National Museum.

Hosts and distribution.—The 13 specimens I have examined were taken from *Eutamias amoenus* and *E. minimus*. Apparently this species is confined to areas within or near the Blue Mountains. The series of specimens I have seen came from Wallowa County, Oreg., and Nez Perce and Idaho Counties, Idaho. (See fig. 5.)

Monopsyllus orarius, new species

(Pls. XIX, 119, 123; XX, 126–128)

Monopsyllus eumolpi cyrturus, Hubbard, 1947, Fleas West. North Amer., p. 239 (partim, some of records from Josephine County, Oreg.).

Diagnosis.—A member of the *eumolpi* group; closest to *wallowensis*. The male is distinguished from that of other members of this group

by a combination of the following characters: The second mesotarsal segment does not have the long slender bristles extending beyond the apex of the following segment. The movable finger (pl. XX, 128) is squared apically; the apical part above the notch on the anterior margin is not broader than below this point, and the posterior margin of the finger is angled below or at the insertion of the large lowest spiniform. The distal arm of the ninth sternum (pl. XX, 126) has the distal part of the apical lobe bent at right angles; this distal part is narrow and the apex is produced into a sharp ventral point. The armature of the inner tube (pl. XX, 127, A.I.T.) is simple, not thick and craggy. The female may be distinguished by the seventh sternum (pl. XIX, 119), which lacks a dorsal lobe; by the bursa copulatrix, which is thick, ridged, and convex, intermediate in size and shape between that of *wallowensis* and *fornacis;* and by the ventral anal lobe (pl. XIX, 123), which is broadest posteriorly and sharply angled posteroventrally.

Description.—*Head:* Eye large. (In holotype and other specimens the color cannot be seen, since the fleas have been overcleared.) Frontal row of five medium-sized bristles. Male with some of apical bristles on second antennal segment reaching three-fourths length of club. (Many bristles are missing on these specimens, and all the long bristles on the second antennal segment of the holotype are gone.) Occiput with two rows of one and two bristles each, other than posterior submarginal row. Antennal groove lined dorsally with about 20 small hairs. Anteroventral head margin as in *eumolpi* (pl. XV, 90). ***Thorax:*** Pronotal comb of 18 dark heavy pointed spines. ***Legs:*** Mesotarsal segment one of male with long slender bristles extending beyond apex of following segment. Slender bristles of mesotarsal segment two not reaching apex of following segment.

Male: Ventral anal lobe extending half its dorsal length beyond dorsal anal lobe. Movable finger (pl. XX, 128) squared apically; area above notch on anterior margin somewhat higher than broad, no broader than area below notch; posterior margin straight, with middle spiniform nearer large lowest spiniform (this character will probably prove to be variable); margin angled just below or at level of lowest spiniform. Apex of fixed process of clasper about two times as long as broad measured from insertion of acetabular bristles. Eighth sternum as in *e. eumolpi* (pl. XV, 98). Distal arm of ninth sternum (pl. XX, 126) with distal part of apical lobe bent at right angles, this distal part narrow, apex produced into short ventral point; row of medium-sized marginal bristles on apical lobe plus group on ventral part of margin; median lobe slightly convex, with several various-sized bristles, most dorsal one is thick, short, and curved. ***Aedeagus*** (pl. XX, 127): Median dorsal lobe (M.D.L.) with angulate dorsal margin. Armature of inner tube (A.I.T.) thin, not thick or craggy. Extension of inner tube (E.I.T.) thick and long, apparently not divided into two parallel tubes. Crochet (CR.) with posterior sclerotized margin slightly sinuate; peg (PEG) elongate. Accessory lateral lobe (A.L.L.) apparently narrow somewhat crescentic structure. Aedeagal apodeme with short apical appendage. Penis rods neither particularly long nor coiled.

Female: Seventh sternum (pl. XIX, 119) lacking dorsal lobe. Bursa copulatrix (pl. XIX, 119) thick, ridged, convex, not coiled. Spermathecal bulga twice as long as broad, sides parallel; hilla narrow and no longer than bulga. Ventral anal lobe (pl. XIX, 123) sharply angled posteroventrally, widest at this point in allotype; posteromarginal bristles thick, heavy, some apically bent. Anal stylet of female allotype and paratype from Josephine County, Oreg., with extra subapical bristles on anal stylet (other than usual one dorsal and one ventral subapical bristles).

