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# ENTOMOLOGICA AMERICANA

A JOURNAL OF ENTOMOLOGY.

Volume XXI (New Series)  
1941



PUBLICATION COMMITTEE

J. R. DE LA TORRE-BUENO, Editor

CARL G. SIEPMANN

G. P. ENGELHARDT

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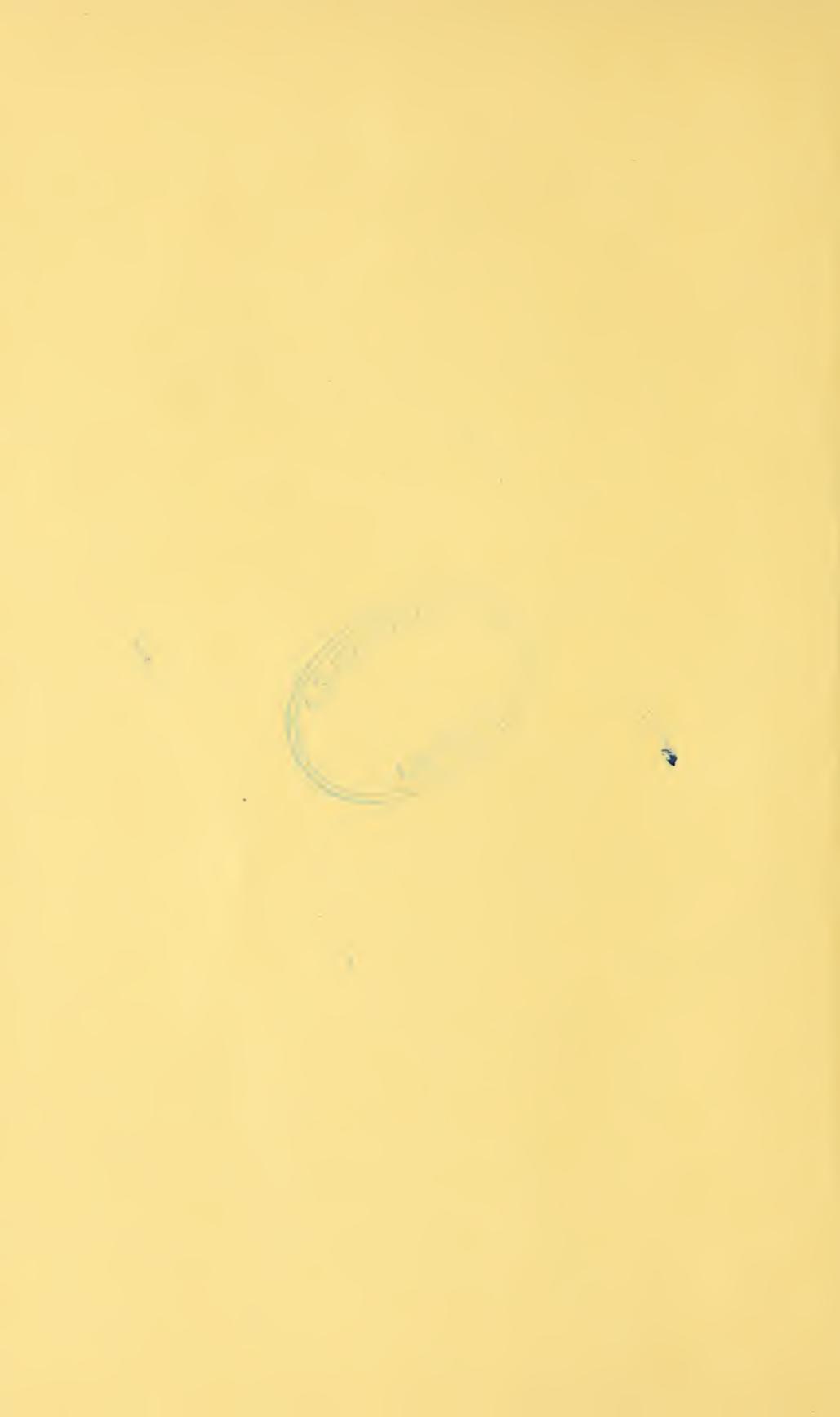
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# ENTOMOLOGICA AMERICANA

VOL. XXI

JANUARY, 1941

No. 1

I

## THE GENUS *DIOTRIA* MEIGEN IN NORTH AMERICA (DIPTERA-ASILIDAE)

BY J. WILCOX

DIVISION OF TRUCK CROP AND GARDEN INSECT INVESTIGATIONS, BUREAU OF  
ENTOMOLOGY AND PLANT QUARANTINE, UNITED STATES DEPARTMENT  
OF AGRICULTURE

AND

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OHIO STATE EXPERIMENT STATION<sup>1</sup>

In this study of the genus *Diotria* Meigen in North America, several species and subspecies are described as new, a division of

<sup>1</sup> We are indebted to R. H. Beamer, University of Kansas, the late E. P. Van Duzee, California Academy of Sciences, F. R. Cole, Redlands, Calif., C. H. Curran, American Museum of Natural History, Nathan Banks, Museum of Comparative Zoology, G. Stuart Walley, Canadian National Collection, C. L. Fluke, University of Wisconsin, H. A. Scullen, Oregon State College, Hugh B. Leech, Vernon, British Columbia, S. W. Bromley, Stamford, Conn., F. S. Blanton, Babylon, L. I., N. Y., A. Earl Pritchard, University of Minnesota, S. E. Crumb and Wm. W. Baker, Puyallup, Wash., Randall Latta, Washington, D. C., M. T. James, Colorado State College, G. P. Engelhardt, Hartsdale, N. Y., L. L. Pechuman, Ithaca, N. Y., and G. Steyskal, Ann Arbor, Mich., either for assistance or for the loan of specimens.

the genus into subgenera is proposed, and keys to the subgenera, species, and subspecies are given. Osten Sacken<sup>2</sup> is apparently the only writer who has previously commented on the variation of the American species from the typical species of the genus. He refers to *D. albius* Walker and *D. resplendens* Loew as rather aberrant forms, and says: "A third species, *D. pusio* n. sp., from California, is remarkably small, but nearer to the normal type of the genus than the other two." The genus *Dioctria* Meigen and the new subgenera proposed by the writers can be separated by the characters given in the following key.

KEY TO THE SUBGENERA OF DIOCTRIA

1. Hind tibiae slender, elongate, apical part enlarged; hind metatarsi enlarged, elongate, or both, longer than joints 2-4 together; scutellum more or less convex with short recumbent discal and marginal pile; anterior branch of third vein reaching margin at or below apex of wings; wings elongate, narrow, axillary cell and alulae greatly reduced in size ..... 2  
 Hind tibiae normal, in some species slightly narrowed on basal half; hind metatarsi normal, subequal in length to joints 2-3 together; scutellum more or less flattened, bare, or disc bare and with long erect marginal hairs; anterior branch of third vein reaching anterior margin before apex of wing; wings normal or very broad, axillary cell and alulae well developed ..... 3
2. First antennal joint longer than second, third of uniform width, and style about equal in diameter to third joint; face concave, oral margin and antennal base more or less prominent.

*Dioctria* Meigen

First and second antennal joints subequal in length, third narrow basally and quite broad at middle, style minute; face in profile slightly convex, oral margin and antennal base not at all prominent ..... **Neodioctria**, new subgenus

3. Scutellum bare of pile; hind femora and tibiae and usually middle and anterior ones with numerous small setigerous tubercles below ..... **Eudioctria**, new subgenus  
 Scutellum with quite numerous, long, erect, marginal hairs; femora and tibiae without setigerous tubercles.

**Metadioctria**, new subgenus

In addition to the foregoing characters, there is considerable variation in the male genitalia. In *Eudioctria* the genitalia are of

<sup>2</sup> Western Diptera: 287, 1877.

especial value in differentiating the species. However, as the hypopygium is apparently rotated in copulation, the form of the various parts must be known before they can be used for this purpose. The *epandrium* (normally the dorsal plate) is always divided into two apical lobes which may be short or long, wide or narrow, or flattened or cylindrical, and in certain species may be emarginate apically or bear an inner apical tooth and an outer tuft of hairs; the *cerci* usually project up between the lobes. On either side below the epandrium are the *surstyli*, which are usually broad basally and narrow into finger-like projections apically. Ventrally between the bases of the *surstyli* is the *hypandrium*, an undivided plate which is usually longer than broad but varies considerably in size and shape in the various species.

In *Dioctria* and *Neodioctria* the epandrium is not definitely lobed, but in some species there are slender, lateral, apical projections. *Metadioctria* has the epandrium similar, but the parts are larger and more plainly seen.

#### *Dioctria* Meigen

*Dioctria* Meigen, Illig. Mag., II : 270, 1803.

*Dioctria* Meigen, Syst. Besch., II : 180, 1820.

*Dioctria* Macquart, Hist. Nat. Dipt. I : 289, 1834

*Dioctria* Schiner, Fauna Austr. I : 119, 1862.

*Dioctria* Coquillett, Canad. Ent. XXV : 80, 1893.

*Dioctria* Back, Trans. Amer. Ent. Soc. XXXV : 250-251, 1909.

*Dioctria* Melander, Psyche XXX : 212-216, 1923.

The principal characters of the genus are given in the key. These characters will suffice for the American forms. However, in one species from Tunis the first antennal joint is not longer than the second, and in some of the Palearctic species the anterior branch of the third vein reaches the margin before the apex of the wing; the characters of the face, scutellum, and hind legs hold for all the material at hand.

Genotype: *Asilus oelandicus* Linnaeus.<sup>3</sup>

The American species that belong here are poorly known, as each of the six indigenous species was described from a single specimen. The seventh species, *D. baumhaueri* Meigen, an introduced species from Europe, was first discovered in this country by the late Charles

<sup>3</sup> Coquillett, D. W. The Type-Species of the North American Genera of Diptera. No. 1719, Proc. U. S. Nat. Mus. XXXVII : 533, 1910.

W. Johnson in Boston in 1916, and in recent years has been taken in large numbers on Long Island by F. S. Blanton and in Connecticut by S. W. Bromley.

Fourteen Palearctic species have been seen and in addition considerable material is at hand from New Mexico, Colorado, Arizona, California, and Washington. It seems unwise to describe all the forms on hand that appear to be new, until the status of the described species is better known, as there is undoubtedly considerable variation in the extent of the black, yellow, and brown areas on the legs and abdomen.

KEY TO THE SPECIES OF DIOCTRIA

1. The pollinose band extending from the fore coxae to the base of the wings broadly interrupted at the suture between the propleura and mesopleura ..... 2  
 The above pollinose band entire ..... 4
2. Third and following abdominal segments reddish; posterior crossvein longer than discal crossvein; first antennal joint slender, nearly twice as long as second joint; length 4.5–6 mm. (Calif., Oreg., Wash., Idaho, Colo.).....*pusio* Osten Sacken  
 Abdomen largely black or third and following segments in part black and yellow ..... 3
3. Abdomen largely black, at most the sides and posterior corners of segments somewhat reddish; discal crossvein longer than posterior crossvein; first antennal joint rather stout and about one and one-half times as long as second; length 6 mm. (Wash.) .....*henshawi* Johnson  
 Abdominal segments 3–4 with anterior and posterior margins, and remaining segments with posterior margins narrowly, yellowish; length 5.5 mm. (Oreg., Wash.) ..... *vertebrata* Cole
4. Coxae black; legs largely black; mesonotum densely golden pollinose and pilose except narrow central stripes and intermediate spots, black; abdomen black; length 12–14 mm. (Mass., N. Y., Conn., Mich.) ..... *baumhaueri* Meigen  
 Coxae yellowish; legs largely yellowish; smaller species ..... 5
5. Humeri reddish yellow; style of antennae small, less than one-sixth length of third joint; abdomen black, the second and following segments in part yellowish; length 8 mm. (Fla.)  
*seminole* Bromley  
 Humeri black; style of antennae at least one-fourth length of third joint ..... 6
6. All femora above black; abdomen largely black; length 7 mm. (Calif.) ..... *vera* Back

Legs largely yellowish; abdomen in large part yellowish; length 8 mm. (Calif.) ..... *pleuralis* Banks

*Dioctria baumhaueri* Meigen

*Dioctria baumhaueri* Johnson, Psyche XXV : 102, 1918.

*Dioctria baumhaueri* Melander, Psyche XXX : 213, 1923.

Johnson described this European species from specimens collected in Boston, Mass., June 28, 1916, and Rawson Road, Aspinwall Hill, Brookline, Mass., July 6, 1917, and July 4, 1918. American specimens have been seen from the following localities:

CONN.: Stamford, VI-7 to 13 '35 (S. W. Bromley). MASS.: Brookline VII-4, '18 (C. W. Johnson); W. Roxboro?, VII-9 '30 (L. R. Taylor). N. Y.: Babylon, L. I., VI-5 to 21 '33 and VI-9 '34 (F. S. Blanton); Farmingdale, L. I., VII-1 '33 (Blanton); Flushing, L. I., V-30 '31 (K. W. Cooper); Lockport, VI-13 to VII-3 '34 (L. L. Pechuman); Nepperhan, VI- '32 (Bromley). MICH.: Oakland County, VI-30 '35 (G. Steyskal).

*Dioctria henshawi* Johnson

*Dioctria flavipes* Banks, Psyche XXIV : 119, 1917.

*Dioctria henshawi* Johnson, Psyche XXV : 103, 1918 (new name for *flavipes* Banks, not Meigen).

*Dioctria henshawi* Melander, Psyche XXX : 214, 1923.

Described from a single female specimen taken at Yakima, Washington, July 2, 1882 (Samuel Henshaw). Specimens are on hand with the following data:

WASH.: Tieton, VII-4 '33 (S. E. Crumb, Itol J. and J. Wilcox).

*Dioctria pleuralis* Banks

*Dioctria pleuralis* Banks, Psyche XXIV : 118-119, 1917.

*Dioctria pleuralis* Melander, Psyche XXX : 214, 1923.

Described from a single female specimen from Los Angeles, California (Clarke coll.). We have quite a large series of specimens from California, Nevada, and Arizona which might be placed here but because of the variations in the color of the abdomen and legs we cannot determine for sure that they belong here.

*Dioctria pusio* Osten Sacken

*Dioctria pusio* Osten Sacken, West. Dipt. : 288, 1877.

*Dioctria pusio* Williston, Trans. Amer. Ent. Soc. XIII : 288, 1886.

*Dioctria pusio* Back, Trans. Amer. Ent. Soc. XXXV : 254, 1909.

*Dioctria pusio* Melander, Psyche XXX: 214, 1923.

Described from a single female specimen with the following data: Sonoma County, California, July 4. Williston described a male specimen from Colorado. Specimens on hand from the following localities:

CALIF.: Lake City, Modoc County, VIII-1 '22 (C. L. Fox); Lucerne, VII-7 '35 (R. H. Beamer); Monrovia Canyon, VII-19 '31 (C. H. Martin); Oroville, V-30 '28 (H. H. Keifer); Sequoia National Park, VI-2 '29 (A. T. McClay); Sequoia National Park, Potwisha, 2,000-5,000 feet, V-26 '29 (E. C. Van Dyke). COLO.: Manitou, VI-19 and 23 '28 (Van Dyke). IDAHO: Bliss, VII-7 '31 (R. H. Beamer). OREG.: Antelope Mt., Grant County, 5,500 feet, VIII-12 '32 (D. K. Frewing); Grants Pass, V-4 '25 (G. R. McGinnis), and VII-12 '35 (Beamer). WASH.: Signal Peak, Ranger Station, VII-20 '34 (Wm. W. Baker).

*Dioctria seminole* Bromley

*Dioctria seminole* Bromley, Occas. Pap. Bost. Soc. Nat. Hist. V: 125-126, 1924.

Described from a single female specimen with the following data: Tallahassee, Florida, May 2, 1915 (C. S. Spooner), in the Cornell University collection.

*Dioctria vera* Back

*Dioctria vera* Back, Trans. Amer. Ent. Soc. XXXV: 256-257, 1909.

*Dioctria vera* Melander, Psyche XXX: 213, 1923.

Described from a single female specimen with the following data: Monterey County, California, July 2, 1892 (W. M. Wheeler), in the American Museum of Natural History.

*Dioctria vertebrata* Cole

*Dioctria vertebrata* Cole, Proc. Calif. Acad. Sci. IX (4th series): 230, Pl. 16, fig. 12, 1919.

*Dioctria vertebrata* Melander, Psyche XXX: 214, 1923.

*Dioctria vertebrata* Cole, Pan-Pac. Ent. I: 9, 1924.

Described from a single female specimen with the following data: Parkdale, Oregon, July 12, 1917 (Cole). In 1924 Cole says this may prove to be a variety of *pusio* Coquillett? (Osten Sacken) as he has both forms from California but no males of *vertebrata*. A specimen we place here is at hand from the following locality:

WASH.: Rainier National Forest, Sawmill Flat, VII-20 '34 (Wm. W. Baker).

**Neodioctria**, new subgenus

Similar to *Dioctria* Meigen, differing mainly by the characters given in the key.

Genotype: *Dioctria* (*Neodioctria*) *albicornis*, new species.

The only species included here is described below.

**Dioctria** (**Neodioctria**) **albicornis**, n. sp.

*Male*: Length 8 mm. Face and front densely silvery white pollinose; vertex, ocellar tubercle, upper occiput, palpi, and proboscis shining black; lower occiput and along eye margins above gray pollinose. Hairs and bristles white, 6 long ones and 2 shorter ones on oral margin forming the mystax. First two antennal joints and basal one-third of third joint yellowish white, remainder brownish black; first two joints subequal in length, the joints about  $1\frac{1}{2}$  times as long as broad, fine sparse white haired; third joint broadest at middle, gradually tapering apically, basal one-third quite strongly narrowed; style cylindrical, truncate apically, about one-seventh length of third joint, with a short apical black bristle.

Mesonotum and scutellum shining black, humeri, lateral margins, postalar calli, and narrow posterior margin yellowish. Short sparse hairs yellowish; bristles yellow, 1 presutural and 1 postalar. Pleura yellowish, mesosternum and metasternum black below, mesopleura brownish below; coxae, propleura, mesosternum anteriorly and a spot on posterior corner above, mesopleura above and narrowly posteriorly, hypopleura, and metanotum grayish white pollinose; band of pollen extending from base of wings to fore coxae interrupted below on mesopleura; sparse hairs white.

Abdomen brown, sides and narrow posterior margins yellowish; sparse hairs white, longer on sides of first two segments. Genitalia brown, hairs white; a rather long, sparse posterior fringe on epandrium.

Legs yellowish, hind legs largely brownish and outer joints of fore and middle tarsi brownish. Hairs and bristles white; claws brown.

Squamae and halteres yellowish white, the former with short white hairs. Wings hyaline, veins brown; anterior crossvein at one-third distance from base to apex of discal cell; posterior crossvein nearly twice as long as discal crossvein; anterior branch of third vein reaching margin at apex of wing.

*Female*: Length 8 mm. Similar. Hind femora only brownish near middle and hind tibiae only brownish below.

*Holotype*: Male, Giant Forest, Calif., VII-28 '29 (R. H. Beamer); in the Snow Collection, University of Kansas.

*Allotype*: Female, same data; in the Snow Collection, University of Kansas.

*Paratypes*: 2 specimens, same data, in the writers' collections; and 1 female, Round Cioni ?, Calif. ?, Sept. 1, in the California Academy of Sciences. The latter specimen has the middle legs as well as the hind legs largely brownish.

**Eudioctria**, new subgenus

The entirely bare, flattened scutellum and the presence of numerous setigerous tubercles below on the hind femora and tibiae separate this group from the others.

Genotype: *Dioctria albius* Walker.

The species in this subgenus tend to be dimorphic in the male sex. This group is represented by several species in the Eastern States and a number of other species in the Pacific Coast States, but so far no species are known from the Middle Western States.

KEY TO THE SPECIES OF EUDIOCTRIA

1. Eastern species ..... 2  
 Western species ..... 10
2. Third antennal joint  $1\frac{1}{2}$  times as long as first two joints together, style subequal in length to second joint; mesopleura entirely and mesonotum largely bare of pollen (*banksi* Johnson) ..... 3  
 Third antennal joint at most  $1\frac{1}{4}$  times as long as first two joints together, style shorter than second joint; mesopleura above and mesonotum more extensively pollinose ..... 4
3. Legs wholly black; length 7-9 mm. (Va., Md.) ..... *banksi* Johnson  
 All tibiae reddish on basal half; length 7-9 mm. (Va., Md.)  
*banksi tibialis* Banks
4. Legs entirely black ..... 5  
 At least tibiae in part yellowish or brownish ..... 9
5. Humeri entirely shining black, mesonotum largely shining black; third antennal joint  $1\frac{1}{4}$  times as long as first two joints together; face of males coppery, of females yellow; length 8-10 mm. (N. Y., N. J., N. C., Pa., Tenn.)  
*brevis* Banks  
 Humeri largely pollinose, mesonotum largely or entirely pollinose; third antennal joint subequal in length to first two joints together ..... 6

6. Mesonotum entirely pollinose; posterior margin of mesopleura pollinose; length 9 mm. (Que.) ..... *propinqua* Bromley ?  
 Mesonotum with a shining black spot on either side; mesopleura below bare of pollen (*albius* Walker) ..... 7
7. Females: Face golden pollinose ..... *albius* Walker  
 Males ..... 8
8. Face white pollinose (N. Y., Ont., Wis., Que.) ..... *albius* Walker  
 Face golden pollinose (Wis., Ont.).  
*albius aurifacies*, new form
9. Mesonotum with a spot on either side bare of pollen and posterior margin of the mesopleura below bare of pollen; fore femora below and tibiae largely yellowish; wings yellowish on basal two-fifths; length 8 mm. (Wis.).  
*albius xanthopennis*, new form  
 Mesonotum wholly pollinose, posterior margin of mesopleura below pollinose; female femora wholly black, basal half of tibiae pale brownish; male fore femora below and tibiae largely yellowish; male wings yellowish on basal two-fifths; length 9–11 mm. (Mass., N. S., N. Y., Que.).  
*propinqua* Bromley ?
10. Legs entirely black ..... 11  
 At least the tibiae in part reddish or yellowish ..... 15
11. Wings yellowish on basal half, blackish on apical half; length 4 mm. (Calif.) ..... *parvula* Coquillett  
 Wings not markedly yellowish basally ..... 12
12. Large species; mesonotum entirely pollinose with rather long and quite numerous orange hairs and bristles; posterior margin of mesopleura pollinose; lobes of epandrium cylindrical, the vertical diameter greater than the horizontal; length 14–16 mm. (Calif.) ..... *beameri*, n. sp.  
 Smaller species, less than 10 mm. in length; mesonotum with sparse hairs and bristles ..... 13
13. Mesonotum entirely pollinose; hairs of front and vertex and bristles of mesonotum black ..... 14  
 Humeri and sides of mesonotum largely shining black; hairs of front and vertex and bristles of mesonotum golden; lobes of epandrium narrow, tapering and curved inward toward each other apically; hypandrium shorter than epandrium; length 6–7 mm. (Calif.) ..... *monrovia*, n. sp.
14. Humeri almost wholly pollinose, posterior margin of mesopleura below bare of pollen; lobes of epandrium of uniform width, truncate apically, flattened; hypandrium as long as

epandrium, rather broad; length 7-9 mm. (Calif., Oreg., Wash.) ..... *media* Banks

Humeri largely shining black, narrow posterior margin of mesopleura below pollinose; lobes of epandrium slender, cylindrical, with an outer apical pencil of hairs and a short, blunt, black tooth on inner side apically; hypandrium much shorter than epandrium; length 7-8 mm. (Idaho, Wash., Oreg., Calif., B. C., Mont.).

*sackeni rivalis* Melander

15. Smaller species, 8 mm. or less in length; lobes of epandrium slender, cylindrical, with an apical inner black tooth and a tuft of black hairs (*sackeni* Will.) ..... 16

Larger species, 11 mm. or more in length; lobes of epandrium broad, flattened, without tooth or tuft of hairs apically ... 17

16. Male fore and middle femora and sometimes hind femora below yellowish; female femora sometimes yellowish below at tips but usually entirely black; face of both sexes golden; length 7-8 mm. (Wash., Oreg., Calif., B. C., Idaho, Mont.).

*sackeni* Williston

Femora entirely black; face of males silvery.

*sackeni rivalis* Melander

17. Posterior margin of mesopleura pollinose; face of males usually silvery, of females golden; hairs of antennae, front, ocellar tubercle, and upper occiput in both sexes golden; lobes of epandrium deeply emarginate on inner side apically, the epandrium broad basally; length 13-16 mm. (Calif.).

*doanei* Melander

Posterior margin of the mesopleura below bare of pollen; face of both sexes brassy; hairs mentioned above black; lobes of epandrium truncate apically and epandrium narrowed basally; length 11-13 mm. (*nitida* Will.) ..... 18

18. Femora entirely black; mesonotum entirely pollinose (Wash., Oreg., Calif., B. C.) ♂ ♀ ..... *nitida* Williston

Male fore femora below yellowish; mesonotum with a denuded spot on either side (Calif.) ..... *nitida denuda*, new form

*Dioctria (Eudioctria) albius* Walker

*Dioctria albius* Walker, List II: 301, 1849.

*Dioctria albius* Osten Sacken, West. Dipt.: 287, 1877.

*Dioctria albius* Williston, Trans. Amer. Ent. Soc. XI: 8, 1884.

*Dioctria albius* Back, Trans. Amer. Ent. Soc. XXXV: 251-253, 1909.

*Dioctria albius* Banks, Psyche XXIV : 117, 1917.

*Dioctria albius* Melander, Psyche XXX : 212, 1923.

Osten Sacken records specimens from Catskill Mts., N. Y., White Mts., N. H., and from the Palisades, N. J., and similar specimens from San Rafael, Marin County, Calif., May 29, Sonoma County, Calif., July 4, and Vancouver Island (G. R. Crotch). Williston records specimens from Washington Territory and Connecticut which were apparently the same. Back gives the following additional distribution: Amherst, Mass., June 13 and July 28; Conn.; N. J., July 19, 20, 24, 29, 30 (E. Daecke); Montgomery County, Pa., May 30 (C. W. Johnson); Potomac Cr., Va., May 22 and Dixie Landing, Va., June 1; N. C., Ga., Fla.

Just how many of the above records can apply to *albius* is not known, as Banks in 1917 described two eastern species and a species from California all of which formerly had been called *albius*. Our material has been divided into several forms which are indicated below.

*Dioctria (Eudioctria) albius albius* Walker

*Male*: Length 9–11 mm. Face white pollinose; mystax and hairs of head and mesonotum largely black; mesonotum with an elongate spot on either side crossing the suture denuded of pollen; posterior margin of mesopleura below bare of pollen; legs entirely black; wings brown, anal angle somewhat lighter.

*Females*: Length 9–10 mm. Similar except that the face is light golden pollinose and the anal angle is the same color as the remainder of the wings.

Specimens on hand from the following localities:

N. J.: Alpine, VI–19 '18 (J. Bequaert). N. Y.: Ringwood, Tompkins County, VII–25 '28 (H. A. Scullen). ONTARIO: Guelph, VI–22 '13 and VII–26 '15 (C. H. Curran); Jordan, VI–13 '20 (Curran). PA.: Montgomery County, VI–4 '92 (C. W. Johnson). QUEBEC: Montfort, VII–11 '16. WIS.: Madison, VI–26 '29 (C. L. Fluke).

*Dioctria (Eudioctria) albius aurifacies*, new form

*Male*: Length 8 mm. Similar to the typical form except that the face is golden pollinose and the anal angle is not noticeably lighter than the remainder of the wings.

*Holotype*: Male, Madison, Wis., VI–26 '29 (C. L. Fluke), in the writers' collection.

*Paratypes*: Male, same data, VI–17 '31, in the writers' collection

and male, Guelph, Ontario, VI-27 '13 (C. H. Curran), in the Canadian National Collection.

*Dioctria (Eudioctria) albius xanthopennis*, new form

*Male*: Length 10 mm. Differs from the typical form in having the face golden pollinose; the mystax and hairs of the head and mesonotum largely golden; the fore femora below and the tibiae except their tips yellowish; and the basal two-fifths of the wings and the veins in this portion yellowish.

*Holotype*: Male, Forest County, Wis., VI-17 '31, in the writers' collection.

*Dioctria (Eudioctria) banksi* Johnson

*Dioctria longicornis* Banks, Psyche XXIV : 118, 1917.

*Dioctria banksi* Johnson, Psyche XXV : 103, 1918 (new name for *longicornis* Banks, not Meigen).

*Dioctria banksi* Melander, Psyche XXX : 212, 1923.

Described from specimens from Chain Bridge, Glencarlyn, and Dead Run, Virginia. Johnson records additional specimens from Long Branch, N. J., June 9, 1913, and Philadelphia, Pa., June 22, 1893. Specimens on hand from the following locality:

Md.: Cabin John, VI-29 (F. R. Cole).

*Dioctria (Eudioctria) banksi tibialis* Banks

*Dioctria longicornis tibialis* Banks, Psyche XXIV : 118, 1917.

*Dioctria banksi tibialis* Melander, Psyche XXX : 212, 1923.

Described from two male specimens taken at Chain Bridge, Virginia. Specimens on hand from the following locality:

Md.: Cabin John, VI-29 (F. R. Cole).

*Dioctria (Eudioctria) brevis* Banks

*Dioctria brevis* Banks, Psyche XXIV : 118, 1917.

*Dioctria brevis* Johnson, Psyche XXV : 103, 1918.

*Dioctria brevis* Melander, Psyche XXX : 213, 1923.

Described from specimens taken in the following localities: Sea Cliff, N. Y.; Medina, Ohio; Englewood, N. J.; and north fork Swannanoa River, Black Mountains, N. C. Johnson records specimens from the following localities: Mt. Tom, Mass., July 14, 1905; Delaware Gap, N. J., July 11, 1895; and Aquia Creek, Va., May 24, 1896. Specimens are on hand from the following localities:

Mass.: Forest Hills (J. Bequaert). N. J.: Englewood (Osten Sacken). N. Y.: Babylon, L. I., VII-1 '34 (F. S. Blanton); Dix

Hills, L. I., VI-11 '33 and VI-10 '34 (Blanton and Borders); Hollis, L. I., VI-17 '17; Wildwood Park, L. I., VI-11 '33 (Blanton). PA.: Greensburg, VI-26 '34 (D. H. Cross); Hummelstown, VII-6 (J. N. Knull). TENN.: Unaka Mts., VI-19 and 23 '29 (C. L. Fluke).

*Dioctria (Eudioctria) propinqua* Bromley

*Dioctria propinqua* Bromley, Occas. Pap. Bost. Soc. Nat. Hist. V: 125, 1924.

Described from a single female specimen with the following data: Dorchester, Mass., June, in the Boston Society of Natural History. A pair of specimens that we doubtfully place here are at hand from the following locality:

NOVA SCOTIA: Barrington Passage (C. H. Young), in the Canadian National Collection.

The male is very similar to *D. albius xanthopennis* except that the mesonotum is entirely pollinose and the posterior margin of the mesopleura below is pollinose. The mystax and hairs of the head and mesonotum of the male are largely golden, and of the female largely black. About the basal half of the fore and middle tibiae of the female is brownish, and the female femora are wholly black.

Three female specimens on hand agree well with the above specimen except that the legs are wholly black. They were taken at Montfort, Quebec, VII-12 and 14 '16, and Upper Ausable Lake, Essex County, N. Y., VII-30 '20 (J. Bequaert). A male specimen which agrees well with the characters for these females was taken at White Mts., N. H., Valleys (Osten Sacken). It will be necessary to have more material before this species can be separated from *albius* satisfactorily.

*Dioctria (Eudioctria) beameri*, n. sp.

*Male*: Length 14 mm. Palpi, proboscis, cheeks, and ocellar tubercle black, remainder of head densely golden pollinose. Mystax black, bristles of oral margin yellowish; remainder of hairs of head yellow. Antennae black, first two joints subequal in length and yellow haired, each not quite twice as long as broad; third joint  $1\frac{1}{4}$  times length of first two joints together, narrowed on basal third; style about one-fifth length of joint, concave and shorter behind, bearing a short blackish bristle in the convexity.

Thorax shining black, mesonotum uniformly thinly golden pollinose, central and dorsocentral stripes appearing darker. A narrow central row, dorsocentral rows, and broad sides in-

cluding humeri and postalar calli and posteriorly yellow haired, somewhat longer posteriorly. Scutellum shining black, flattened, without pile or pollen. Pleura and coxae shining black, broad sides of coxae yellowish white pollinose and pilose; propleura entirely, mesosterna with a large spot above, upper half and narrow posterior margin of mesopleura, hypopleura, and posterior half of metasterna golden pollinose; hairs yellowish.

Abdomen shining black with metallic blue, purple, and green reflections; short, sparse, yellow pilose, longer on sides of first three segments. Genitalia black, basal portion of epandrium polished and bare of hairs, lobes cylindrical, vertical diameter slightly greater than horizontal, short blackish and brownish pilose; surstyli broad basally, tapering apically, brownish pilose; hypandrium broader basally, slightly emarginate apically, and with an apical fringe of quite long fulvous hairs.

Legs black; hairs and bristles entirely golden except that the hind tibiae and tarsi have short, recumbent, black hairs; femora on sides and below and tibiae below with numerous small setigerous tubercles; claws black, narrowly brownish basally; empodium brownish; pulvilli light brownish black.

Halteres dull yellowish, brown basally. Wings uniformly brown, darker in costal and axillary cells, and along anterior margin of first basal cell; veins black, anterior crossvein slightly before middle of discal cell.

*Female*: Length 14 mm. Similar. Halteres brownish.

*Holotype*: Male, Giant Forest, Calif., VII-28 '29 (R. H. Beamer), in the Snow Collection, University of Kansas.

*Allotype*: Female, same data, in the Snow Collection, University of Kansas.

*Paratypes*: 5 males and 10 females, same data (Beamer, P. W. Oman, L. D. Anderson), in the Snow and the writers' collections; 1 male, Giant Forest, Sequoia National Park, Calif., VII-21 to 26 '07 6,000-7,000 feet (J. C. Bradley), 3 males, Potwisha, Sequoia National Park, Calif., 3,000-5,000 feet, V-8 to 24 '29 (E. C. Van Dyke), 1 male, Hot Springs, Tulare County, Calif., VI-29 '25 (E. R. Leach), and 1 female, Green Horn Mts., Tulare County, Calif., V-7 '31 (E. C. Van Dyke), in the California Academy of Sciences.

*Dioctria (Eudioctria) doanei* Melander

*Dioctria doanei* Melander, Psyche XXX: 214, 1923.

*Dioctria doanei* Cole, Pan-Pac. Ent. I: 9, 1924.

Described from two male specimens taken at Pasadena, Califor-

nia, June 6, 1895 (R. W. Doane). Cole records a male swept from *Ceanothus*, near the Summit of Mt. Wilson, California, July 6, 1916 (Harold Morrison). The female is described below.

*Female*: Length 14 mm. Similar to the male except that the face is golden pollinose and the anal cell and anal angle of the wings are brown, not lighter as in the male.

Described from a specimen with the following data: Monrovia Canyon, Calif., VII-6 '30 (C. H. and D. Martin), in Martin's collection. Additional specimens on hand from the same locality, V-3 to 31 '31 and VII-4 '30 (C. H. and D. Martin).

A few of the males appear to have the face golden instead of white pollinose.

*Dioctria (Eudioctria) media* Banks

*Dioctria media* Banks, Psyche XXIV : 118, 1917.

*Dioctria media* Johnson, Psyche XXV : 103, 1918.

*Dioctria media* Melander, Psyche XXX : 213, 1923.

Described from five specimens taken in the following localities: Sonoma County, Calif., July 4 (Osten Sacken); San Raphael, Calif. (Osten Sacken), and California (H. Edwards). Johnson reports a specimen from Seattle, Washington (O. B. Johnson). Specimens on hand from the following localities:

CALIF.: Grass Valley, 12 mi. So., V-18 '30 (E. P. Van Duzee); Lafayette, VII-14 '33 (R. H. Beamer); Mill Valley, Marin County, V-24 and VI-25 (C. L. Fox and Van Duzee); Oroville, IV-17 and V-26 '28 (H. H. Keifer); Pentz, Butte County, V-22 '28 (Keifer); Siskiyou National Forest, VII-14 '35 (Beamer); Weott, Humboldt County, VII-13 '19 (E. C. Van Dyke). OREG.: Brookings, VII-8 '25 (H. A. Scullen and G. R. McGinnis); Corvallis, VII-8 '26 (Wilcox); Kiger's Island, VI-11 '25 (Wilcox).

*Dioctria (Eudioctria) monrovia*, new species

*Male*: Length 7 mm. Head densely golden pollinose, the palpi, proboscis, and occiput except along the eyes shining black. Hairs and bristles golden except about the upper half of the mystax, black. First two antennal joints subequal in length, thinly golden pollinose and golden haired; third joint and style dull black, third joint  $1\frac{1}{3}$  times length of first two joints together, style about one-fourth length of third joint.

Mesonotum shining black, inner third of humeri and a triangular area behind humeri densely golden pollinose, remainder except lateral spots thinly covered with golden pollen. Scu-

tellum flattened, shining black, bare of pile or pollen. Pleura shining black with golden pollinose spots and pile, coxae in part grayish yellow pollinose and pilose.

Abdomen shining black and short, sparse, golden haired, hairs on sides of first segment longer. Genitalia shining black and quite long golden brown haired; lobes of epandrium short, tapering apically and curved toward each other apically; hypandrium about half as long as epandrium.

Legs shining black, hairs and bristles golden, those on hind tarsi brown; claws black; pulvilli brown. Hind femora very strongly swollen and all femora and tibiae bearing ventral setigerous tubercles.

Halteres dull yellowish, base and lower stem brown. Wings brown, anal angle white; veins brown, anterior crossvein at one-third distance from base to apex of discal cell.

*Female*: Length 7 mm. Similar. Mystax black except for one golden bristle and anal angle brown like remainder of wings.

*Holotype*: Male, Monrovia Canyon, Calif., VII-20 '30 (C. H. and D. Martin), in Martin's collection.

*Allotype*: Female, same data, VII-12 '30, in Martin's collection.

*Paratypes*: 1 male and 1 female, same data, VII-6 '30; 1 male, and 1 female, San Onofre, Calif., V-12 '27 (A. C. Davis), in the California Academy of Sciences; 1 male, Laguna Mts., Calif., VII-6 '29 (R. H. Beamer), and 1 male and 1 female, San Jacinto Mts., Calif., VI-30 '33 (Beamer), in the Snow Collection, University of Kansas; and 1 male and 2 females, Los Angeles County, Calif., June (Coquillett), in U. S. National Museum.