Types.—The male holotype, female allotype, and two male paratypes were taken from *Eutamias townsendi siskiyou*, Bolan Lake, Josephine County, Oreg., July 18, 1939, C. A. Hubbard collector. One female paratype bears data as above, except it was collected on July 17, 1939. One female paratype was taken from the same host but at Gasquet, Del Norte County, Calif. The holotype, allotype, and paratypes are in the British Museum (Natural History).

Hosts and distribution.—This species probably normally occurs on *Eutamias townsendi*, and possibly it is restricted to a very small area of the Siskiyou Mountains, which are the coastal mountains in this area. Here *Eutamias* approaches the coast most closely.

Monopsyllus eutamiadis Augustson

(Pl. XXI, 133, 137, 140–144)

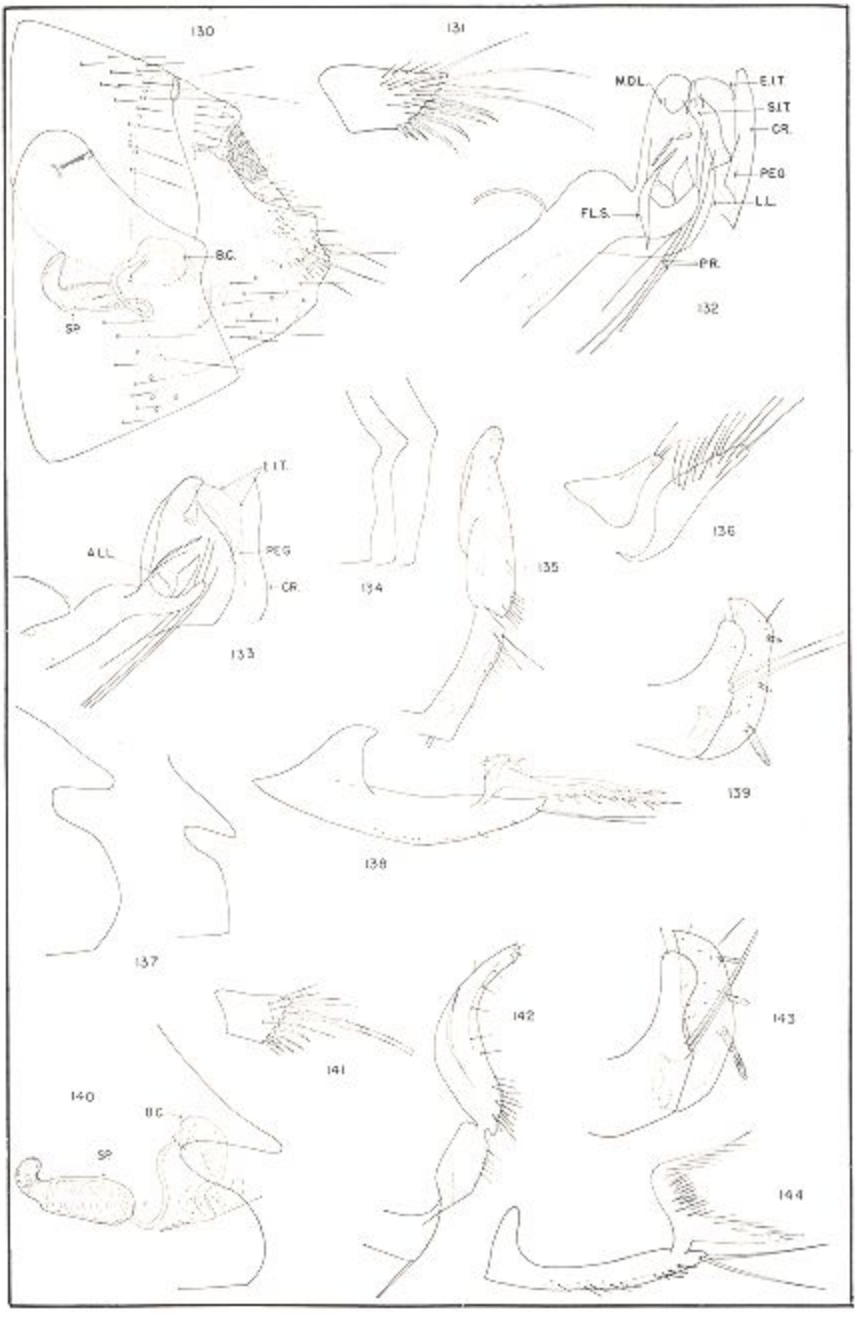
Monopsyllus eutamiadis Augustson, 1941, South. Calif. Acad. Sci. Bul. 40: 141, figs. 1, 2. Augustson, 1941, loc. cit. 40: 153.