### *Dioctria (Eudioctria) nitida* Williston

*Dioctria nitida* Williston, Trans. Amer. Ent. Soc. XI: 8, 1884.

*Dioctria nitida* Back, Trans. Amer. Ent. Soc. XXXV: 253, 1909.

*Dioctria nitida* Melander, Psyche XXX: 213, 1923.

Described from specimens of both sexes from Washington Territory. Back gives the following localities: Seattle, Washington, May 1; California (Hy. Edwards); and San Gabriel, Los Angeles County, California, June. Specimens on hand from the following localities:

BRITISH COLUMBIA: Steelhead, VII-24 and VIII-1 '33 (Hugh B. Leech); Victoria, VI- '19 (P. N. V.). CALIF.: Meadow Valley, Plumas County, 5,000-6,000 feet, VI-20 '24 (E. C. Van Dyke); Orick, Humboldt County, VII-4 '31 (Van Dyke); Shasta County, VI-26 '21 (J. A. Kusche). OREG.: Alsea, V-23 '31 (H. A. Scullen);

Alsea Grade, Benton County, VI-12 '25 (Van Dyke); Corvallis, IV-25 '28 (H. Richmond), and IV-28 '18; Hood River, VI-2 '17 (F. R. Cole); Rock Creek, VI-16 '13 (A. L. Lovett); Triangle Lake, V-24 '25 (Scullen); Waldport, VI-5 '25 (Van Dyke). WASH.: Cle Elum, VII-3 '33 (G. P. Engelhardt); Olympia, V-28 '32 and VI-10 '33 (C. H. and D. Martin); Puyallup, V-12 and VI-1 '32 (Wm. W. Baker); Sumner, VI-18 '28; Toppenish, VII-8 '35 (R. H. Beamer).

A new form is described below.

***Dioctria (Eudioctria) nitida denuda*, new form**

*Male*: Length 11 mm. Differs from the typical form in having the fore femora below yellowish, a spot on either side of the mesonotum crossing the suture bare of pollen, and the hairs of the front and mesonotum shorter.

*Female*: Length 10 mm. Similar except that the femora all black.

*Holotype*: Male, Yosemite, Calif., VI-11 '21 (E. C. Van Dyke), in the California Academy of Sciences.

*Allotype*: Female, same data, VI-21 '21, in the California Academy of Sciences.

*Paratypes*: Female, same data, VI-25 '21; 3 females, Meadow Valley, Plumas County, Calif., 3,500-4,000 feet, VI-11 to 15 '24 (Van Dyke), male, Yosemite Valley, Calif., VII-11 '25 (E. H. Nast), and 1 male, near Mather, Tuolumne County, Calif., VII-13 '29 (E. C. Zimmerman), in the California Academy of Sciences.

*Dioctria (Eudioctria) parvula* Coquillett

*Dioctria parvula* Coquillett, Canad. Ent. XXV: 80, 1893.

*Dioctria parvula* Back, Trans. Amer. Ent. Soc. XXXV: 253-254, 1909.

*Dioctria parvula* Melander, Psyche XXX: 212, 1923.

Described from two male specimens taken in Los Angeles County, California (D. W. Coquillett). A hasty examination of the types indicate that this may be the same as *resplendens* Lw. but it will be necessary to study the types of both species before this can be established.

*Dioctria (Eudioctria) sackeni* Williston

*Dioctria sackeni* Williston, Trans. Amer. Ent. Soc. XI: 8, 1884.

*Dioctria sackeni* Back, Trans. Amer. Ent. Soc. XXXV: 255-256, 1909.

*Dioctria sackeni* Banks, Psyche XXIV : 119, 1917.

*Dioctria sackeni* Melander, Psyche XXX : 213, 215, 1923.

Described from three male specimens taken in Washington Territory. Back records a typical specimen from North Mt., Pa., June 9 (C. W. Johnson) and thinks *sackeni* will prove to be a male variety of *albius*; and other specimens from Mt. Hood, Oreg., and White Mts., N. H. (Osten Sacken and Geo. Dimmock). Banks says the specimen from the White Mts., N. H., reported by Osten Sacken is a male and has genitalia similar to those of *albius*. Melander records taking typical males at Priest Lake, Idaho, and Nelson, British Columbia. Specimens are on hand from the following localities:

BRITISH COLUMBIA: Buccaneer Bay, III-16 '16 (R. C. Treherne); Departure Bay, B. C. Biol. Sta., VII-24 '09; Eberts, VI-19 '14 (R. H. Crystal); Goldstream, VI-28 '23 (W. Downes); Kaslo, VIII-11 '12 (R. C. Osburn); Steelhead, VIII-7 '33 (Hugh B. Leech); Victoria, VI-20 and 25 '23, VII-25 '26 (Downes and K. F. Auden); Wellington, VI-3 and 28 '08. CALIF.: Meadow Valley, Plumas County, 4,000-5,000 feet, VII-8 '24 (E. C. Van Dyke). IDAHO: Coolin, Priest Lake, VII-24 '27 (Van Dyke); Long Valley, Alpha, VII-8 '34 (Martin); Moscow (C. V. Piper); Moscow Mts., 3,000 feet, VII-27 '25 (C. L. Fox). OREG.: Dodge Park, VI-18 '30 (R. Latta); Dodson, VII-8 '23 (C. D. Duncan). WASH.: Forks, Clallam County, VII-4 '30 (E. P. Van Duzee); Mineral, VII-14 '35 (Wm. W. Baker); Mt. Rainier, Ohanapeosh, VII-14 '35 (Baker); Olympia, VII-9 to 20 '32 (Martin and Wilcox); Puyallup, VI-19 and VII-30 '33, and VII-19 and 30 '32 (Baker and Wilcox); Rainier National Forest, Lodgepole Camp, VIII-16 '32 (S. E. Crumb); Spanaway, VI-29 to VII-3 '33, VI-10 '34 and VII-15 '30 (Baker and Wilcox); Sumner, VI-2 '33 (Martin); Vashon Island, VII-25 '33 (Baker); Yelm, VII-6 and 15 '32 (Martin and Wilcox).

*Dioctria (Eudioctria) sackeni rivalis* Melander

*Dioctria sackeni rivalis* Melander, Psyche XXX : 215-216, 1923.

*Dioctria sackeni rivalis* Cole, Pan-Pac. Ent. I : 9, 1924.

Described from specimens from the following localities: Priest Lake, Idaho, Aug., 1920; Coeur d'Alene, Moscow Mt., Avon, Idaho; Big Fork, Mont.; Friday Harbor, Quilcene, Wash.; Nelson, B. C. (Melander); Stuart Island, Wash. (H. S. Davis); Wolf Fork of Touchet River, Wash. (V. Argo). Cole records specimens from Dodson, Oregon, July 8, 1923 (C. D. Duncan). Specimens on hand from the following localities:

BRITISH COLUMBIA: Kaslo, VIII-11 '12 (R. C. Osburn); Nanaimo, Biol. Station, VI-17 '30 (E. P. Van Duzee). CALIF.: Shasta County, VII-6 '21 (J. A. Kusche). WASH.: Mt. Rainier, VIII-12 '27 (L. A. Stephenson); Olympia, VI-25 to VII-20 '32 (Martin and Wilcox); Puyallup, VII-30 '32 (Wilcox); Sumner, VI-15 '33 (R. Latta); Yelm, VII-15 '33 (Martin).

### Metadioctria, new subgenus

The rather long, erect marginal hairs on the scutellum separate this group from the others. Additional characters are given in the key to the subgenera.

Genotype: *Dioctria rubida* Coquillett.

#### KEY TO THE SPECIES OF METADIOCTRIA

1. First antennal joint longer than second; third vein branched before or opposite discal crossvein ..... 2  
 First two antennal joints subequal in length; third vein branched beyond discal crossvein; entirely black in ground color, mystax and thoracic and abdominal hairs fulvous; length 5 mm. (Calif.) ..... *resplendens* Loew
2. Mystax and mesonotal, scutellar, and abdominal hairs fulvous; femora entirely and tibiae in part yellowish; length 7 mm. (Calif.) ..... *rubida* Coquillett  
 Hairs mentioned above black ..... 3
3. Legs entirely black; length 7 mm. (Calif.).  
*rubida atripes*, new form  
 Femora entirely and tibiae in part yellowish; length 7 mm. (Calif.) ..... *rubida nigripilosa*, new form

*Dioctria (Metadioctria) rubida* Coquillett

*Dioctria rubidas* Coquillett, Canad. Ent. XXV: 80, 1893.

*Dioctria rubida* Baek, Trans. Amer. Ent. Soc. XXXV: 255, 1909.

*Dioctria rubida* Melander, Psyche XXX: 213, 1923.

Described from three male specimens taken in Los Angeles County, California (D. W. Coquillett). Specimens of both sexes on hand from the following localities:

CALIF.: Idyllwild, VIII-3 '35 (Jack Beamer); Mill Creek Canyon, VII-20 '20 and VII-4 '22 (F. R. Cole); Monrovia Canyon, VIII-2 '31 (Martin).

*Dioctria (Metadioctria) rubida nigripilosa*, new form

*Male*: Length 7 mm. Face and occiput along eye margins

yellowish gray pollinose, otherwise the head shining black. Hairs black, the beard and those below on the proboscis whitish. Antennae black, first two joints black haired, first joint  $1\frac{1}{2}$  times length of second, second broader than first; third joint of nearly uniform width and  $1\frac{1}{4}$  times length of first two joints together; style one-fifth length of third joint, concave behind above.

Mesonotum shining black, inner third of humeri yellowish gray pollinose. Numerous short erect hairs black; bristles black, 1-2 presutural, 3 supra-alar, 2-3 postalar, and 4-5 dorso-central. Scutellum shining black, flattened, bare, with 8-10 rather long, erect, black, marginal hairs. Pleura and coxae shining black, sides of coxae, pro-, meso-, and metasterna, and mesopleura above yellowish pollinose; hairs yellowish.

Abdomen shining black and black haired; posterior corners of second segment, anterior and posterior margins of segments 3-4, posterior margin of segment 5, segment 6 largely, and remainder of abdomen and genitalia yellowish red; genitalia black haired, hypandrium acute apically.

Femora and about basal fourth of fore and middle and narrow base of hind tibiae yellowish red, remainder black; bristles, claws, and empodium black; pulvilli brown. Hairs black, those below on femora, the short pile anteriorly on fore tibiae, and hairs below on hind tibiae fulvous.

Halteres reddish brown, the base brown. Wings brown, lighter apically and posteriorly; axillary cell and alulae whitish. Veins dark brown; anterior crossvein at two-fifths distance from base to apex of discal cell; third vein branched before discal crossvein; posterior crossvein somewhat longer than discal crossvein.

*Holotype*: Male, Idyllwild, Calif., VI-29 '28 (E. C. Van Dyke), in the California Academy of Sciences.

*Paratypes*: Male, same data, and male, Tahquitz Canyon, Riverside County, Calif., VI-22 '28 (Van Dyke), in the California Academy of Sciences; and 2 males, Idyllwild, Calif., VIII-3 '35 (Jack Beamer), in the Snow Collection, University of Kansas.

### ***Dioctria (Metadioctria) rubida atripes*, new form**

*Male*: Length 7 mm. Differs from *rubida nigripilosa* in that the legs are entirely black. The second abdominal segment is also entirely black, but this character is probably variable.

*Holotype*: Male, Monrovia Canyon, Calif., VIII-3 '30 (C. H. Martin), in Martin's collection.

*Paratypes*: 6 males, same locality, VII-19 and 20 '30 (C. H. and D. Martin).

*Dioctria (Metadioctria) resplendens* Loew

*Dioctria resplendens* Loew, Cent. X : 21, 1872.

*Dioctria resplendens* Osten Sacken, West. Dipt. : 288, 1872.

*Dioctria resplendens* Back, Trans. Amer. Ent. Soc. XXXV : 255, 1909.

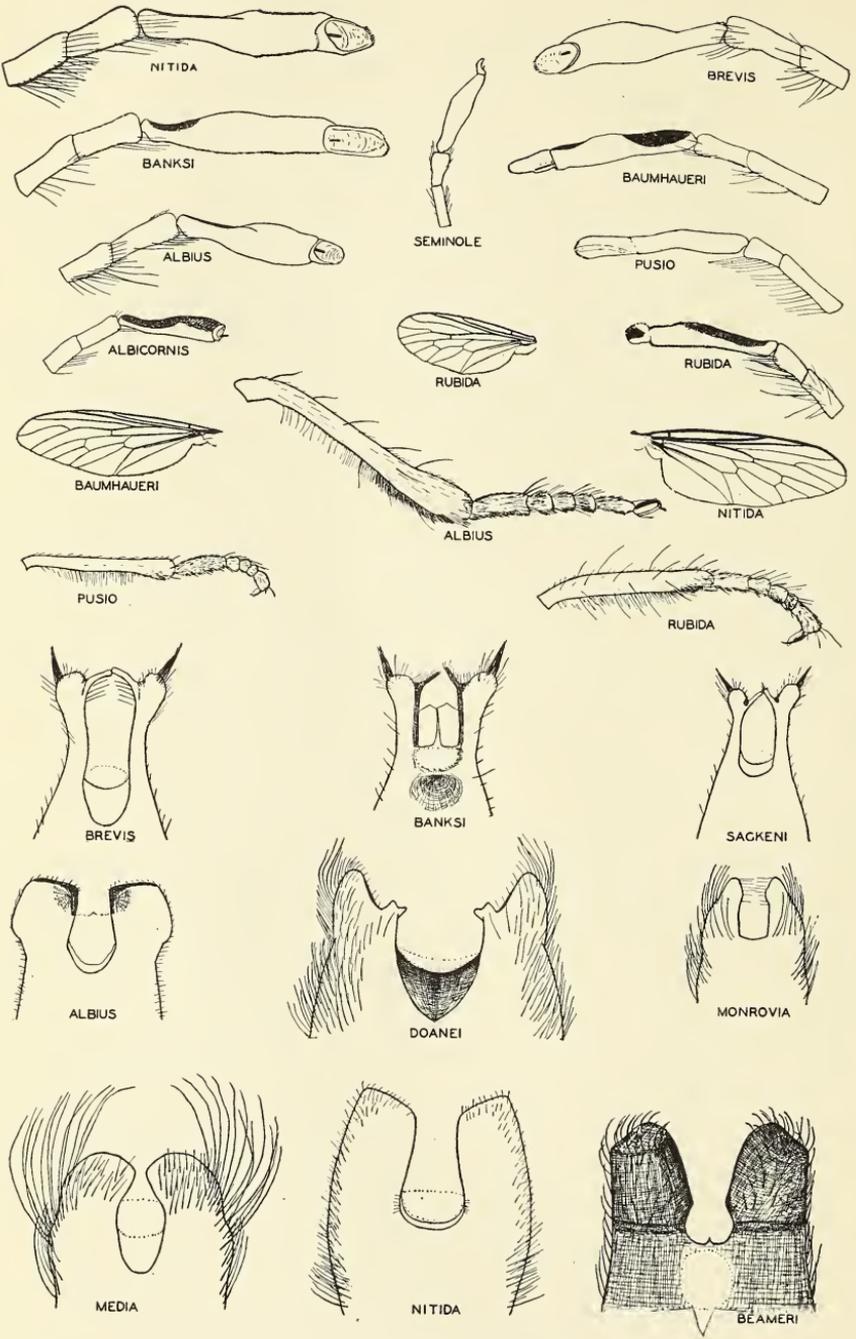
*Dioctria resplendens* Melander, Psyche XXX : 212, 1923.

Described from a single male specimen with the following data : California (Hy. Edwards). Osten Sacken mentions seeing a specimen in Mr. Burgess's collection in Boston. Back records another specimen from California (C. A. Stearns), in the U. S. National Museum. We have not definitely identified this species but Mr. Nathan Banks has kindly examined the type and indicated its proper place in the key. Specimens that we doubtfully place here are listed below ; they have short, sparse, recumbent discal hairs on the scutellum in addition to the erect marginal hairs.

CALIF. : Mint Canyon, VII-6 '33 (R. H. Beamer) ; Ukiah, III-31 '31 on grass (C. C. Wilson).

#### EXPLANATION OF PLATE I

Diagrammatic sketches of characters of taxonomic value of the asilid genus *Dioctria*. The dotted circles indicate the position of the bases of the cerci. The antennae and male genitalia of all species, except the antenna of *D. seminole*, are drawn to a scale of 12 $\times$ , the legs 7 $\times$ , and the wings about 3 $\times$ .



## II

# THE AMERICAN BEES OF THE SUBGENUS HALICTUS

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This paper is a review of the species of *Halictus* belonging to the typical subgenus *Halictus* which occur in the Americas. Thirty-four names of species or varieties have been proposed, of which 2 are homonyms, 2 names were proposed to replace these homonyms, 22 are synonyms, and 8 are here recognized as separate species. One new species is described, bringing the total number of species to 9. The collection in the United States National Museum has served as a basis for this study, but it was supplemented by loans from other institutions as well as private collections.

To Mr. P. H. Timberlake, of the Citrus Experiment Station at Riverside, Calif., I am indebted for the comparison of specimens with the types which are deposited there and for the privilege of including in this paper a species of which he had a description in manuscript.

As in my other papers, the terminology of structures is essentially as found in Snodgrass' *Anatomy and physiology of the honey-bee* (1925) and *Principles of insect morphology* (1935). The names for the parts of the male genitalia were kindly furnished by Mr. Snodgrass,<sup>2</sup> who has in press a comprehensive paper on the genitalia of the Hymenoptera. The structures are very similar to those found in *Agapostemon* and *Augochlora*; and while it seems unnecessary to describe all of them, some explanation of the parts of the male genitalia may be pertinent, especially since the terminology differs in some respects from that customarily used for those genera.

*Male genitalia.*—The basal part of the genitalia consists of a *basal ring* to which are attached the bases of the lateral parts, or *parameres*. The basal ring is ovate with the ventral portion much narrower than the dorsal portion. The base of each paramere is a hollow, subcylindrical structure which is slightly compressed; on

<sup>1</sup> Died November 9, 1940.

<sup>2</sup> Since this paper was sent to press "The Male Genitalia of Hymenoptera," by R. E. Snodgrass, has been published as Smithsonian Institution Miscellaneous Collections, Vol. 99, No. 14.

the basal part of the mesal surface is a concavity into which extend the base of the *volsella* and a basal process of the *sagitta* of the *aedeagus*; just laterad of the insertion of the volsella in the wall of the paramere is a longitudinal ridge, at the apex of which there is usually a projection which is described under each species; the bases of the parameres are attached dorsally and ventrally, the ventral junction being much shorter than the dorsal one; the apex of the paramere is greatly modified and will be described under each species, as it furnishes the best characters for the separation of species. The aedeagus, or middle organ, with the heavily sclerotized pair of sagittae, lies between the parameres and dorsad of the volsellae and is rather constant in form; the apical half of the sagitta is declinate, and at the base of this portion there is a ventral digitiform projection. The volsella is a subrectangular, flat structure with the lateral portion inserted into the opening of the paramere; the basal angles are somewhat rounded, and the apical margin is provided with a notch, the sides of which are thickened and papillose; mesad of this notch the apical margin projects considerably beyond that of the lateral portion.

As considered here, the subgenus *Halictus* contains those species of the genus *Halictus*, both black and metallic greenish, which have apical fasciae of hair on the abdominal tergites and corresponds to the genus *Halictus* as treated by Robertson in his *Synopsis of Halictinae* (Can. Ent., vol. 34, pp. 244 and 245, 1902). Later (Ent. News, vol. 29, p. 91, 1918), Robertson erected *Seladonia* for the greenish species and *Odontalictus* for *H. ligatus* Say.