Trichopsylla (Trichopsylla) eutamiadis, Costa Lima and Hathaway, 1946, Inst. Oswaldo Cruz Monog. 4: 305.

Monopsyllus eutamiadis, Hubbard, 1947, Fleas West. North. Amer., p. 242, fig. 125. Traub and Johnson, 1952, Amer. Mus. Novitates 1598: 18, 25, figs. 24, 32, 39, 42, 46, 48, 52.

Diagnosis.—A member of the *cumolpi* group. In the male the movable finger is narrow, and the apex is strongly slanted and extends only slightly above the long apically expanded fixed process of the clasper (pl. XXI, 143). The lowest spiniform on the posterior margin of the finger is inserted above the level of the acetabular bristles on the fixed process. The posterior margin of the crochets (pl. XXI, 133, CR.) is slightly sinuate. The distal arm of the ninth sternum (pl. XXI, 142) is narrowed and bent posteriad apically. In the female the bursa copulatrix (pl. XXI, 140, B.C.) is short, only slightly curved, and rather broad. The seventh sternum (pl. XXI, 137) has a long acute or sharply rounded upper lobe surmounting a deep rounded sinus.

Description.—***Head:*** Eye large and dark. In male, frontal row of three to four large bristles plus two to three smaller ones above; in female, three to four medium-sized bristles. Occiput with two rows of one and two bristles each, other than submarginal posterior row; dorsal margin of antennal groove lined with about 18 to 20 small bristles. ***Thorax:*** Pronotal comb of 18 to 20 stout pointed spines. ***Legs:*** Male with long slender bristles on posterior margin of mesotarsal segments one and two; in each segment these bristles extend beyond apex of following segment.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E.IT
S.IT
CR.
PEG
LL.
FLS.
PR.
132
BC.
SP
133
E.IT.
ALL.
PEG
CR.
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135
136
137
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BC
SP
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142
143
144

Male: Ventral anal lobe much longer than dorsal anal lobe (as in pl. XXI, 136, *fornacis*). Eighth sternum (pl. XXI, 144) with subapical plume on either side, each plume bifurcate near base; two large apical bristles plus several small bristles along entire ventral margin. Fixed process of clasper (pl. XXI, 143) three times as long as broad, expanded apically. Movable finger narrow throughout its length, extending only slightly beyond process; anteroapical angle acute; posterior margin rapidly slanting ventrally from this angle to first short blunt spiniform; three spiniforms equidistant, upper two half length of lowermost; lowermost set above level of acetabular bristles on process; posterior margin of finger not angled in this area. Distal arm of ninth sternum (pl. XXI, 142) with curved narrowed apex; row of small bristles submarginally on apical lobe, bristles growing larger as row proceeds basad; median lobe only somewhat convex, with several slender marginal bristles. ***Aedeagus*** (pl. XXI, 133): Accessory lateral lobe (A.L.L.) present, very narrow, entirely lateral to apodeme and aedeagal end chamber. Angle at juncture of end chamber and apodeme broad, apodeme not strongly humped in this area. Extension of inner tube (E.I.T.) long, not heavily sclerotized. Crochets (CR.) long and thin, posterior margins slightly sinuate and well sclerotized; peg (PEG) long, narrowly triangulate. Penis rods not coiled.

Female: Ventral anal lobe (pl. XXI, 141) broadest posteriorly, posteroventral angle marked; bristles on posterior margin slightly bent down apically, five to six smaller lateral bristles. Seventh sternum (pl. XXI, 137, 140) with long narrowly rounded dorsal lobe surmounting deep rounded sinus. Bursa copulatrix (pl. XXI, 140, B.C.) rather short, with posterior margin convex, only this margin sclerotized. Spermatheca (SP.) with bulga twice as long as broad, sides parallel, hilla shorter and about half as wide as bulga (in illustration hilla is foreshortened).

Types.—The female holotype, male allotype, and two female paratypes were taken from *Eulamias quadrivittatus inyoensis* Merriam, Cascade Valley, Fresno County, Calif., August 27, 1941, Rutherford and Augustson collectors. One female paratype was taken from the same host, Mammoth Lakes, Mono County, Calif., July 22, 1941, Augustson collector. The holotype is in the collections of the Los Angeles County Museum.

M. fornacis Jordan: 130, Modified segments, female (holotype); 131, ventral anal lobe, female (holotype); 132, aedeagus (allotype); 134, seventh sternum, female, variations (Monterey County, Calif.); 135, distal arm of ninth sternum, male (allotype); 136, dorsal and ventral anal lobes, male (allotype); 138, eighth sternum, male (allotype); 139, clasper, male (allotype).

M. eulamiadis Augustson: 133, Aedeagus (Fresno County, Calif.); 137, seventh sternum, female, variations (Fresno County on left; Douglas County, Nev., on right); 140, seventh sternum, spermatheca, and bursa copulatrix (Fresno County); 141, ventral anal lobe, female (Fresno County); 142, distal arm of ninth sternum, male (Fresno County); 143, clasper, male (Fresno County); 144, eighth sternum, male (Fresno County).

Hosts and distribution.—Of the 15 specimens available to me for study, 9 were taken from *Eutamias* and 6 from *Tamiasciurus*. The range of *eutamiadis* is probably the central Sierra Nevada Mountains (fig. 5), and it appears to replace *fornacis* in this area. However, *fornacis* occurs with *eutamiadis* in Madera County.

Monopsyllus fornacis Jordan

(Pl. XXI, 130–132, 134–136, 138, 139)

Monopsyllus fornacis Jordan, 1937, Novitates Zool. 40: 263, fig. 45. Jellison, 1940, U.S. Pub. Health Rpts. 55: 491, fig. 2. Jellison and Good, 1942, U.S. Natl. Inst. Health Bul. 178: 90.

Trichopsylla (*Trichopsylla*) *fornacis*, Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Pub. 500, p. 61. Costa Lima and Hathaway, 1946, Inst. Oswaldo Cruz Monog. 4: 305.

Monopsyllus fornacis, Hubbard, 1947, Fleas West. North Amer., p. 241, fig. 124. Traub and Johnson, 1952, Amer. Mus. Novitates 1598: 18, 25, figs. 31, 37, 41, 43, 47, 51. Augustson, 1955, South. Calif. Acad. Sci. Bul. 54: 39. Linsdale and Davis, 1956, Calif. Univ. Pubs., Zool. 54: 314.

Diagnosis.—A member of the *eumolpi* group. In the male the fixed process of the clasper is about 1½ times as long as broad and the same width throughout. The movable finger is narrow and extends only slightly above the process, the apex is strongly slanted, and the lower of the three spiniforms on the posterior margin is inserted well below the level of the insertion of the acetabular bristles on the process. The posterior outline of the crochets (pl. XXI, 132, CR.) is slightly convex, not at all sinuate. The distal arm of the ninth sternum (pl. XXI, 135) is narrowly rounded apically, with the subapical posterior margin cut or creased, so that the margin above and below this point overlaps slightly; the apical lobe has only a few small lateral bristles plus a group of several small bristles at its ventral end; the median lobe is not produced posteriorly and has several medium-sized and small bristles. In the female the seventh-sternum margin (pl. XXI, 130, 134) lacks a sinus, but it has a rather pronounced dorsal projection. The bursa copulatrix (pl. XXI, 130, B.C.) is relatively long and broad, with a slightly sinuate or angled sclerotized dorsal (posterior) margin.

Description.—***Head:*** Eye large and dark. Frontal row of three to four rather large bristles plus two to three smaller bristles above these. Occiput with two rows of one and two bristles each, other than posterior submarginal row. Dorsal margin of antennal groove lined with about 20 small bristles in male, 15 in female. ***Thorax:*** Pronotal comb of 18 to 19 heavy apically pointed spines. ***Legs:*** Male mesotarsal segments one and two with long slender bristles on posterior margin, bristles of each reaching beyond apex of succeeding segment.