KEY TO THE AMERICAN SPECIES OF HALICTUS

1. Black, entirely without metallic tints. Sixth abdominal sternite of male without a median furrow or depression ..... 2  
 Green, blue-green, or black with metallic tints of dark greenish blue which are strongest on the face and dorsum of thorax. Sixth abdominal sternite of male with a median furrow or depression ..... 5
2. Vertex behind ocelli rather strongly convex, ocellocipital line subequal to ocellocular line. Basal portions of wings yellowish infumate, apices infumate. Sides of mesoscutum contiguously punctured. (Head, dorsum of thorax, and abdominal tergites with interspaces between punctures strongly aciculate. Transverse carina of seventh tergite of male truncate medially.) ..... *parallelus* Say  
 Vertex behind ocelli weakly convex or flat, ocellocipital line

- about two-thirds as long as ocellocular line, or female with a tooth at inferior-posterior angle of temple. Basal portions of wings not yellowish, apices not so deeply infumate. Sides of mesoscutum with shiny interspaces between punctures ..... 3
3. Dorsal surface of propodeum dull and granular, length in the middle nearly twice that of metanotum. Male: Ventral surface of seventh tergite subtriangular, half as long as wide; flagellum uniformly dark. Female: Platelet at base of hind tibia with apex rounded; inner calcar with posterior edge serrate ..... *farinosus* F. Smith
- Dorsal surface of propodeum shiny between irregular rugae, length in the middle subequal to that of metanotum. Male: Ventral surface of seventh tergite about one-fourth as long as wide; flagellum fulvotestaceous beneath. Female: Platelet at base of hind tibia with apex pointed; inner calcar with posterior edge dentate ..... 4
4. Female: Head wider than thorax, inferior-posterior angle of temple projecting down as a toothlike process, or at least sharply angulate; clypeus nearly flat. Male: Transverse carina of seventh tergite projecting at the middle; tergites 1 to 5 each with an apical fascia of white hair; apical margins of fourth and fifth sternites truncate, no band of erect hair on fourth; first flagellar joint two-thirds as long as second ..... *ligatus* Say
- Female: Head not wider than thorax, temple rounded posteriorly, clypeus rather strongly convex. Male: Transverse carina of seventh tergite emarginate at the middle; tergites 1 to 4 each with an apical fascia of white hair; apical margin of fourth sternite concave and with a submarginal band of suberect hair, fifth deeply emarginate at the middle; first flagellar joint half as long as second..... *rubicundus* (Christ)
5. Black, tinged with a very dark greenish blue which is most conspicuous on the face and thoracic dorsum. Dorsal surface of propodeum with irregularly anastomosing rugae. Abdominal tergites indistinctly punctured. Male: Supra-orbital line extending just below anterior ocellus. .... *virgatellus* Cockerell
- Brassy or bluish green. Dorsal surface of propodeum with the rugae on the lateral portions principally longitudinal. Abdominal tergites with fine but distinct punctures (except *harmonius*, which has the tergites brown). Male: Supra-orbital line coinciding with postocellar line ..... 6

6. Dorsal surface of propodeum with rugae on middle portion principally transverse. Male: Apices of abdominal tergites not constricted; apical margin of fourth sternite truncate, not bordered by a band of suberect hair; sixth sternite with a median furrow. Female: Posterior portion of hypostomal carina higher than the anterior portion (in some specimens forming a subtriangular projection). (Southern Mexico and Central America.) ..... *agilis* F. Smith
- Dorsal surface of propodeum with rugae on middle portion more irregular and principally longitudinal. Male: Apices of abdominal tergites constricted, especially at the sides; apical margin of fourth sternite slightly concave and bordered by a band of suberect hair; sixth sternite with a median pit in basal half. Female: Hypostomal carina uniform. (North America, North of Mexico.) ..... 7
7. Dorsal surface of propodeum with posterior margin truncate medially. Thorax rather coarsely punctate, the punctures separated by about a puncture's width. Olive or brassy green. Male: Apical margin of fifth sternite emarginate in the middle ..... *provancheri* Dalla Torre
- Dorsal surface of propodeum suberescens. Thorax rather finely punctate, the punctures usually separated by twice a puncture's width. Bluish green. Male: Apical margin of fifth sternite truncate (in *tripartitus*; male of *harmonius* unknown) ..... 8
8. Female: Clypeus and supraclypeal area rather sparsely but distinctly punctured; labrum with a median furrow; flagellum relatively slender, joints 4 to 9 as long as wide. Mandible rufopiceous, with a band of rufotestaceous about half way between base and apex. Length 5 to 8 mm., usually 7 mm.  
*tripartitus* Cockerell
- Female: Clypeus and supraclypeal area practically impunctate; labrum without a median furrow; flagellum stouter, joints 4 to 9 at least one and one-half times as wide as long. Mandible rufotestaceous with apex rufopiceous. Length 4 mm.  
*harmonius*, n. sp.

1. *Halictus (Halictus) ligatus* Say

Plate II, Figure 15

*Halictus ligatus* Say, Boston Journ. Nat. Hist., vol. 1, p. 396, 1837; female, male.—Le Conte, The complete writings of Thomas Say on the entomology of North America, vol. 2,

p. 774, 1859.—Cockerell, Trans. Amer. Ent. Soc., vol. 25, p. 185, 1898.—Michener, Pan-Pacific Ent., vol. 12, p. 169, 1936.

*Odontalictus ligatus* Robertson, Ent. News, vol. 29, p. 91, 1918.

*Halictus poeyi* Lepeletier, Histoire naturelle des insectes. Hyménoptères, vol. 2, p. 271, 1841; male. (New synonymy.)

*Halictus capitosus* F. Smith, Catalogue of hymenopterous insects in the collection of the British Museum, pt. 1, p. 67, 1853; female.—Cockerell, Trans. Amer. Ent. Soc., vol. 31, p. 351, 1905. (New synonymy.)

*Halictus armaticeps* Cresson, Trans. Amer. Ent. Soc., vol. 4, p. 250, 1872; female.—Hicks, Univ. Colorado Studies, p. 222, 1926.

*Halictus texanus* Cresson, Trans. Amer. Ent. Soc., vol. 4, p. 251, 1872; female, male.

*Halictus ornatipes* Cresson, Trans. Amer. Ent. Soc., vol. 4, p. 252, 1872; male. (New synonymy.)

*Halictus townsendi* Cockerell, Ann. Mag. Nat. Hist., ser. 6, vol. 18, p. 293, 1896; female. (New synonymy.)

The female of *ligatus* is readily distinguished by its wide head, with the clypeus and the supraclypeal area flat and wide, as well as by the toothlike projection at the inferior-posterior angle of the temple. The male may be separated from those of all the other black species by the more sparsely punctured mesoscutum and scutellum, the longer hair on the second and third abdominal sternites, the nearly truncate posterior margin of the sixth sternite, and the very short ventral portion of the seventh tergite; from *parallelus*, by the shorter vertex and dorsal surface of the propodeum; and from both *farinosus* and *rubicundus* by the paler flagellum. In *ligatus* the submarginal band of erect hair on the fourth sternite and the median emargination of the fifth, which characterize *rubicundus*, are lacking.

*Male genitalia*.—Paramere without a ventral process; apex of basal portion (in lateral view) obliquely truncate; apical process (in lateral view) narrowest at base and progressively wider to tip, apex somewhat Y-shaped, with two arms, of which the ventral one is the larger, between these arms a subcircular membranous flap which extends considerably beyond the ends of the arms and has the mesal surface densely pubescent. Volsella with basal margin more strongly rounded than in *parallelus*; mesal projection of apical margin more nearly triangular. Ventral digitiform projection of sagitta of aedeagus much shorter than in *parallelus*.

*Types*.—Of *ligatus*, lost; of *armaticeps* and *ornatipes*, in the Academy of Natural Sciences, Philadelphia; of *capitosus*, in the British Museum; of *texanus*, not located; of *poeyi*, “Musée de M. Serville”; of *townsendi*, in the U. S. National Museum.

*Type localities*.—Of *ligatus*, United States; of *armaticeps*, Texas; of *capitosus*, St. John’s Bluff, Fla.; of *texanus*, Texas; of *poeyi*, Cuba; of *ornatipes*, Texas; of *townsendi*, San Rafael, Vera Cruz, Mexico.

*Distribution*.—Widely distributed in North America south of 50 degrees latitude and extending through Central America to Colombia, South America, and to Cuba and Jamaica, West Indies. I have seen specimens from the following: Canada (Ontario); United States (Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Ohio, Indiana, Michigan, Illinois, Wisconsin, Minnesota, Iowa, Missouri, Louisiana, Oklahoma, Texas, Kansas, Nebraska, South Dakota, Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Idaho, California, Oregon, and Washington); Mexico (Baja California, Durango, Jalisco, Nuevo Leon, Vera Cruz, and Oaxaca); Honduras (Tegucigalpa); Guatemala; Panamá (Canal Zone); Colombia (Vista Nueva and Agua Dulce, San Lorenzo Mountains); Cuba and Jamaica.

*Remarks*.—This species exhibits considerable diversity in size. The inferior-posterior angle of the temple of the female usually has a toothlike projection but in some specimens is merely angulate.

## 2. *Halictus (Halictus) rubicundus* (Christ)

Plate II, Figure 6

*Apis rubicunda* Christ, Naturgeschichte, Klassifikation und Nomenclature der Insecten vom Bienen, Wespen und Ameisengeschlecht. . . . Hymenoptera, p. 190, pl. 16, fig. 10, 1791; female.

*Halictus rubicundus* Stephens, A systematic catalogue of British insects, p. 388, No. 5249, 1829.—Kirby, Fauna Boreali-Americana, vol. 4, p. 267, 1837; female.—Blüthgen, Deutsch. Ent. Zeitschr., p. 390, 1925.—Atwood, Canad. Journ. Res., vol. 9, p. 451, 1933, vol. 10, p. 216, figs. 3 and 17, 1934.

*Halictus lerouxi* Lepeletier, Histoire naturelle des insectes. Hyménoptères, vol. 2, p. 272, 1841; female.—Robertson,

Trans. Amer. Ent. Soc., vol. 20, p. 146, 1893.—Hicks, Univ. Colo. Studies, p. 222, 1926.—Brittain, Canad. Dept. Agr. Bull., No. 162 (n. ser.), p. 94, 1933.

*Halictus (Halictus) lerouxii* Lovell, Psyche, vol. 15, p. 34, 1908.

*Halictus (Agapostemon) lerouxi* Viereck, Ann. Rept. N. J. State Mus., p. 688 (1909), 1910.

*Halictus parallelus* Say of F. Smith, Catalogue of hymenopterous insects in the collection of the British Museum, pt. 1, p. 72, 1853.

*Halictus lerouxi* var. *ruborum* Cockerell, Canad. Ent., vol. 30, p. 52, 1898; female.—Canad. Ent., vol. 69, p. 88, 1937; female. (New synonymy.)

*Halictus lupinelli* Cockerell, Pan-Pacific Ent., vol. 12, p. 158, 1936; female. (New synonymy.)

*Halictus leurouxi lupinelli* Michener, Pan-Pacific Ent., vol. 12, p. 170, 1936.—Cockerell, Canad. Ent., vol. 69, p. 88, 1937.

Kirby was the first to report the species *rubicundus* from Boreal America. Smith commented upon the similarity of *rubicundus* and *lerouxi* but separated them on trivial differences. Blüthgen, however, was the first definitely to establish their synonymy. Cockerell (1937) suggested that his *lerouxi* variety *ruborum* might be the same as *rubicundus* and that *lerouxi* and *lupinelli* might be subspecies, but in this study of a large series of specimens no limits for the separation of subspecies were found.

The female of *rubicundus* resembles most closely that of *farinosus*, from which it is distinguished by the narrower apical fasciae on the abdominal tergites, the more coarsely rugose dorsal area of the propodeum, the more uniformly punctured mesoscutum, and the more sharply pointed apex of the platelet at the base of the hind tibia. The male is readily distinguished by the submarginal band of suberect hair on the fourth sternite, the deep median emargination of the fifth sternite, and the median notch in the transverse fold of the seventh tergite.

*Male genitalia*.—Paramere with ventral process short and subtriangular; basal portion (in lateral view) with apical margin subtruncate, apical-dorsal portion of outer surface striate; apical process (in lateral view) rectangular but constricted at base, dorsal margin undulating, mesal surface with a dorsal, subrescentic, membranous flap which is densely pubescent, with pubescence denser at base, and ventrad of which extend several large, curved, spatulate bristles. Volsella and ventral projection of sagitta very similar to those of *parallelus* but apex of projection of volsella truncate.

*Type*.—Of *rubicundus*, not located; of *lerouxi*, “Musée de M. Serville”; of *ruborum*, in Cockerell’s collections; of *lupinelli*, in the California Academy of Sciences.

*Type localities*.—Of *rubicundus*, Europe; of *lerouxi*, “Amérique septentrionale”; of *ruborum*, Seattle, Wash.; of *lupinelli*, Garberville, Calif.

*Distribution*.—Holarctic, in North America occurring in Canada, Newfoundland, and the United States (except the lower part of the Mississippi Valley). I have seen specimens from Newfoundland; Canada (Nova Scotia, New Brunswick, Quebec, Ontario, Alberta, British Columbia, and the Mackenzie District); and the United States (Maine, New Hampshire, Massachusetts, Connecticut, New York, Pennsylvania, New Jersey, Delaware, Maryland, Virginia, North Carolina, Georgia, Florida, Tennessee, Ohio, Indiana, Michigan, Wisconsin, Illinois, Minnesota, Iowa, Missouri, Kansas, Nebraska, South Dakota, North Dakota, Montana, Wyoming, Colorado, Arizona, Utah, Idaho, Nevada, California, Oregon, and Washington).

*Remarks*.—This species exhibits some difference in size (but not so much as in *ligatus*) and in the color of the legs, which in some specimens are reddish.

### 3. *Halictus (Halictus) parallelus* Say

Plate II, Figures 1, 2, 3, 4, 5

*Halictus parallelus* Say, Boston Journ. Nat. Hist., vol. 1, p. 397, 1837; female.—Le Conte, The complete writings of Thomas Say on the entomology of North America, vol. 2, p. 775, 1859.—Robertson, Trans. Amer. Ent. Soc., vol. 20, p. 145, 1893.

*Halictus occidentalis* Cresson, Trans. Amer. Ent. Soc., vol. 4, p. 250, 1872; female, male.

In both sexes *parallelus* is readily distinguished by the long and somewhat convex vertex, the strongly aciculate interspaces between the punctures, the long and granular dorsal area of the propodeum, and the yellowish wings with infumate apices. The male agrees with that of *ligatus* in having the flagellum yellowish beneath but differs by the more rounded apical margin of the sixth sternite and the longer ventral portion of the seventh tergite. (The males of *rubicundus* and *farinosus* have the flagellum uniformly dark brown.)

*Male genitalia*.—Paramere with ventral process more nearly digitiform than in *rubicundus*; apical margin of basal portion of

paramere subtruncate and slightly oblique; apical process (in lateral view) not so regularly rectangular as in *rubicundus*; membranous flap extending beyond distal portion of dorsal margin, mesal surface with several coarse, curved, spatulate bristles. Volsella with mesal projection of apical margin rather broad. Ventral digitiform projection of aedeagus rather long (in ventral view), wide, with tip rounded.

*Types*.—Of *parallelus*, lost; of *occidentalis*, in the Academy of Natural Sciences, Philadelphia.

*Type localities*.—Of *parallelus*, Indiana; of *occidentalis*, Texas.

*Distribution*.—In the United States from Pennsylvania south to Georgia and west to New Mexico and Montana. I have seen specimens from Pennsylvania, Maryland, North Carolina, Georgia, Alabama, Tennessee, Ohio, Indiana, Michigan, Illinois, Minnesota, Iowa, Missouri, Texas, Kansas, Nebraska, South Dakota, Montana, Colorado, and New Mexico.

*Remarks*.—This species exhibits practically no variation. Although *parallelus* is rather widely distributed, it is represented in collections by relatively few specimens.

#### 4. *Halictus (Halictus) farinosus* F. Smith

Plate II, Figures 9, 10

*Halictus farinosus* F. Smith, Catalogue of hymenopterous insects in the collection of the British Museum, pt. 1, p. 69, 1853; female.—Cockerell, Trans. Amer. Ent. Soc., vol. 31, p. 350, 1905; female.—Crawford, Canad. Ent., vol. 38, p. 300, 1906.

*Halictus montanus* Crawford, Canad. Ent., vol. 34, p. 234, 1902; female, male.

*Paranomia venablesii* Ashmead, Canad. Ent., vol. 35, p. 243, 1903; female.

*Halictus denticulus* Vachal, Bull. Soc. Scient., Hist. et Arch. Corrèze, vol. 26, p. 469, 1904; female, male.

*Halictus procerus* Vachal, Bull. Soc. Scient., Hist. et Arch. Corrèze, vol. 26, p. 469, 1904; male.

The female of *farinosus* superficially resembles that of *parallelus*, from which it is readily separated by the shorter and less convex vertex, the more widely separated punctures, and the shorter dorsal area of the propodeum. The male has an unusually long ventral portion of the seventh tergite.

*Male genitalia*.—Very similar to those of *parallelus* but differing as follows: Ventral process of paramere considerably wider at

base, membranous flap at apex of paramere narrower with pubescence denser on basal portion, spatulate bristles on mesal surface of apical portion of paramere finer and more abundant; mesal projection of apical margin of volsella longer.

*Types*.—Of *farinosus*, in the British Museum of Natural History; of *montanus* and *venablesii*, in the U. S. National Museum; of *denticulus*, in the Hofmuseum, Vienna; of *procerus*, not given.

*Type localities*.—Of *farinosus*, California; of *montanus*, Almota, Wash.; of *venablesii*, Vernon, British Columbia; of *denticulus*, Nevada; of *procerus*, Spence's Bridge, British Columbia.

*Distribution*.—From New Mexico west to California and north to British Columbia and Montana. I have seen specimens from New Mexico, Colorado, Arizona, Utah, Idaho, Montana, Nevada, California, Oregon, Washington, and British Columbia.

*Remarks*.—This species exhibits practically no variation. It apparently replaces *parallelus* in the Western States.

5. *Halictus (Halictus) agilis* F. Smith

Plate II, Figures 13, 14

*Halictus agilis* F. Smith, Descriptions of new species of Hymenoptera in the collection of the British Museum, p. 37, 1879; male.—Vachal, Bull. Soc. Scient., Hist. et Arch. Corrèze, vol. 26, p. 470, 1904; male, female.—Cockerell, Trans. Amer. Ent. Soc., vol. 31, p. 352, 1905; male.

*Halictus vagans* F. Smith, Descriptions of new species of Hymenoptera in the collection of the British Museum, p. 37, 1879; female. (New synonymy.)

*Halictus errans* Ritsema, Tijdschr. Ent., vol. 23, p. xcvi, 1880. (Proposed for *Halictus vagans* F. Smith 1879, not 1858.) (New synonymy.)

This species is readily separated from the other greenish species by its weakly punctured thorax and abdominal tergites, with the interspaces shining; the transverse rugae on the middle of the dorsal surface of the propodeum; and the weakly constricted apices of the tergites. The female has the posterior portion of the hypostomal carina higher than the anterior portion; in some specimens a subtriangular projection is formed. The male has a median carina on the sixth sternite instead of the median pit found in the other greenish species.

*Male genitalia*.—Paramere without a ventral process; basal portion of paramere similar to that of *parallelus*; apical portion (in lateral view) nearly square, apical-dorsal angle with a slender

process which is more heavily sclerotized than the membranous flap of *farinosus*, on the mesal surface just basad of process a whorl of bristles with a number of coarser bristles at its base (bristles finer than in *farinosus*). Volsella with basal-lateral angles and projection mesad of emargination in apical margin more rounded than in *parallelus*. Digitiform process on ventral surface of aedeagus shorter and slenderer than in the species which precede (except *ligatus*).

*Types*.—Of *agilis* and *vagans*, in the British Museum of Natural History.

*Type localities*.—Of *agilis* and of *vagans*, Oaxaca, Mexico.

*Distribution*.—From southern Mexico south through Central America to Colombia, South America. I have seen specimens from the following: Mexico (Vera Cruz and Oaxaca); Guatemala (Gualan, Zacapa, and Guatemala City); Honduras (Tegucigalpa); Nicaragua (San Antonio and Chinandega); Costa Rica (San Mateo); Panamá (Taboga Island and Canal Zone); and Colombia (Cincinnati).

*Remarks*.—This is the only greenish species of this subgenus known to occur in Central America. There is little variation except in the elevated posterior portion of the hypostomal carina of the female.

## 6. *Halictus (Halictus) provancheri* Dalla Torre

Plate II, Figures 16, 17

*Halictus constrictus* Provancher, Nat. Canad., vol. 13, p. 202, 1882; male.—Petite faune entomologique du Canada et particulièrement de la Province de Quebec, Hyménoptères, p. 702, 1883; male (not female).—Additions et corrections au volume II de la faune entomologique du Canada traitant des Hyménoptères, p. 316, 1888; female.

*Halictus provancheri* Dalla Torre, Catalogus Hyménopteroorum . . . , vol. 10, p. 77, 1896. (Proposed for *Halictus constrictus* Provancher 1882, not F. Smith 1853.)—Crawford, Canad. Ent., vol. 38, p. 303, 1906; female.—Blüthgen, Deutsch. Ent. Zeitschr., p. 390, 1925.—Brittain, Canada Dept. Agr. Bull., No. 162 (n. ser.), p. 94, 1933.—Atwood, Canad. Journ. Res., vol. 9, p. 452, 1933; vol. 10, p. 216, fig. 4, 18, 1934.

*Halictus (Halictus) provancheri* Lovell, Psyche, vol. 15, p. 33, 1908.

*Halictus flavipes* Fabricius of F. Smith, Catalogue of hymenop-

- terous insects in the collection of the British Museum, pt. 1, p. 48, 1853 (in part).
- Halictus coactus* Cresson, Trans. Amer. Ent. Soc., vol. 4, p. 254, 1872; female, in part.
- Halictus fasciatus* Nylander of Robertson, Trans. Amer. Ent. Soc., vol. 22, p. 117, 1895.
- Halictus nearcticus* Vachal, Bull. Soc. Scient., Hist. et Arch. Corrèze, vol. 26, p. 470, 1904; female, male.
- Halictus arapahonum* Cockerell, Ann. Mag. Nat. Hist., ser. 7, vol. 17, p. 316, 1906; female.—Hicks, Canad. Ent., vol. 68, p. 48, 1936. (New synonymy.)
- Halictus (Chloralictus) olivarius* Sandhouse, Proc. U. S. Natl. Mus., vol. 65, No. 2532, p. 10, 1924; female. (New synonymy.)

Both sexes of *provancheri* are readily separated from *tripartitus* and *harmonius* (female) as follows: Head and thorax more coarsely punctured, head longer and narrower, posterior margin of dorsal surface of propodeum truncate medially, brassy or olive rather than bluish green; the male with the flagellum longer and yellowish beneath and the joints more strongly curved, the trochanters yellowish and the apical margin of fifth sternite emarginate medially.

*Male genitalia*.—Paramere with ventral process much larger than in *agilis* and widest at tip; basal portion of paramere rather strongly rounded; apical portion expanded along ventral edge to apex; dorsal edge some distance basad of apical-lateral angle with a slender process which extends only slightly beyond angle; mesal surface with a tuft of rather long hairs, just basad of which are several coarse, curved bristles. Volsella and aedeagus as in *agilis*.

*Types*.—Of *constrictus*, in the Quebec Provincial Museum; of *nearcticus*, in the Paris Museum; of *arapahonum* and *olivarius*, in the U. S. National Museum.

*Type localities*.—Of *constrictus*, Canada; of *nearcticus*, "Amer. septentr. (Castelnau)"; of *arapahonum*, Boulder, Colo.; of *olivarius*, Jumbo Reservoir, Logan County, Colo.

*Distribution*.—In North America from New Brunswick south to North Carolina and west to New Mexico and Washington. I have seen specimens from Canada (New Brunswick, Quebec, Ontario, and Saskatchewan) and the United States (Maine, New Hampshire, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Virginia, North Carolina, Ohio, Indiana, Michigan, Illinois, Wisconsin, Minnesota, Iowa, Missouri, Louisiana, Texas, Kansas, Nebraska, South Dakota, North Dakota, Montana, Wyoming, Colorado, New Mexico, Utah, Oregon, and Washington).

*Remarks.*—This species is more widely distributed than the other greenish species and is the only metallic species occurring east of the Rocky Mountains. Variation in size or color is slight.

7. *Halictus (Halictus) tripartitus* Cockerell

Plate II, Figures 11, 12

*Halictus tripartitus* Cockerell, Ann. Mag. Nat. Hist., ser. 6, vol. 16, p. 63, 1895; female.

*Halictus meliloti* Cockerell, Ann. Mag. Nat. Hist., ser. 6, vol. 16, p. 67, 1895; female.—Pan-Pacific Ent., vol. 11, p. 54, 1935. (New synonymy.)

*Halictus (Seladonia) meliloti* Cockerell, Psyche, vol. 35, p. 234, 1928; female.

*Halictus catalinensis* Cockerell, South. Calif. Acad. Sci., vol. 2, p. 84, 1903; female. (New synonymy.)

*Halictus (Seladonia) catalinensis* Cockerell, Proc. Calif. Acad. Sci., ser. 4, vol. 14, p. 191, 1925; female.

*Halictus (Seladonia) meliloti catalinensis* Cockerell, Pan-Pacific Ent., vol. 13, p. 151, 1937.

The characters in which *tripartitus* differs from *provancheri* are discussed under that species.

*Male genitalia.*—Paramere with ventral process uniformly slender, and slightly curved; apical portion of paramere rather similar to that of *parallelus*, but the apical projection more heavily sclerotized and sparsely pubescent. Volsella and aedeagus as in *agilis*.

*Types.*—Of *tripartitus* and *catalinensis*, in the U. S. National Museum; of *meliloti*, in the collection of the Citrus Experiment Station at Riverside, Calif.

*Type localities.*—Of *tripartitus*, Santa Fe, N. Mex.; of *meliloti*, College Farm, Mesilla Valley, N. Mex.; of *catalinensis*, Avalon, Catalina Island, Calif.

*Distribution.*—In the western part of the United States from Washington and Idaho south to California and Texas. I have seen specimens from Oklahoma, Texas, Colorado, New Mexico, Arizona, Utah, Idaho, Nevada, California, Oregon, and Washington.

*Remarks.*—The females of *tripartitus* exhibit greater variation in size than do the males. Some females have the head somewhat wider, but in a series intergrading forms are found. This species apparently replaces *provancheri* in the western portion of the United States.

8. *Halictus (Halictus) harmonius*, n. sp.

This species resembles rather closely small females of *tripartitus*, from which it differs as follows: Clypeus and supra-clypeal area practically impunctate, basal portion of labrum without a median furrow; flagellum stouter, posterior portion of dorsal surface of propodeum without rugae, platelet at base of hind tibia with apex more sharply pointed.

*Female*.—Length 4 mm. Head and thorax metallic bluish green, labrum and mandible rufotestaceous (tip of mandible rufous), apex of clypeus nearly piceous, flagellum and legs brown, tegula testaceous, abdomen brownish and somewhat iridescent. Wings hyaline and strongly iridescent, veins testaceous. Pubescence white. Punctures on head and thorax fine and well separated, interspaces between punctures shiny. Abdomen indistinctly punctured.

*Type*.—Holotype, U. S. National Museum No. 55161.

Paratypes in the U. S. National Museum and the collection of P. H. Timberlake.

*Type locality*.—Mill Creek, San Bernardino Mountains, Calif.

*Distribution*.—Described from the following female specimens all collected in California by P. H. Timberlake: Holotype and three paratypes from the type locality, taken at an altitude of 4,000 ft., August 21, 1939, on *Erigonum gracile*; two paratypes taken at Idyllwild, San Jacinto Mountains, one, July 14, 1912, and one, July 22, 1933, on *Asclepias eriocarpa*.

*Remarks*.—The name *harmonius* was given this species in manuscript by Mr. Timberlake, who permitted the inclusion of the species in this paper.

9. *Halictus (Halictus) virgatellus* Cockerell

Plate II, Figures 7, 8

*Halictus virgatellus* Cockerell, Psyche, vol. 9, p. 284, 1901; female.

*Halictus sansoni* Crawford, Proc. U. S. Nat. Mus., vol. 41, p. 267, 1911; female. (New synonymy.)

*Halictus fraseræ* Cockerell, Entomologist, vol. 49, p. 100, 1916; female. (New synonymy.)

*Halictus typographicus* Cockerell, Entomologist, vol. 51, p. 261; male. (New synonymy.)

*Halictus (Seladonia) ororyctes* Cockerell, Ann. Ent. Soc. America, vol. 26, p. 40, 1933; female. (New synonymy.)

This is the only American species of the subgenus which has

obscure metallic tints only on the face and thorax. The malar space is longer (especially in the male), and the dorsal surface of the propodeum has irregularly anastomosing rugae. The male has the sixth sternite provided with the median depression which is characteristic of the more strongly metallic species but is readily distinguished by its longer face, blackish abdominal tergites with indistinct punctures, and dark femora as well as spots on the tibiae.

*Male genitalia.*—Paramere with ventral process narrower than in *provancheri*, tip rounded and mesal surface rather densely pubescent; basal portion of paramere similar to that of *parallelus*; apical portion resembling rather closely that of *provancheri* but longer, with the process much longer and its tip expanded. Volsella and aedeagus similar to those of *agilis* and *provancheri*.

*Types.*—Of *virgatellus*, *sansoni*, *fraserae*, and *typographicus*, in the U. S. National Museum; of *ororyctes*, in the collection of the Citrus Experiment Station at Riverside, Calif.

*Type localities.*—Of *virgatellus*, top of Las Vegas Range, N. Mex.; of *sansoni*, Banff, Alberta; of *fraserae*, Tolland, Colo.; of *typographicus*, Pikes Peak, Colo.; of *ororyctes*, Pingree Park, Colo.

*Distribution.*—In western North America from the Mackenzie District south to New Mexico and east to Alberta. I have seen specimens from Canada (Alberta, Mackenzie District, and British Columbia) and the United States (Colorado, Oregon, and New Mexico).

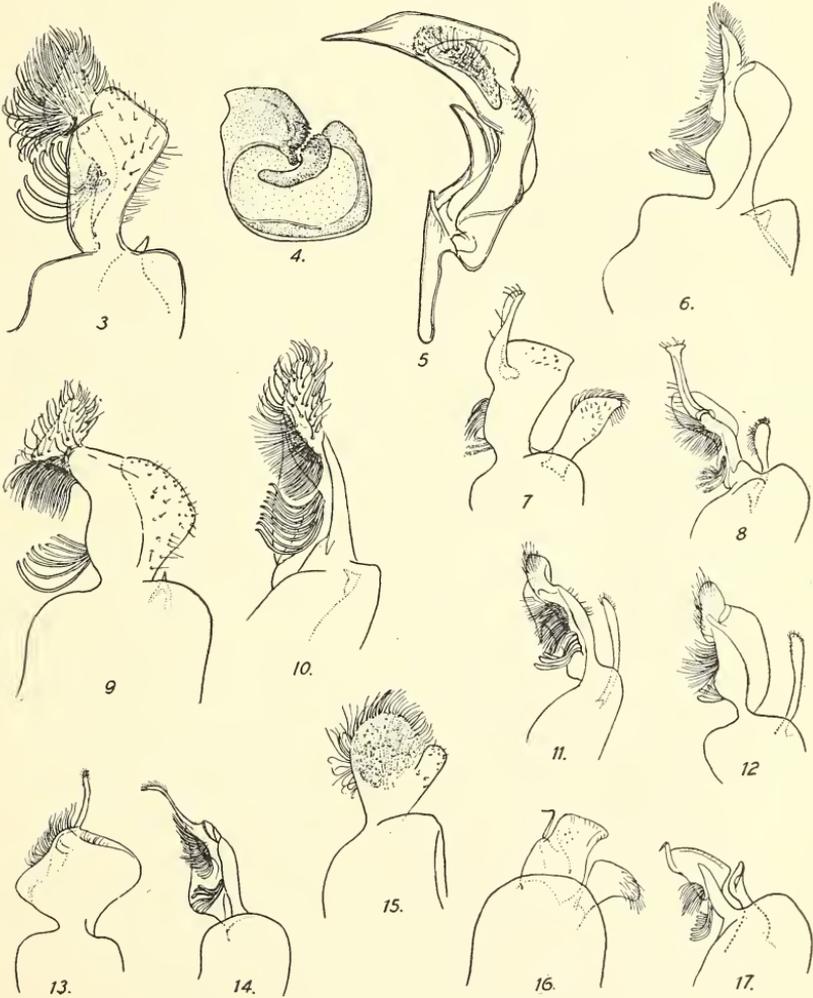
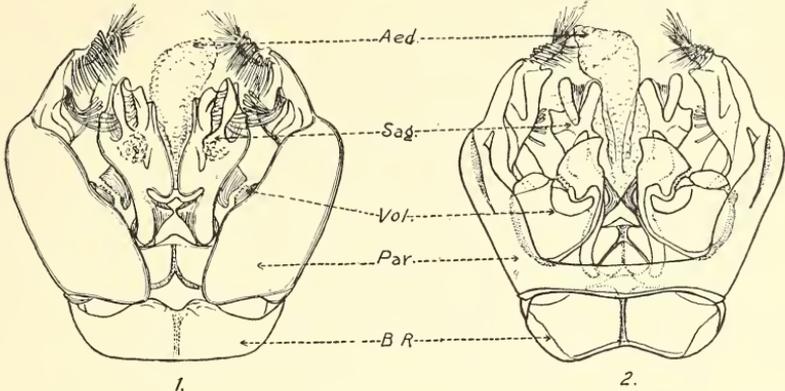
EXPLANATION OF PLATE II<sup>1</sup>

- Fig. 1. *Halictus parallelus* Say. Male, genitalia in dorsal view.  
 Fig. 2. *Halictus parallelus* Say. Male, genitalia in ventral view.  
 Fig. 3. *Halictus parallelus* Say. Male, apex of paramere in apical-lateral view.  
 Fig. 4. *Halictus parallelus* Say. Male, volsella in dorsal view.  
 Fig. 5. *Halictus parallelus* Say. Male, sagitta in lateral view.  
 Fig. 6. *Halictus rubicundus* (Christ). Male, apex of paramere in apical-lateral view.  
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## EXPLANATION OF SYMBOLS APPLIED TO THE MALE GENITALIA

<i>BR</i> ,	Basal ring.	<i>Sag.</i> ,	Sagitta.
<i>Par.</i> ,	Paramere.	<i>Vol.</i> ,	Voltsella.
<i>Aed.</i> ,	Aedeagus.		

<sup>1</sup>The drawings were made, under the author's supervision, by Mrs. Eleanor A. Carlin of the Bureau of Entomology and Plant Quarantine. On account of the diversity of size of the male genitalia, it was impossible to draw all the figures to the same scale.





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# ENTOMOLOGICA AMERICANA

VOL. XXI

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No. 2

A SYNOPSIS  
of the  
HEMIPTERA-HETEROPTERA  
of  
America North of Mexico

BY J. R. DE LA TORRE-BUENO  
(Continued from vol. XIX, no. 4, p. 310)

PART II

Families Coreidae, Alydidae, Corizidae, Neididae,  
Pyrrhocoridae and Thaumastotheriidae

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## FOREWORD

This is Part II of my Synopsis of the Heteroptera, now in progress. As in Part I, all keys are cast in a pure dichotomy and after a standard pattern. In many instances, the couplets, or halves of couplets, are actual redescriptions of species from individual specimens, with which descriptions other specimens of the species have been compared and checked. Such specimens are so labelled in my collection. These specimens become in effect plesiotypes of the species, as defined by Banks and Caudell. It *must* be borne in mind that these keys have no pretensions to a monographic status—they are designed solely for the practical end of naming specimens unknown or unrecognized by the users of the keys. These keys are the distillation of widely scattered data, to make such facts available in one place. In other words, their purpose is to make extensive research unnecessary in identifying specimens. This statement, however, is not to be taken to mean that all reference to original descriptions, if available, should be neglected.

In this part also, the greater number of the keys are original, mostly from specimens in hand. In the groups keyed, there are not many reliable antecedent keys, with the exception of Stål's partial keys in his many works; and not many of such keys are on a basis of structure. The keys to genera and higher groups are recast of necessity from extant keys, wherein are the primary definitions of such aggregations; these keys are sometimes expanded, but all the original characters are preserved, as for example, Stål's restrictions of the subgenera in *Rhopalus* (*Corizus*). They are literal, even though recast in form. It is assumed that the authors who made these primary keys knew what they were saying and doing.

In this Part II are included in the keys many species recorded from Mexico (but not all), but not as yet known from the United States. Experience and records cropping up indicate that there is a substantial number of such species likely to be found north of Mexico, particularly in the Gulf strip and southern border of Texas, and in Arizona and California. West Indian species are included occasionally, since many of these have been recorded from Florida, and others may appear.

In the family Corizidae, Van Duzee is adhered to in family and generic and subgeneric names. It should be pointed out that *Corizus* Fallén has been shown to be the same as *Therapha* A. & S.; and that the correct name for the aggregation known as *Corizus* is *Rhopalus* Schilling. This is merely pointed out, since the old prac-

tice is followed, because this Synopsis is *in no sense* a revision—it simply reflects current practice, right or wrong. It is impossible to clear up this condition without a complete revision of this genus, which nobody seems to have done as yet.

In the family Pyrrhocoridae, the keys to *Euryophthalmus* (olim *Largus*) and to *Dysdercus* have been drawn up newly on a structural basis from specimens determined by Dr. R. F. Hussey, who worked over the species in my collection for his pending monograph of the Family. These determinations have been accepted as correct. For the preceding reason, it will be possible later to readily control and synonymize the species, in view of the structural character of the keys.

It is to be remembered that in this part, as in Part I, all structures used are easily to be seen at  $\times 20$ . If a greater magnification is used or required, it will be specifically stated. Measurements and proportions are by eye-piece micrometer and true to 1/20 mm. However, all such are conditioned by individual variation, and can be nothing but averages about a norm peculiar to each form.

Further, as far as possible, the keys are on a strictly structural basis. Where color is used as a character, it is either because there were no authentically named specimens from which to construct the key; or because color is a striking characteristic and aid to prompt recognition of a species. Otherwise, as will be abundantly evident, color is not considered in any degree. Color varieties are omitted, and also subspecies on such a flimsy basis.

Widths of insects are not given in many instances, either because they are not significant within many groups, or because they have not been given in the descriptions used to make keys.

All other information on the keys, on structures used in them, and on definition of terms, will be found in Part I.