Male: Ventral anal lobe much longer than dorsal anal lobe (pl. XXI, 136). Eighth sternum (pl. XXI, 138) rather broad, with apical plumes that are inserted on either side of apex and each bifurcate; with two long apical bristles plus three to four very small bristles near apex on posterior margin; remainder of margin with pockets probably representing bristle bases of once-present bristles. Fixed process of clasper (pl. XXI, 139) about twice as long as broad, not expanded apically; movable finger extending only short distance

above fixed process; with acutely slanted apex, posterior margin with three blunt spiniforms equidistant; dorsal two spiniforms less than half length of lower, which is inserted well below level of insertion of acetabular bristles on fixed process. Distal arm of ninth sternum (pl. XXI, 135) apically narrowly rounded, subapical crease or break in posterior margin, which causes margins above and below this point to overlap slightly; apical lobe with only minute lateral bristles, except ventrally where there are several small bristles grouped together; median lobe not expanded posteriorly, with marginal row of several small bristles. ***Aedeagus*** (pl. XXI, 132): Accessory lateral lobe apparently missing, although lateral flange called flanking sclerite (FL. S.) may actually be homologous to displaced accessory lateral lobe. Extension of inner tube (E.I.T.) short and narrow. Angle at juncture of aedeagal apodeme and aedeagal end chamber acute; apodeme strongly humped in this area. Crochet (CR.) long and narrow, posterior margin slightly convex; peg (PEG) long, broadly triangulate.

Female (pl. XXI, 130): Ventral anal lobe (pl. XXI, 131) not broadest posteriorly, posteroventral angle definite, posteromarginal bristles slightly bent apically; lateral surface with several small bristles (not always as many as shown in illustration). Seventh sternum (pl. XXI, 134) lacking sinus, but with small sharply rounded to acute projection dorsally. Bursa copulatrix (B.C.) relatively large and broad, dorsal (posterior) margin angulate or slightly sinuate and more heavily sclerotized. Spermatheca (SP.) with bulga twice as long as broad, sides parallel; hilla narrower and shorter than bulga.

Types.—Jordan described this species from two females taken from *Sciurus griseus*, Sevenoaks, [San Bernardino County], Calif., May 1936, G. M. Kohls collector. The holotype is at the Rocky Mountain Laboratory, Hamilton, Mont. Jellison (1940) based his description of the male allotype on material collected from *Eutamias merriami*, Hastings Natural History Reservation, Monterey County, Calif.

Hosts and distribution.—Apparently chipmunks serve as natural hosts to *fornacis*, although the holotype was taken from the western gray squirrel (*Sciurus griseus*). All 25 specimens seen by me were taken from *Eutamias* species. Linsdale and Davis (1956) reported a few specimens of this species from *Neotoma* and *Peromyscus* from the Hastings Reservation, but these rodents are undoubtedly only rarely infested and are not important hosts to *fornacis*. Most of their specimens were taken from *Eutamias*.

The geographical range of *fornacis* probably extends from the south-central Sierra Nevada Mountains, along the Tehachapi range, to the coastal mountains south of San Francisco Bay, and southeast to the San Bernardino Mountains (fig. 5).

Monopsyllus polumus Traub and Johnson

(Pl. XXII, 145–151)

Monopsyllus polumus Traub and Johnson, 1952, Amer. Mus. Novitates 1598: 17, figs. 21–23, 25, 27, 29, 33–35, 40, 45.

Diagnosis.—A member of the *eumolpi* group. The male may be distinguished from that of all species but *orarius*, n. sp., because on mesotarsal segment two it lacks long slender bristles, which reach

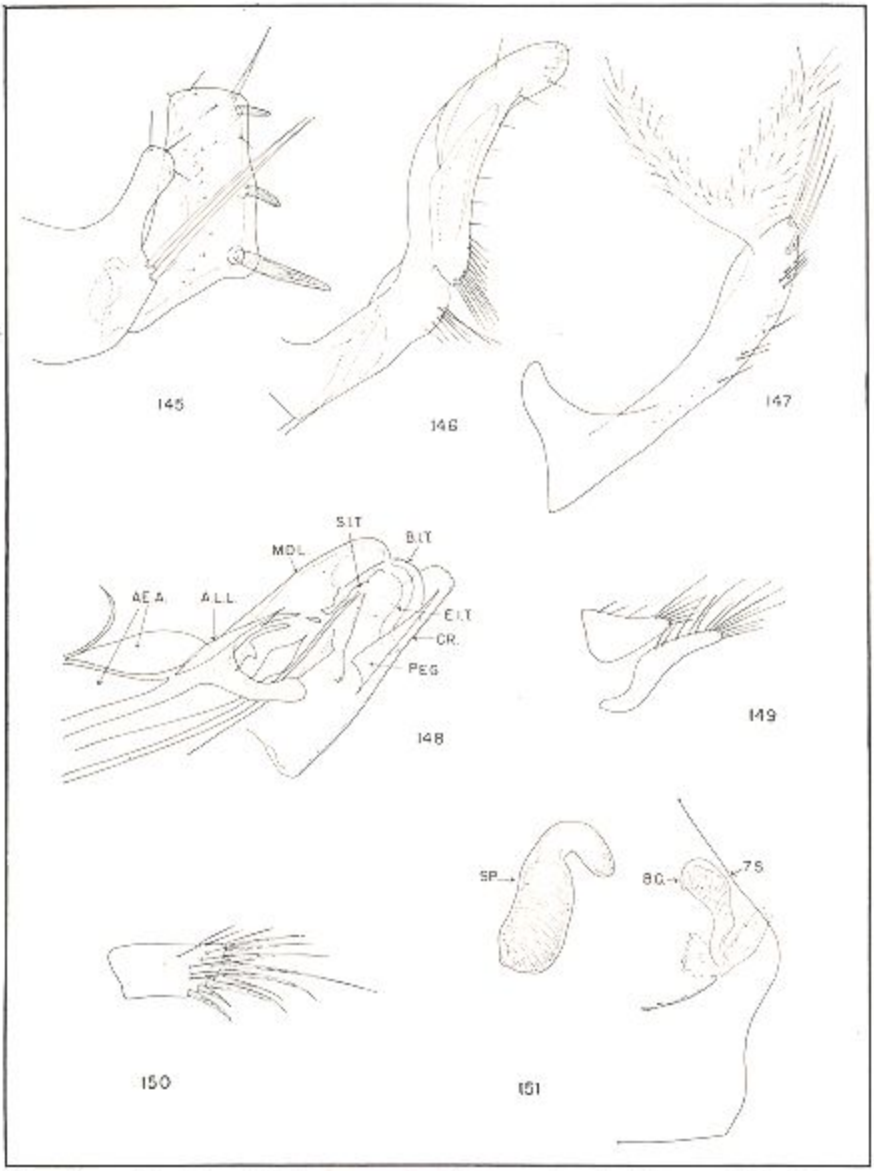
beyond the apex of the following segment; segment one of the mesotarsus has one bristle reaching about to the apex of segment two. *M. polumus* may be distinguished from *orarius*, n. sp., because the apical part of the distal arm of the ninth sternum is not bent at a right angle to the remainder of this segment. In the female, *polumus* closely resembles *fornacis* and without comparative material might easily be mistaken for *fornacis*. The seventh sternum lacks a lobe or sinus and the margin is somewhat sinuate; some specimens of *fornacis* are similar. The bursa copulatrix is much smaller than that of *fornacis* and the height of the combined bursa plus its duct is not more than the length of the spermathecal bulga, whereas in *fornacis* the height of the bursa plus its duct is much more than the length of the bulga.

Description.—***Head:*** Eye large and dark. Frontal row of five medium-sized bristles. Anteroventral head margin as in *eumolpi* (pl. XV, 90). Occiput with four rather than three medium-sized bristles, other than posterior submarginal row; these bristles arranged 1:2:1 (from anterior to posterior). ***Thorax:*** Pronotal comb of 17 (♂) or 18 (♀) heavy spines. ***Legs:*** Male with one of slender bristles on mesotarsal segment one about reaching apex of second segment, but second segment lacking long slender bristles.