Family VII. **COREIDAE** Leach 1815

(Subfamily *Coreinae* olim)

KEY TO SUBFAMILIES

1. Veins of membrane arising from a transverse vein remote from the apical margin of the corium; entire upper surface, except the membrane, *thickly* beset with small seta-bearing (hispid) granules; posterior coxae contiguous or nearly so; (antennal segment I *always* shorter than the head).

3. PSEUDOPHLOEINAE Stål 1867

Veins of membrane arising directly from the apical margin of the corium; entire upper surface *not* thickly beset with small hispid granules (except in *Nissoscolopocerus*); posterior coxae widely separated; (antennal segment I *rarely* shorter than the head) ..... 2

2. Apex of the posterior tibiae ending beneath in a short projecting spine; (antennal segment IV longer than II and III taken together); posterior femora recurved, strongly clavate, basal half very slender, apical half much thickened and spined beneath; length, in general, 9 mm. or less.

1. MEROCORINAE Stål 1870

Apex of posterior tibiae *without* a projecting spine; posterior femora not, or rarely, curved and strongly clavate; (head much narrower and shorter than the pronotum; bucculae reaching behind the insertion of the antennae); length, in general, 10 mm. or more.....2. COREINAE Stål 1867

Subfamily 1. **Merocorinae** Stål 1870

Genus I. *Merocoris* Perty 1830

(*Corynocoris* auctt.)

This is the only genus in the subfamily recognized from north of Mexico. It may be further known by the following generic characters, in addition to those given for the subfamily in the key: Pubescent; head much shorter than the pronotum and bearing a short spine above, near the base of each antenna; rostrum going beyond the anterior coxae; humeri acute; scutellum triangular, its apex acute; posterior angles of the pronotum produced into a short erect blunt spine; ostiole set in front of the posterior coxae, without a canal or an auricle; posterior coxae distant, practically lateral.

## KEY TO SPECIES

(or Subspecies)

1. Head nearly square, *not* prolonged in front; antennal segment I constricted basally only, hairs of antennae thick and bristle-like; rostrum not, or just, reaching intermediate coxae..... 2  
 Head subtriangular, prolonged anteriorly between the bases of the antennae; antennal segment I subclavate, tapering toward the base from the middle, finely pubescent; rostrum reaching beyond intermediate coxae; length, 7-8 mm., width, 2.7-3 mm. .... *typhaeus* Fabricius 1798  
 Virginia, North Carolina, Florida, Alabama, (Florida only, according to McAtee); on *Persea gratissima*.
  2. Antennal segment IV subequal to or longer than II and III taken together, over 5 to over 7 times as long as its own diameter; length, 7.5-8.7 mm., width, 3-3.5 mm.  
*distinctus* Dallas 1852  
 New England, New York to Virginia, Alabama, Arkansas, Mississippi, Iowa to Kansas and Oklahoma.  
 Antennal segment IV shorter than II and III taken together, 3 to 4.5 times as long as its own diameter; length, 8.25 mm., width, 3.1 mm. .... *curtatus* McAtee 1919  
 Arizona, California, New Mexico, Colorado, Texas.
- N.B.—These three forms are variously considered as distinct species, or as subspecies of *typhaeus* Fabricius. The distribution is as given in the literature.

## Subfamily 2. Coreinae Stål 1867

## KEY TO TRIBES

1. Posterior tibiae in both sexes dilated on one or both sides in the form of a thin foliaceous plate ..... 2  
 Posterior tibiae simple, terete, subcylindrical or somewhat flattened, *not* foliaceously dilated ..... 3
2. Tylus longer than the juga, compressed and *upwardly projecting between the antenniferous tubercles* in the form of a triangular spine; antennal segment I *at least* one-half longer than the head ..... 1. *Acanthocephalini* Stål 1870  
 Tylus longer than the juga, compressed and *deflexed in front of them*; antennal segment I but little, if at all, longer than the head ..... 2. *Anisoscelini* Amyot & Serville 1843
3. Head as long, or nearly as long, as the pronotum, distinctly narrowed and prolonged in front of the bases of the antennae; femora armed beneath ..... 4

- Head *not over* two-thirds the length of the pronotum, little produced in front of the bases of the antennae ..... 5
4. Antennal segments II and III *not* 3-angled or 3-sided.  
     3. *Leptoscelini* Stål 1867  
 Antennal segments II and III 3-angled or 3-sided.  
     7. *Chelinidini* Blatchley 1926
5. Posterior femora armed beneath with numerous teeth, strongly incrassate in males, slender or but slightly thickened in females; anterolateral margins of the pronotum toothed or crenulate ..... 4. *Mictini* Stål 1867  
 Posterior femora with only two or three small spines beneath, or unarmed, not much thickened in either sex; anterolateral margins of the pronotum unarmed, or with distinct teeth... 6
6. Antenniferous tubercles *very* prominent, head appearing incised anteriorly, juga and tylus strongly, abruptly deflexed..... 8  
 Antenniferous tubercles *not* prominent, neither juga nor tylus strongly deflexed, head not appearing incised ..... 7
7. Spiracles of the intermediate abdominal segments equidistant from the anterior and posterior margins of the segments, or at most, not twice as far from the posterior as from the anterior margin of the segments; rostrum long, reaching beyond the anterior coxae ..... 8. *Coreini* Stål 1867  
 Spiracles of the intermediate abdominal segments *at least* twice as far from the posterior as from the anterior margins of the segments, more distant from the lateral than from the anterior margin of the segments; rostrum short, barely reaching anterior coxae or just beyond them.  
     9. *Discogastrini* Stål 1867
8. Antennal segment III *not* dilated at or near its apex; antenniferous tubercles *without* a spine; (anterolateral margins of the pronotum not toothed); broad oval in shape.  
     5. *Corecorini* Van Duzee 1917  
     (*Menenotini* Bergroth 1913)  
 Antennal segment III lamellately expanded near its apex; antenniferous tubercles *with* a distinct spine above their bases; elongate narrow in shape  
     6. *Chariesterini* Stål 1867

Tribe 1. *ACANTHOCEPHALINI* Stål 1870

Genus I. *Acanthocephala* Laporte 1832

This, the only North American Genus in the tribe is further characterized as follows: Head small, porrect, shorter than the

pronotum and narrower than its anterior margin; rostrum reaching at least to the intermediate coxae; antennal segment III shortest, the other three subequal, I stout, somewhat curved; pronotum wider at its base than the hemelytra, much narrowed anteriorly, its anterolateral margins straight, strongly converging from the prominent humeri to the narrow apex, which is but little wider than the head, the margins with nodules or blunt teeth; scutellum small, nearly triangular, its sides of nearly equal length, apex acute; hind tibiae with large laminate dilations, the outer dilation longer and wider than the inner; ostiole large, with a short curved auricle.

## KEY TO SPECIES

1. Pronotum greatly expanded beyond the margins of the abdomen and of the hemelytra, concave; outer dilation of the posterior tibiae broad almost to the apex (subgenus *Acanthocephala* s.s.); scutellum with a marginal sulcus; length, 28-34 mm., width, 11-12 mm. .... *declivis* Say 1832  
North Carolina, Georgia, Florida, Louisiana, Texas, Arizona, (Central America); on *Persea borbonica*.

Pronotum wider than the abdomen, but not greatly expanded nor prominently concave; outer dilation of the tibiae *not* wide at or near the apex (subgenus *Metapodiessa* Kirkaldy 1902) ..... 2

2. Outer dilation of the posterior tibiae in both sexes broad almost to the apex of the tibia, but *not* widened apically; length, 24 mm., width, ..... *granulosa* Dallas 1852  
Texas, Arizona, California.

Outer dilation of the posterior tibiae *not* wide at or near the apex of the tibia, much narrowed if extended to near the apex ..... 3

3. Dilation of the posterior tibiae in both sexes extending but two-thirds or slightly more of the entire length of the tibia, deeply scalloped; (antennal segment IV pale); length, 18-22 mm., width, 6-7 mm. .... *terminalis* Dallas 1852  
(*instabilis* Uhler 1871)

New England west to Colorado and south to Louisiana, Oklahoma, Texas; on Solidago and Joe-pye-weed (*Eupatorium purpureum*).

Dilation of the posterior tibiae extending *distinctly more* than two-thirds the length of the tibia, sometimes nearly to the apex; 23 mm. or more in length ..... 4

4. Pronotum *prominently* tuberculate; outer dilation of the tibia in the male *without* distinct scallops; posterior femora of the male *prominently* thickened and curved, with a long stout spine beneath; antennae concolorous; length, 25–28 mm., width, 9–10 mm. .... *femorata* Fabricius 1775  
North Carolina to Florida, Texas, Oklahoma and Minnesota, (Mexico).

Pronotum *minutely* tuberculate or granulate; outer dilation of the tibia in the male with *distinct* scallops; posterior femora of the male nearly or quite straight and not much enlarged, median tooth or spine not enlarged; antennal segment IV reddish; length, 23–25 mm., width, 9–10 mm.

*confraterna* Uhler 1871

Georgia, Florida, Alabama, Texas.

Tribe 2. *ANISOSCELINI* Amyot & Serville 1843

KEY TO GENERA

1. Antennal segment I *shorter* than the length of the head.  
III. *Narnia* Stål 1862  
Antennal segment I *long, as long as, or longer* than the head..... 2
2. Antennal segment I *equal* to the length of the head, or but *slightly longer*; antennae simple, without dilations.  
II. *Leptoglossus* Guérin 1838  
Antennal segment I *very much longer* than the head, II and III dilated on both sides ..... I. *Chondrocer*a Laporte 1832

Genus I. *Chondrocer*a Laporte 1832

To the characters of this monotypic genus, as given in the key, may be added: Head longer than wide, apically pointed; juga wider than the tylus; pronotum strongly declivent anteriorly, anterolateral margins straight and converging apically from the acute humeri, anterior lobe separated from the posterior by a strong carina, declivent posteriorly; legs elongate, especially the anterior femora, hind tibiae with the outer expansion angulate near the middle, the outer nearly three times as wide as the inner expansion.

Its one species is reported north of Mexico:

*C. laticornis* Laporte 1832

In this the antennae are nearly as long as the body, segment I 3-angled, longer than the head, distinctly curved, the margins of the dilations of segments II and III finely serrate; pronotum closely

and unevenly finely reticulate-punctate, the scutellum and hemelytra more coarsely so; length, 16-18 mm., width, 3.12 mm.

Florida, (West Indies).

Genus II. *Leptoglossus* Guérin 1838

KEY TO SPECIES

1. Rostrum reaching just to or slightly past middle coxae; (antennal segment II one and one-half times as long as III, IV longest; posterior tibial dilation more than one-half but less than two-thirds the length of the tibia, with 3 teeth in both sexes; length, 12-14 mm., width, 5 mm.).

*brevirostris* Barber 1918

Arizona, California.

Rostrum extended much beyond middle coxae, generally on to the abdomen ..... 2

2. Apex of head (tylus) extended into a long spine-like projection; length, 16-20 mm., width, 4-6 mm.

*clypealis* Heidemann 1910

Oregon, California, Arizona, Utah, Colorado, New Mexico; on ornamental pomegranate.

Apex of head pointed or rounded, tylus not extended into a long spine-like projection ..... 3

3. Pronotum very *coarsely* punctate or rugose, almost alveolate; (hemelytra without a pale transverse fascia; length, 18-25 mm., width, 6-9 mm.) ..... *fulvicornis* Westwood 1842

(*magnoliae* Heidemann 1910)

Massachusetts and New York to Florida and Alabama; on magnolia fruit.

Pronotum *not* rugose, *finely* punctate only ..... 4

4. Antennal segment IV *equal to or shorter* than III ..... 5

Antennal segment IV *longer than* III ..... 6

5. Outer expansion of posterior tibiae *lanceolate*, *not* scalloped, reaching almost to the apex of the tibia; rostrum reaching to or passing ventral segment III; (pronotum with large dark dots); length, 16-19 mm., width, 4.5-6 mm.

*corculus* Say 1932

New Jersey south to Georgia and west to Colorado, Arizona and California.

Outer expansion of posterior tibiae reaching only two-thirds the length of the tibia, foliaceous; length, 16-18 mm., width, 4-6 mm. .... *occidentalis* Heidemann 1910

British Columbia, Idaho, California, Colorado.

6. Posterolateral margins of the pronotum more or less crenulate or dentate ..... 7  
 Posterolateral margins of the pronotum *not* crenulate or dentate ; (transverse fascia of the hemelytra, if present, a mere trace ; length, 18-20 mm., width, 5-6 mm.)  
*oppositus* Say 1932  
 New York west to Indiana and Minnesota and Oklahoma, south to Florida and Texas, (Mexico) ; on cucurbits, fruits, and garden vegetables, also on *Yucca filamentosa*.
7. Posterior angles of the pronotum terminating in a prominent spine ; pronotum with a curved transverse line anteriorly, which is sometimes reduced to two small spots ; (length, 16-19 mm., width, 5-6.5 mm.) ..... *gonagra* Fabricius 1775  
 Florida, Texas.  
 Posterior angles of the pronotum *not* terminating in a prominent spine ; pronotum *without a transverse* yellow line ..... 8
8. Pronotum margined all around with bright orange ; foliations of the posterior tibiae short ; (antennal segments II and IV subequal, IV the longer, each more than one and one-half times as long as III ; rostrum hardly reaching the posterior coxae, segment IV twice III ; length, 14-16.5 mm., width, 5-6 mm.) ; (upper surface covered with fine hairs).  
*ashmeadi* Heidemann 1909  
 Florida ; on *Phoradendron flavescens* (mistletoe).  
 Pronotum *without an orange* border ; foliations of posterior tibiae large and long ..... 9
9. Transverse fascia of the hemelytra solid, not wavy ; pubescence of upper surface short, not tomentose and *not* heavy ; pronotum concolorous ; scutellum with a fine sparse pubescence ; antennal segment IV about one and two-fifths the length of I ; body beneath with a fine short silvery pile ; length, 17.5-20 mm., width, 5.5-6 mm.  
*phyllopus* Linné 1767  
 New York to Florida, Mississippi, Texas, Oklahoma, Arizona ; on cotton bolls ; fruit, potatoes, etc., and on *Carduus spinosissimus*.  
 Transverse fascia of the hemelytra wavy, the veins *only* white, and a solid small patch on the costal margin ; pubescence of upper surface long, heavy, nearly tomentose ; two light colored areas on the pronotum anteriorly, with a few large black dots in them ; scutellum with close, very thick silvery

hairs; antennal segment IV one and four-fifths times as long as I; length, 17–21 mm., width, 5.25 to 7 mm.

*zonatus* Dallas 1852

Arizona, California, (Mexico); on ornamental pomegranate.

Genus III. *Narnia* Stål 1862

KEY TO SPECIES

1. Surface of body with a close grayish mottled pubescence; form narrow; head proportionally long; connexivum narrow; antennae long and slender; median carina of pronotum not pronounced; lateral margins of the pronotum not very distinctly carinated; hemelytra without a transverse white band, or with obsolete vestiges of such a band (subgenus *Narnia* s.s) ..... 2  
 Surface of body *not* covered with a close grayish pubescence; head proportionally short; connexivum broad; antennae short and stout; median carina of the pronotum distinct; margins of the pronotum distinctly carinated; hemelytra *with* a transverse white band (subgenus *Xerocoris* Van Duzee 1906) ..... 3
2. Dilations of hind tibiae reaching three-quarters the length of the tibia; (no distinct red coloration); length, 19.5 mm., width, 5.5 mm. .... *inornata* Distant 1892  
 Arizona, California, (Mexico).  
 Dilations of hind tibiae reaching two-thirds the length of the tibia; length, 15–17 mm., width, 4–5 mm.  
*femorata* Stål 1862  
 (*pallidicornis* Stål 1870)  
 New Mexico, Arizona, California, Texas, (Mexico); on cactus.
3. Dilations of hind tibiae two-thirds the length of the tibia, rather broad; hemelytra ferruginous with a *distinct* broad white transverse band; length, 14.3–16.5 mm., width, 4.25–4.9 mm. .... *snowi* Van Duzee 1906  
 Texas, New Mexico, Arizona, California.  
 Dilations of hind tibiae three-quarters the length of the tibiae, almost linear; (apex of the head, antennal segment I and the legs ferruginous or red; antennal segment I hardly surpassing the apex of the head); hemelytra black, the costa narrowly pale; length, 12 mm.  
*wilsoni* Van Duzee 1906  
 California.

Tribe 3. *LEPTOSCELINI* Stål 1867

- A. Humeral angles prominent, acute; posterior tibiae as long as or longer than the posterior femora .....I. *Phthia* Stål 1862  
 B. Humeral angles hardly prominent, rounded; posterior tibiae shorter than the femora .....II. *Amblyomia* Stål 1870

Genus I. *Phthia* Stål 1862

To the characters in the key may be added these generic: Head including the eyes wider than the anterior margin of the pronotum; antennal segment I almost straight, as long as or slightly longer than the head; apical margin of the pronotum with a collar; femora slender, the apices of the posterior passing the apex of the abdomen, posterior tibiae simple; spiracles set at the middle or nearly behind the middle of the ventral segments.

The only species of this subtropical genus so far recorded for North America is

*P. picta* Drury 1770.

Selected specific characters are: Anterolateral margins of the pronotum straight, finely toothed, humeri subacute or subtruncate, the disc, together with the scutellum and the hemelytra finely and densely punctate; abdominal spiracles equidistant from the anterior and the posterior margins of the ventral segments; length, 14–16 mm., width, 4–5 mm. Florida, Texas, California, (ranges through Mexico south to Brazil).

N.B.—There are numerous color varieties of this which will be found listed by McAtee in the Bulletin of the Brooklyn Entomological Society for 1919, p. 13.

Genus II. *Amblyomia* Stål 1870

The principal generic characters, from Stål's original characterization (Enumeratio II: 171), are: Head slightly exserted, a little shorter than the pronotum; juga and tylus produced in front of antenniferous tubercles; ocelli close to the eyes; rostrum reaching to posterior coxae, segment I extended behind the eyes; pronotum with a collar, anterolateral margins obtuse, convex; humeral angles hardly prominent, rounded; scutellum equilateral; femora granulated, beneath biserially spinose, posterior in male incrassate, subfusiform; tarsi short, stout, segment I of posterior tarsus subequal to the two terminal segments taken together.

The one species is

*A. bifasciata* Stål 1870

The original description, from the Latin, reads: "Black, glossy; thorax, scutellum, hemelytra, pleura (except the anterior half of the mesosternum and the metasternum) strongly punctate; thorax levigate anteriorly, collar, and median fascia of the corium, flavescent; a broad subarcuate fascia behind the middle of the thorax, as well as two apical spots in ventral segments III, IV and V, sanguineous; male, length, 13 mm., width, 4 mm."

Doubtfully recorded by Van Duzee from "West. States"; may occur along the southern borders of Texas, Arizona and California; Barber states (1926) that it does not occur in the United States.

Tribe 4. *MICTINI* Stål 1867

KEY TO GENERA - SEE CORRECTION NEXT PAGE

1. Antennal segment III compressed or dilated, (shorter than II); large species, *over 35 mm.* long; brightly colored.

I. *Thasus* Stål 1865

Antennal segment III cylindrical, not compressed or dilated, (shorter than II?); smaller species, *less than 35 mm.* long; in dull colors .....

2. Antennal tubercles spined on the outer side; head with a distinct tubercle behind each eye .....

Antennal tubercles *without* a spine on the outer side; head *not* tuberculate behind the eyes .....

3. Posterior coxae covered by a lamellate process.

VI. *Hymeniphera* Laporte 1832

Posterior coxae *not* covered by a lamellate process; (antennal segment II shorter than III)—VII. *Euthochtha* Mayr 1865

4. Posterior margin of the pronotum *not* wider than the base of the scutellum; posterior femora in the male *not* incrassate .....

Posterior margin of the pronotum *distinctly* wider than the base of the scutellum; posterior femora in the male *distinctly* incrassated .....

5. Posterior tibiae in the male curved, with one large spine and several smaller ones in the inner aspect, in the female terete, straight, unspined; posterior femora in both sexes more or less spined in both aspects, conspicuously so in the male; pronotum granulose .....

IV. *Archimerus* Burmeister 1835  
 Posterior tibiae in both sexes straight, flattened finely dentate from near base to apex; posterior femora *not* spined on outer (or upper) aspect; pronotum *not* granulose.

V. *Mamurius* Stål 1862

6. Mesosternum longitudinally sulcate near the anterior coxae.

II. *Mozena* Amyot & Serville 1843

Mesosternum *not* longitudinally sulcate.

III. *Capaneus* Stål 1862

Genus I. *Thasus* Stål 1865

This genus is further characterized thus, from Stål's original description: Body oblong, large; head subquadrate, antenniferous tubercles but little distant, base of the lobes deflexed, hardly produced in front of the antenniferous tubercles; rostrum short, stout; antennal segment III dilated; thorax with a collar, humeri rounded or angular; scutellum equilateral; apical angle of the corium not produced; membrane with longitudinal veins; legs robust, posterior quite distant; posterior femora in male incrassate, posterior tibiae in both sexes dilated above and below.

The single species recorded north of Mexico is

*T. acutangulus* Stål 1858

In this the antennal segments I and IV are equal, III shortest, II one and one-seventh the length of III; rostral segments I and II laterally compressed, more or less ovate, IV longest, cylindrical, II not extending beyond the anterior margin of the prosternum; anterolateral margins of the pronotum dentate anteriorly from the acute humeri, which are tuberculate; veins of corium thick, smooth, yellow, as are the marginal thickenings of the corium, corium sparsely silvery pubescent; pubescence of scutellum longer and more abundant; posterior angles of abdominal segments III, IV and V with a strong spine at the apical angles, spine of VI set midway of the segment between the base and apex, that on III shortest, on VI longest. Length, 35-40 mm., width, 11-14 mm.

Arizona, New Mexico; on mesquite (*Prosopis*).

N.B.—*T. gigas* is the only species recorded north of Mexico in Van Duzee's Catalogue, but is not included here as probably a misidentification.

Genus II—*Mozena* Amyot & Serville 1843

KEY TO SPECIES

1. Abdomen widely dilated, ampliate, much wider at the widest part than at the humeri; humeri projecting acutely outward; antero-lateral margins of the pronotum straight or very obtusely sinuated (subgenus *Rhombogaster* Dallas.

# CORRECTION TO A SYNOPSIS OF THE HEMIPTERA- HETEROPTERA OF AMERICA NORTH OF MEXICO

By J. R. DE LA TORRE-BUENO, Tucson, Ariz.

The key to the genera of the Tribe Mictini in my Synopsis [Ent. Am. XXI (n.s.), pp. 53-54], on extensive use has been found to be unworkable and in part wrong. This key was derived from certain of the literature in which differential characters were not sharply delimited. To replace this unsatisfactory key the following is offered, which has been in part derived, recast and expanded from that of Stål (Hemiptera Mexicana, 1862, Stett. Ent. Zeit. XXIII, pp. 277-278).

## Tribe 4. *MICTINI* Stål 1867

### KEY TO GENERA

1. Antennal segment III compressed and dilated (and shorter than II) ; large species, *over* 35 mm. long ; brightly colored.  
I. *Thasus* Stål 1865  
Antennal segment III cylindrical, *not* compressed or dilated ; smaller species, *less than* 35 mm. long ; in dull colors ..... 2
2. Antennal tubercles spined on the outer side ; head with a distinct tubercle behind each eye ..... 6  
Antennal tubercles *without* a spine on the outer side ; head *not* tuberculate behind the eyes ..... 3
3. Mesosternum anteriorly, and behind the anterior coxae, with a longitudinal groove or sulcus which has more or less elevated margins ; (base of pronotum and posterolateral margins rounded in a continuous line, and without definite posterior angles) ..... II. *Mozena* Amyot & Serville 1843  
Mesosternum not, or hardly, grooved or sulcate anteriorly ..... 4
4. Posterior angles of the pronotum rounded, not distinctly angulate, the posterolateral margins and the base frequently forming a continuous curve, in which case the posterior angles are *not* defined ..... III. *Capaneus* Stål 1862  
Posterior angles of the pronotum distinct, its posterior margin straight or nearly straight, and wider than the base of the scutellum, with the posterolateral margins more or less distinctly sinuated near to the posterior angles ..... 5
5. Median lobe of the head obtuse, slightly produced anteriorly as seen from the side ; posterior coxae twice as far from each other as the intermediate coxae from each other ; posterior

tibiae in the male curved at or behind the middle, and armed on the inner side with a tooth.

IV. *Archimerus* Burmeister 1835

Median lobe of the head carinate-elevated and somewhat prominent; (head *not* spined); posterior coxae slightly more distant from each other than are the intermediate coxae from each other; posterior tibiae in the male quite straight, *without* a large tooth on the inner side; (body hardly depressed; spiracles set a little further from the apices of the ventral segments than from their bases).

V. *Mamurius* Stål 1862

6. Posterior coxae covered by a lamellate process.

VI. *Hymeniphera* Laporte 1832

Posterior coxae not covered by a lamellate process; (antennal segment II shorter than III).

VII. *Euthochtha* Mayr 1865

1852); [antennal segments I, III and IV subequal, II longest, antennae little longer than the head and pronotum taken together; humeri very slightly prominent, obtuse or angular; abdomen with a small prominent sharp spine or tooth at the posterior angle of each segment; length, 20-22 mm., width (humeral), 8-9 mm., (at abdomen), 10 mm. ?]

*obtusa* Montandon 1899

Kansas, Nebraska, Mississippi, Florida.

Abdomen moderately dilated, not ampliate, not wider at the widest part than at the humeri, which are either greatly extended anteriorly lunately or not great projecting laterally, or rounded; anterolateral margins of the pronotum obviously sinuated (subgenus *Mozena* s.s.) ..... 2

2. Humeral angles obtuse, acute or subacute, *not* anteriorly directed nor lunate ..... 3  
 Humeral angles very acute and markedly lunate and anteriorly produced ..... 4

3. Humeri acute, outwardly projecting but short; anterolateral margins of the pronotum sparingly tuberculate, tubercles prominent anteriorly, low posteriorly; apical angles of abdominal segments III, IV and V prominently acutely produced; posterior femora in male with four rows of small, whitish tubercles above, two rows of teeth beneath; length, 18.5 mm., width at humeri, 7.8 mm.

*nestor* Stål 1862

Arizona.

Humeri neither acute nor outwardly produced, sublunately prominent, barely curved anteriorly, acuminate at the extreme tip; anterolateral margins unevenly and coarsely serrated or tuberculate; apical angles of abdominal segments III, IV and V acute but not prominent; posterior femora with three rows of pale tubercles above and two rows of teeth beneath; length, 17-20 mm., width, 6.5-7 mm.

*obtusa* Uhler 1876

Arizona.

4. Length 25 mm. or over; [pronotal angles very wide and flaring; antennal segment I long, black; anterior lobe of pronotum with a very few small black tubercles, tubercles of the anterolateral margins coarse, pale, that of the anterior angle not much larger than the others, posterolateral margins with distinct small teeth; anterior and intermediate femora with two large apical spines, in the anterior preceded by

several smaller or obsolete ones; length, 25 mm. (male), 28 mm. (female), width, (male), 12.5 mm.]

*brunnicornis* Herrich-Schaeffer 1842  
(*spinicrus* A. & S. 1843)

Arizona, (Mexico).

Length less than 23 mm. .... 5

5. Anterior femora in male with two large lateral apical spines, preceded by three or four small spines or hispid tubercles, in females with the apical pair of spines only; (pronotum anteriorly with several *small whitish* points or tubercles, anterolateral margins with small teeth; posterior femora above with *two* rows of small tubercles and two rows of spines beneath; connexivum spotted; antennal segment I conspicuously longer than II; length, 16.7–17.9 mm., width, 8.5 mm.) ..... *affinis* Dallas 1852  
Texas, (Mexico).

Anterior femora in both males and females with only two lateral apical spines ..... 6

6. Antennal segment I one and two-thirds length of III, IV about one and one half times the length of III, I, II and III black above, pale below, IV wholly pale; pronotum with many white tubercles of varying size anteriorly and two large ones at the transverse groove, teeth of the anterior angles large, coarse, truncate; length, 20–22.25 mm., width, 8.5–9 mm. .... *lunata* Burmeister 1835  
Texas.

Antennal segment I about one and one-fifth times the length of III, IV equal or subequal to III; segments I, II and III pale, IV pale at base, the remainder dusky; anterior lobe of the pronotum with a very few very small tubercles, and no prominent tubercles, teeth at anterior angles conical and not much larger than the other marginal teeth; length, 17–20 mm., width, 7–8.5 mm.—*lineolata* Herrich-Schaeffer 1842  
Arizona; on mesquite (*Prosopis*).

N.B.—*Mozena lurida* Dallas 1852 is omitted because unidentifiable from the description, and because of the absence of specimens through which to differentiate it.

Genus III. *Capaneus* Stål 1862

## KEY TO SPECIES

1. Antennal segment I tuberculate; disc of pronotum tuberculate, margins with *stout* teeth; [antennal segment I longer than II; femora dentate above and below, tibiae with spines or tubercles above; abdomen slightly ampliate, venter laterally of the discs of segments II to V with a slightly raised tubercle, abdominal segment VI in the male slightly but noticeably narrowed posteriorly, its apex roundedly produced, its apical angles square or slightly acute, the apical angles of the preceding five segments with a stout acute tooth; posterior tibiae in the male somewhat curved at middle, below with a large tooth; (subgenus *Acantholobus* Stål 1870)]; length, 20 mm. ....(A.) *multispinus* Stål 1862 Mexico.

Antennal segment I unarmed or granulate, *not* tuberculate; disc of pronotum *not* tuberculate, its margins more or less dentate or granulate ..... 2

2. Antennal segment I *without* tubercles or granules, smooth ..... 3  
Antennal segment I granulate ..... 7

3. Antennal segment I longer than II; abdomen in male hardly, in female slightly ampliate, apical angles of the segments with a very minute spine; anterior femora *unarmed*, posterior tibiae in the male bidentate below at the middle, [(tibiae above unarmed; last abdominal segment in the male noticeably subrotundate-angustate, its apex narrowly truncate, its apical angles obtuse; venter without tubercles; anterior femora unarmed, posterior femora as far from each other as from the sides; posterior tibiae in the male distinctly curved at middle, straight before, below at middle strongly bidentate (subgenus *Acidomus* Stål 1870); length, 24 mm.)] .....(A.) *achilles* Stål 1862 Mexico.

Antennal segment I hardly longer than II; abdomen in the male with sides subparallel, in female slightly ampliate and somewhat wider than the hemelytra, (ventral segment III in male as seen from the side tuberculate near its base); femora below near apex with two distinct or largish spines followed by numerous small spines, posterior femora somewhat further from each other than from the sides; posterior tibiae in the male somewhat curved behind the middle, be-

- low with a stout tooth, arcuate before the middle, above unarmed (subgenus *Capaneus* Stål 1870) ..... 4
4. Anterolateral margins of the pronotum minutely denticulate 5  
 Anterolateral margins of the pronotum anteriorly granulate or  
 obsoletely crenulate ..... 6
5. Posterior femora (incrassate), above and below distinctly spined  
 or *acutely* tuberculate; humeri rounded, not auriculate,  
 (anterolateral margins of the pronotum *not* spined); all  
 femora spined; (angles of the abdominal segments neither  
 spined nor prominent); posterior tibiae in the male curved,  
 with one long spine close to the apex, in the female straight,  
 unspined; length, 18–20 mm., width, 6 mm.

(*C.*) *odiosus* Stål 1862

Mexico, Central America to Panama.

Posterior femora above and below with small tubercles; humeri  
 subacutely prominent, not auriculate; all femora *unspined*,  
 the posterior much incrassate with a single tubercle toward  
 the apex; posterior tibiae in male flattened, curved, with  
 one large spine beyond the middle and a number of smaller  
 ones toward the apex; length, 18–20 mm., width, 6 mm.

(*C.*) *tetricus* Stål 1862

Mexico, Guatemala.

6. Anterolateral margins of the pronotum obsoletely granulate an-  
 teriorly, humeri subrotundate, slightly prominent; pos-  
 terior femora with three obtuse spines above toward the  
 apex, the middle one smaller than the other two, below with  
 two to three tubercles in series; posterior tibiae below ob-  
 tusely denticulate behind the large tooth; (abdomen some-  
 what wider than the hemelytra, apical angles of segments  
 II to V slightly dentate-prominent); length, 26 mm., width,  
 7.5 mm. .... (*C.*) *rubronotatus* Stål 1862

Mexico, Guatemala.

Anterolateral margins of the pronotum crenulate anteriorly;  
 humeri rounded, not prominent; posterior femora above  
 with three distinct acute tubercles, below behind middle  
 outwardly with several small tubercles, inwardly with three  
 conical tubercles; posterior tibiae curved, flattened, with a  
 coarse spine beyond the middle; length, 28 mm., width,  
 8 mm. .... (*C.*) *vates* Stål 1862

Mexico.

7. Antennal segment I hardly granulate, hardly or but little longer  
 than II; abdomen in both sexes quite rotundate laterally,

much wider than the hemelytra, the apical angles of the segments *prominent*, the venter without tubercles; all femora spined below with many somewhat prominent spines, the posterior femora equally distant from each other and from the sides; posterior tibiae in the male distinctly curved at the middle, with a large tooth below, and before the middle straight and tuberculate above (subgenus *Xuthus* Stål 1870); anterolateral margins of the pronotum with obtuse small spines, quite sinuate at middle, thence suddenly quite ampliate, humeri somewhat obtuse, auriculate; length, 20–22 mm., width, 7–7.5 mm.

(*X.*) *auriculatus* Stål 1862

Texas, New Mexico, Mexico, Guatemala.

Antennal segment I shorter than II, granulate; abdomen in both sexes somewhat ampliate, wider than the hemelytra, venter without tubercles, ventral segment VI in the male noticeably quite narrow, the apex obtusely rounded, its apical angles produced into a tooth; femora tuberculate, the anterior with many spines below, the posterior equally distant from each other and from the sides; posterior tibiae in the male hardly curved, below at middle with a large tooth (subgenus *Rhyparopharus* Stål 1870); (antennae short, segments III and IV equal, each shorter than I); anterolateral margins of the pronotum very slightly sinuate, denticulate, the humeri quite obtusely rotundate, hardly prominent; abdomen somewhat rotundate-ampliate laterally, nearly one-half wider at the middle than at the base, apices of the ventral segments distinctly spinose-prominent; femora tuberculate, the posterior straight, quite incrassate, below at middle bispinose; posterior tibiae slightly curved, somewhat widened, below before the middle with a distinct spine, beyond this with a number of small unequal spines; length, 19 mm., width, 9 mm.

(*R.*) *spurcus* Stål 1862

Mexico, Guatemala.

N.B.—This key contains all the species of *Capaneus* described by Stål in *Hemiptera Mexicana* (Stett. Ent. Zeit. XXIII: 280–281 and 289–292). The subgenera and the distribution of the species keyed are as set forth in *Enumeratio* and later by Distant in *Biologia Centrali Americana*. While the subgenera and the species are dichotomized on a structural basis, as in all keys herein, this dichotomy has been set up by a sorting out of the structures in each subgenus as given

by Stål. The supporting characters in the key are entirely those given by Stål in his original descriptions of the species (*op. cit. supra*). The two species described by W. L. Distant (*Biologia Centrali Americana*, Rhynchota I, p. 354, 1892) are not included, since this author failed to place them subgenerically. *Capaneus humerosus* Distant (*op. cit.*, pl. 33, fig. 5) according to the description might seem to belong in the subgenus *Acantholobus* Stål because of the character of the granulate pronotum, even though its author inferentially places it in the subgenus *Xuthus* Stål, near *auriculatus* Stål. *C. chontalensis* Distant (*op. cit.*, pl. 33, fig. 3) is set by its author near *C. achilles* Stål, again by inference, in the subgenus *Acidomus* Stål. Both these species are from the Tierra Caliente in Mexico and not likely to range as far North as the southern border of the U. S.

Genus IV. *Archimerus* Burmeister 1835

KEY TO SPECIES

1. Antennae stout, less than one-half the length of the body ..... 2  
 Antennae not noticeably stout, slightly more than one-half the length of the body; (anterior angles of the connexival segments II and III with a small pale spot only; length, 19.5–20 mm., width, 6.5–6.8 mm.) ..... *ashmeadi* Montandon 1899 Florida.
2. Femora *without* erect bristly hairs ..... 3  
 Femora *with* numerous erect blackish bristly hairs; (connexivum distinctly alternated with yellow and fuscous spots; length, 16–21 mm., width, 6–7 mm.) ..... *alternatus* Say 1825 New Jersey and North Carolina to Florida, and west to Colorado and Oklahoma.
3. Connexivum concolorous reddish-brown; length, 18–21 mm., width, 6–7.5 mm. .... *calcarator* Fabricius 1803 Florida; on flowers of *Asimina parvifolia*.  
 Connexivum with lighter lines at the incisures; length, 18.5–25 mm., width, 6.7–7 mm. .... *indecorus* Walker 1871 Arizona.

Genus V. *Mamurius* Stål 1862

There seems to be no formal description of this genus. It was established by Stål in Hemiptera Mexicana (*Stett. Ent. Zeit.*, XXIII: 278). The following generic characterization is derived

from his key (pp. 277-278): Tylus elevated, carinate, prominent, unarmed; posterior angles of the pronotum distinct, posterior margin straight, wider than the base of the scutellum, posterolateral margins more or less distinctly sinuate near the posterior angles; mesosternum scarcely sulcate anteriorly; posterior tibiae in the male quite straight, without a large median tooth; posterior coxae scarcely more separated from each other than the intermediate; spiracles a little more distant from the apices than from the bases of the ventral segments; body not much depressed.

The characters of the single species in the genus, described from Mexico, are taken from the original description in the same work, as follows:

*M. mopsus* Stål 1862

Antero- and posterolateral margins of the pronotum denticulate, anterior angles subspinose, humeri terminating in a small tooth; abdomen hardly wider than the hemelytra; venter remotely punctate; femora below with two rows of spines or acute tubercles, posterior tibiae slightly compressed, denticulate below, slightly shorter than the femora; length, 15 mm., width, 6 mm.

Arizona, (Mexico).

Genus VI. *Hymeniphera* Laporte 1832

Further generic characters are: Antennal tubercles with a lateral spine; rostrum hardly reaching to the intermediate coxae; anterolateral margins of the pronotum hardly, or not spinose; anterior and posterior legs somewhat thickened and spined, posterior longer than the others, posterior coxae concealed by a foliaceously dilated membrane arising from the sides of the thorax at that point, posterior femora incrassate, fusiform, spined below, posterior tibiae slightly flattened.

The one species recorded north of Mexico is

*H. lobata* Burmeister 1835

In this, antennal segments I, II and III are cylindrical, IV fusiform; lamella over the coxae pale; length, 12.5 mm.