Male: Ventral anal lobe, measured along its dorsal margin, extending half its length beyond dorsal anal lobe (pl. XXII, 149). Movable finger (pl. XXII, 145) squared apically, though apex is slightly convex; posterior margin sharply angled at level of lowest large spiniform; finger broadest at this point. Apex of fixed process of clasper three times as long as broad at narrowest point. Eighth sternum (pl. XXII, 147) broadened subapically; with two large bifurcate subapical plumes (in the original description this plume was said to have three prongs, but the third prong seen is actually on the plume of the other side of the apex); four large apical and subapical bristles on posterior (ventral) margin plus several smaller marginal bristles proximal to these. Distal arm of ninth sternum (pl. XXII, 146) apically rounded; apex not narrowed or with posterior (ventral) subapical projection; apical lobe with marginal row of small bristles plus group of bristles posteroventrally; median lobe rounded, with several various-sized bristles. ***Aedeagus*** (pl. XXII, 148): Median dorsal lobe (M.D.L.) evenly convex. Armature of inner tube not broad or especially craggy. Extension of inner tube (E.I.T.) not very long, sclerotized on one margin. Band of inner tube (B.I.T.) well developed, unlike other species. Crochet (CR.) small, narrow, with large elongate peg (PEG). Area of juncture of aedeagal apodeme with median dorsal lobe broadly concave. Penis rods short, not extending much beyond apex of apodeme. Aedeagal apodeme with very short apical appendage.

Female: Seventh sternum (pl. XXII, 151, 7S.) with ventral half of posterior margin only sinuate, lacking marked lobe or sinus. Spermatheca (SP.) with bulga twice as long as broad, sides parallel; hilla shorter and narrower than bulga. Bursa copulatrix (B.C.) small, ridged, convex, and ductus bursae very short; height of entire structure not more than length of spermathecal bulga. Ventral anal lobe (pl. XXII, 150) not sharply angled posteroventrally; bristles on posterior margin heavy, dark, and somewhat bent apically.

Types.—The female holotype was taken from a "sciurid," San Juan, 5 miles west of El Salto, Durango, Mexico, July 8, 1951, B. S. Davis



M. polumus Traub and Johnson, male holotype, female allotype: 145, Clasper, male; 146, distal arm of ninth sternum, male; 147, eighth sternum, male; 148, aedeagus; 149, dorsal and ventral anal lobes, male; 150, ventral anal lobe, female; 151, spermatheca, bursa copulatrix, and seventh sternum, female.

collector. The female allotype is from the same locality but was collected from *Eutamias* sp., July 3, 1951. The holotype is in the collections of the American Museum of Natural History.

Hosts and distribution.—Since this species is known only from the types and because the host data are not complete, no statement can be made about the hosts or possible distribution.

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LIST OF ABBREVIATIONS[1]

A.A.R.	Aedeagal apodemal rod.
AE. A.	Aedeagal apodeme.
A.I.T.	Armature of inner tube of aedeagus.
A.L.	Apical lobe of distal arm of ninth sternum, male.
A.L.L.	Accessory lateral lobe of aedeagus.
AP. A.	Apical appendage of aedeagal apodeme.
B.C.	Bursa copulatrix.
B.I.T.	Band of inner tube of aedeagus.
BU.	Bulga of spermatheca (head or body).
CR.	Crochet of aedeagus.
C.S.	Crescent sclerite of aedeagus.
D.A.L.	Dorsal anal lobe.
D.B.	Ductus bursae.
D.I.R.	Dorsal intramural rod of endophallus (aedeagus).
D.S.	Dorsal sclerite of apodemal strut (aedeagus).
E.I.T.	Membranous or semimembranous extension of inner tube of aedeagus.
F.	Movable finger (or process) of clasper.
FL. S.	Flanking sclerite of aedeagus (probably the same as the accessory lateral lobe).
HI.	Hilla of spermatheca (tail).
L.L.	Lateral lobe of aedeagus.
L.S.	Lateral sclerite of apodemal strut (aedeagus).
L.S.I.	Lateral sclerotization of inner tube of aedeagus.
M.D.L.	Median dorsal lobe of aedeagus.
M.L.	Median lobe of distal arm of ninth sternum, male.
M.S.	Submedian mesal lobe of apodemal strut (aedeagus).
P.	Immovable process of clasper.
PEG	Peg of crochet (aedeagus).
P.R.	Penis rods of aedeagus.
P.S.	Proximal spur of aedeagal apodeme.
S.I.T.	Sclerotized inner tube of aedeagus.
SP.	Spermatheca.
V.A.L.	Ventral anal lobe.
V.I.R.	Ventral intramural rod of endophallus (aedeagus).
7S.	Seventh sternum, female.

[1] The terminology of the aedeagus proposed by Traub (1950) is used in this bulletin.

INDEX TO SPECIES

(Synonyms are in italic; boldface numbers indicate main references and italic numbers refer to keys.)