New Mexico, (West Indies).

Genus VII. *Euthochtha* Mayr 1865

To those in the generic key may be added the following characters: Head short, subquadrate, wider with the eyes than the anterior margin of the pronotum; antennal tubercles prominent, much

exceeding the tylus, head deeply emarginate with a small blunt lateral spine exteriorly on the antennal tubercles; antennal segment II longest; anterior angles of the pronotum produced into a short tooth, anterolateral margins with small tubercles or blunt teeth, base wider than the base of the scutellum; veins of the membrane anastomosing or forked; spiracles nearer to the anterior than to the posterior margins of the ventral segments.

The one species is

*E. galeator* Fabricius 1803

Selected specific characters are: Humeri prominent, rounded, their margins crenulate; disc of the pronotum and of the hemelytra finely, unevenly, not densely punctate; scutellum finely transversely rugulose; length, 15–17 mm., width, 5–6.5 mm.

New England west to Wisconsin and Illinois, south and southwest to Florida, Texas.

Tribe 5. *CORECORINI* Van Duzee 1916

(*Menenotini* Bergroth 1913)

KEY TO GENERA

A. Veins of membrane distinctly and irregularly anastomosing; humeri prominent and reflexed or projected upward; abdomen very widely inflated, body widest behind the middle; antennal segment IV *not* longer than III; metasternal pleura with a posterior margin *broadly rounded*.

I. *Corecoris* Hahn 1834

(*Spartocera* Laporte 1832)

B. Veins of the membrane forked, *not* anastomosing; humeri *not* prominent nor reflexed; sides of the abdomen subparallel, *not* suddenly widely inflated; antennal segment IV longer than III; posterior margin of metasternal pleura *straight*

II. *Sephina* Amyot & Serville 1843

Genus I. *Corecoris* Hahn 1834

(*Spartocera* Laporte 1832)

KEY TO SPECIES

A. Antennae reaching behind the base of the pronotum, segment I *distinctly* longer than the head, II, III and IV subequal; length 20–24 mm., width, 6.5–8 mm.

*fuscus* Thunberg 1783

(= *confluentus* Say 1832)

Florida, Arizona, California.

- B. Antennae hardly reaching the base of the pronotum, segment I *but little* longer than the head, II and III subequal, IV shorter by one-third than either; length, 17–20 mm., width, 7–8 mm. .... *diffusus* Say 1832  
 North Carolina to Texas and New Mexico.

Genus II. *Sephina* Amyot & Serville 1843

KEY TO SPECIES

- A. Scutellum almost flat; (antennal segments I, II and IV subequal, III shorter; rostrum reaching intermediate coxae; connexivum alternated with black above and below); corium concolorous; length, 16–18 mm., width, 6–7 mm.

*grayi* Van Duzee 1909

Florida; on *Metastelma scoparium* (climbing milkweed) and on elder.

- B. Scutellum with a transverse ridge and behind the ridge a furrow; corium with a velvety black spot in the middle; length, (same as above?) ..... *gundlachii* Guérin 1857  
 Florida, with the preceding (Blatchley).

N.B.—Although doubtfully listed by Van Duzee as from “Calif.,” *Sephina limbata* Stål is omitted from the above key. H. G. Barber states it does not occur in the United States.

Tribe 6. *CHARIESTERINI* Amyot & Serville 1843

Genus I. *Chariesterus* Laporte 1832

1. Antennae dilated *equally* on *both* sides of segment III; (dilation of segment III at least  $\frac{4}{10}$  as wide as the segment is long; legs and antennae black, body above brown, below white-farinaceous; length, 11 mm., width, 3.75 mm.).

*albiventris* Burmeister 1835

Texas, Arizona, (Mexico).

Antennal segment III *more angularly dilated* on *lower side* 2

2. Anterolateral margins of pronotum armed with distinct tubercles in front of humeri; antennal segment I with distinct acute tubercles which are larger near its base ..... 3

Anterolateral margins of the pronotum unarmed in front of the humeral spine; antennal segment I with acute tubercles *at base only*, or unarmed; (dilation of antennal segment III not notched; spines of pronotum remarkably long and slender; length, 10 mm., width, 2.5–3 mm.).

*cuspidatus* Distant 1892

Texas (to Panamá).

3. Pronotum *with* expanded elevated lobes at each humeral angle, armed with 4 or 5 acute processes of the same size; head with a prominent multispinose tubercle behind each eye; length, ? (not given in original description).

*balli* Fracker 1919

California.

Pronotum *without* expanded lobes, armed with one large tooth, preceded by several smaller; head with postocular tubercles smooth or slightly muricate; length, 11–14 mm., width, 3–4 mm. .... *antennator* Fabricius 1803  
New York south to Florida and Texas, west to Oklahoma and Colorado; on *Euphorbia corollata*, *Solidago* and cotton.

Tribe 7. *CHELINIDINI* Blatchley 1926

Genus I. *Chelinidea* Uhler 1863

The following selected structural characters of the genus are taken from Uhler's original description, omitting those which experience has shown to be specific: Tylus defined almost to the base of the head; juga produced on each side in a conical point; antennae prismatic, granulose, the edges carinate, segments II and III subequal, III with a minute tooth at the apex, and a minute segment between III and IV, IV fusiform; bucculae wide, more than one-third the length of rostral segment I, obliquely truncate anteriorly, rounded and acute posteriorly; rostrum reaching upon the abdomen, segment I very stout, cylindrical, segments II, III and IV flattened; sternum with a rostral sulcus; corial veins prominent, costal margin acutely elevated, veins of the membrane numerous, forked; posterior femora incrassate, cylindrical, little curved, with two rows of slender teeth beneath, anterior and middle femora denticulate beneath apically, tibiae prismatic, upper edges carinate, posterior tibiae granulated inside.

KEY TO SPECIES

1. Head two-thirds the median length of the pronotum; (juga abruptly pointed, barely surpassing the tylus; antennal segments I, II and III regularly angulate, I carinate; margins of pronotum carinated only and terminating in blunt teeth at the anterior angles of the pronotum; anterior femora with 2–3 small teeth apically; tibiae triangular, their upper edges carinate; length, 10–15 mm., width, 3–5.5 mm.) *vittiger* Uhler 1863 ..... 2  
Virginia (Uhler), Montana, Idaho, Wyoming, Colorado,

Utah, New Mexico, Arizona, California; on *Opuntiae* and *Echinocereus*.

Head subequal in length to the median length of the pronotum 3

2. Postocular spines short, rather blunt, with a distinct notch at the base; pronotal margins elevated anteriorly.

*v. var. vittiger* Uhler 1863

Wyoming, Colorado, Utah, New Mexico, Arizona, California; on *Cereus giganteus*.

Postocular spines reduced to blunt tubercles, or entirely missing; pronotal margin low anteriorly, at times rounded and without a carina ..... *v. var. aequoris* McAtee 1919  
Virginia, North Carolina, Alabama, Texas, Arizona.

3. Juga regularly conical, acutely pointed, much surpassing the tylus; (segment I of antennae foliaceous within; lateral carinae of the pronotum slightly raised and produced at the anterior angles into distinct acute teeth; anterior femora with 5-9 apical teeth; tibiae triangular, with the edges distinctly raised; length, 10-15 mm., width, 3.5-5 mm.) ..... *tabulata* Burmeister 1835  
Texas, Colorado, Utah, California, Arizona; on *Opuntiae* and *Imbricatae*.

Juga abruptly pointed, *not* surpassing tylus ..... 4

4. Antennal segments I, II and III regularly angulate; anterior angles of the pronotum without teeth or tubercles; juga slightly surpassed by tylus; anterior femora with 3-6 teeth apically in two rows; tibiae carinate only; length, 9.5-10.5 mm., width, 3.5-4 mm. .... *hunteri* Hamlin 1923  
Arizona; (Sonora, Mexico); on *Opuntiae*.

Antennal segments I, II and III with the anterior edges much elevated and flattened; lateral margins of the pronotum in distinct compressed crests upwardly curved, with a strong acute tooth at the anterior angles of the pronotum; juga slightly shorter than the tylus, or just reaching its apex; anterior femora with 2-3 small teeth; tibiae triangular, all edges prominently elevated, posterior tibiae with the outer edges almost foliaceous; length, 11-14 mm., width, 4-4.5 mm. .... *canyona* Hamlin 1923  
Texas; on *Opuntiae* and *Echinocereus*.

Tribe 8. *COREINI* Stål 1867

KEY TO GENERA

1. Posterior femora armed beneath with one or several spines; body elongate ..... 2  
 Posterior femora *not* spined; body oblong or long oval; (legs moderately long, apex of posterior femora reaching to or passing ventral segment IV) ..... 4
2. Humeri produced into long sharp spines outwardly directed; length less than 10 mm; (a small spine outwardly on the antennal tubercle; apex of posterior femora reaching to abdominal segment VI; anterolateral margin of the pronotum with a few coarse blunt teeth or elongated tubercles, two similar tubercles on the anterior part of the pronotum, close to the collar; posterior femora clavate).

X. *Zicca* Amyot & Serville 1843

- Humeri *not* spined; length over 14 mm. .... 3
3. Head *with* prominent *postantennal* spines (not lateral to the antenniferous tubercle).

IX. *Anasa* Amyot & Serville 1843

Head *without* spines or tubercles, either *postantennal* or *lateral*; (legs very short, apex of posterior femora not passing ventral segment V; anterolateral margins of the pronotum serrate, no tubercles anteriorly on the pronotum or elsewhere; posterior femora not clavate).

III. *Namacus* Amyot & Serville 1843

4. Veins of membrane numerous, irregularly anastomosing or almost reticulated; tylus elevated and compressed above juga to form a carina between the bases of the antennae ..... 5  
 Veins of membrane reduced in number, coarser, simple or slightly furcate; tylus not compressed and elevated above the juga ..... 7
5. Process of antenniferous tubercles *acute*; antennal segment I stoutest, narrowed and curved at base; anterior angles of the pronotum sharply produced anteriorly; (rostrum not or barely reaching intermediate coxae; pronotum much wider than long, posterolateral margins deeply sinuate; corium with moderately fine punctures).

II. *Margus* Dallas 1852

Process of the antenniferous tubercles *blunt* or *absent*; antennal segment I stoutest, *not* curved at base; anterior margin of the pronotum straight, without produced acute anterior angles ..... 6

6. Antennal segment I longer than the head; entire dorsal surface sparsely granulated or covered with coarse punctures; (posterolateral margin of the pronotum obsoletely sinuate).

IV. *Scolopocerus* Uhler 1875

Antennal segment I *much* longer than the head; entire dorsal surface thickly covered with seta-bearing tubercles.

V. *Nissoscolopocerus* Barber 1928

7. Rostrum almost reaching, or passing, the *intermediate* coxae; anterolateral margins of the pronotum entire or nearly so ..... 8

Rostrum hardly going beyond the *anterior* coxae, (apex of segment I not extending behind the posterior margin of the eyes); anterolateral margin of the pronotum feebly toothed, (collar distinct); (median lobe of the head hardly produced anteriorly beyond the antennal tubercles; bucculae quite high, one-half the length of the head, abruptly declivous posteriorly; scutellum equilateral; body narrowly oval or ovate) .....VIII. *Cimolus* Stål 1862

8. Apex of rostral segment I *not* extended beyond the posterior margin of the eyes, (ocelli much nearer to the eyes than to each other; humeri acute, anterolateral margin of the pronotum entire, rounded, neither acute nor carinate).

XI. *Hypselonotus* Hahn 1831

Apex of rostral segment I extended beyond the posterior margin of the eyes ..... 9

9. Antennae filiform, segment IV ovoid, I clavate apically, (III subequal to I and II taken together; humeri acute, anterolateral margins of the pronotum rough; head slightly broader than long, quadrate, granulose, with neither spines nor tubercles; ocelli further from each other than from the eyes; not over 10 mm. long) .....I. *Madura* Stål 1860

Antennae slender, but *not* filiform, segment IV fusiform, or as slender as the other segments, I *not* clavate apically ..... 10

10. Antennal segment IV longest, slender; head broader than long, quadrate, antenniferous tubercles prominent, subglobose; posterior area of the pronotum coarsely transversely rugulose, humeri angulate; colored metallic blue with a broad yellow transverse band on the corium; (length over 15 mm.) .....XII. *Paryphes* Burmeister 1835

Antennal segment IV *not* longest; head longer than broad; antenniferous tubercles neither prominent nor globose; posterior area of the pronotum *not* rugulose, humeri rounded; no yellow band across the corium ..... 11

11. Apex of rostral segment I *not or barely* reaching the anterior margin of the prosternum; head very wide and subdepressed, eyes projecting distinctly beyond the apical angles of the pronotum; (antenniferous tubercles somewhat, or distinctly, produced into *lateral* tubercles or spines, the distance between the bases of these and the eyes shorter than the longitudinal diameter of one eye; ocelli nearly twice as far from each other as from the eyes; spiracles set nearer to the lateral margins of the ventral segments than to the anterior or posterior margins).

VI. *Catorhintha* Stål 1859

Apex of rostral segment I *passing* the anterior margin of the prosternum; head narrower and more convex ..... 12

12. *With, or without*, a postantennal spine or tubercle, and *without* a *lateral* spine or tubercle on the antenniferous tubercles; eyes not, or but slightly, projecting beyond the anterior angles of the pronotum; ocelli *as far* from each other as from the eyes ..... IX. *Anasa* Amyot & Serville 1843

*Without* a postantennal spine or tubercle, but *with* a *lateral* tubercle on the antenniferous tubercle; eyes distinctly projecting beyond the anterior angles of the pronotum; ocelli *more distant* from each other than from the eyes.

VII. *Ficana* Stål 1862

Genus I. *Madura* Stål 1860

The generic characters as given by Stål (in part) are: Head quadrate, anteriorly short subtriangularly produced; antennae somewhat shorter than the body, segment I nearly equal in length to the head and thorax taken together, its apex abruptly incrassate, IV short, fusiform; rostrum reaching posterior coxae; pronotum as wide as long, quite narrowed anteriorly; scutellum longer than wide; membrane of hemelytra irregularly veined, veins curved, anastomosing; femora slightly enlarged apically.

The single species recorded north of Mexico is

*M. perfida* Stål 1862

Its character as given by Stål are: Antennae somewhat shorter than the body, segment I one and one-half times as long as the head, II one-third shorter than I, III nearly two and one-half times the length of II, IV a little shorter than II, fusiform, slightly compressed; length, 6.5 mm., width, 1.5 mm.

Texas.

Genus II. *Margus* Dallas 1852

1. Apex of the antenniferous tubercles *unarmed*, obtuse, rounded; rostrum reaching the intermediate coxae, segment I hardly passing the eyes posteriorly; antennal segments II and III slightly thickened, III shorter than II; apical angles of ventral segment III hardly, of IV, V, and VI, distinctly and subacutely prominent; (length, 11.75 mm., width, 4.7 mm.) ..... *inconspicuus* Herrich-Schaeffer 1842  
Colorado, New Mexico, Texas, Arizona, California.

Apex of antennal tubercles exteriorly *acutely produced*; rostral segment I more or less extended behind the eyes; humeri very slightly widened, anterolateral margins of the pronotum straight or very slightly sinuate; apical angles of the ventral segments not or hardly prominent; antennal segment II hardly or slightly incrassate basally ..... 2

2. Antennal segment IV longer than I; length, 9-11 mm., width, 3-3.7 mm. .... *obscurator* Fabricius 1803  
Florida, (Neotropical); on *Senecio* and thistle, in grasses and at light.

Antennal segment IV shorter than I, (segments II and III stout, II very slightly incrassate toward the base; rostrum reaching intermediate coxae); length, 8 mm.

..... *repletus* Van Duzee 1925  
California.

Genus III. *Namacus* Amyot & Serville 1843

The following characters are additional to those in the key: Ocelli large, distant, but not very close to the eyes; antennal segment I slightly thickened and longer than the prolongation of the head, II about as long as I, slender, as well as III which is a little shorter than II, IV hardly longer, fusiform; rostrum reaching to the intermediate coxae; all femora of equal thickness, not enlarged, posterior femora with a few spines apically.

Our one species north of Mexico is

*N. annulicornis* Stål 1870

In this species the head is slightly longer than one-half the length of the pronotum, with the disc, juga and tylus behind the middle punctate, the tylus elevated, prominent, unarmed; antennae more than one-half as long as the body, segments I and III subequal, IV three-quarters the length of III, II one-third longer than I or III; posterior margin of the pronotum nearly twice as wide as the anterior; anterior femora of male armed beneath along the whole

length with extremely minute spines, posterior femora with distinct spines; anterior femora in female beneath near the apex with a small spine, posterior with a few small spines toward its apex; length, 13-15 mm., width, 3-4 mm.

Florida, (Mexico).

Genus IV. *Scolopocerus* Uhler 1875

KEY TO SPECIES

1. Antennal segment IV *not stouter* than III, and about one-half the length of the latter, all segments stout; (no spine behind eyes, but a small tumid elevation or lobe behind each eye; length, 6.75-7 mm., width, 1.9-2 mm.).

*secundarius* Uhler 1875

California, Nevada, Colorado, Arizona, Texas.

Antennal segment IV *much stouter* than III, segments II and III much more slender than I and IV ..... 2

2. Antennal segment IV *pyriform*; two short black obliquely set spines behind each eye; apex of the rostrum reaching to middle of intermediate coxae; pronotum much wider than long; length, 7-8.25 mm., width, 2.6 mm.

*granulosus* Barber 1914

Texas, Arizona.

Antennal segment IV *long ovate*, without spines behind eyes; apex of the rostrum reaching the base of the metasternum; pronotum about as wide as long; length, 8 mm.

*uhleri* Distant 1881

Arizona, New Mexico, (Mexico).

Genus V. *Nissoscolopocerus* Barber 1928

The following characters are selected from Barber's original description: Head nearly quadrate, shorter than the pronotum; tylus anteriorly strongly reflexed; ocelli tumid, in line with the posterior margins of the eyes; antennal segment I much incrassate, porrect, longer than the head, densely apiculate and hispid, segments II and III much more slender, IV strongly incrassate; proster-num posteriorly, meso- and metasternum anteriorly, sulcate; legs terete, unarmed, tibiae obsoletely sulcate, tarsal segment I subequal to II and III taken together; posterior coxae widely separated; ostiolar peritreme calloused and interrupted at apex; first, second and third incisures of venter straight at middle, curved toward the sides.

The one species (and type of the genus) is

*N. apiculatus* Barber 1928

(*Dasycoris humilis* Uhler 1875, not 1872)

These characters of the species are selected from Barber's original characterization: Roughly granulate and in great part finely apiculate and hispid; antennal segment I attenuated at base, II and III subequal, very much more slender and finely hispid, IV subpyriform, acuminate, more than the basal half finely hispid, the apical part finely pilose; legs terete, unarmed, hispid; each pleurite with a black sunken pit midway between the acetabula and the lateral margins, the surface densely covered with setigerous tubercles; length, 9-9.5 mm., width, 2.6 mm., (macropterous), 1.85 mm. (brachypterous).

Alberta, Canada; Nebraska, Colorado, New Mexico.

#### Genus VI. *Cathorhintha* Stål 1859

##### KEY TO SPECIES

1. Antenniferous tubercles outwardly produced into anteriorly directed spines or conical tubercles ..... 2  
 Antenniferous tubercles unarmed, or at most with an indication of a tubercle ..... 5
2. Antennal segment III *equal in length* to IV; (head spines very long and slender; connexivum with faint infuscated spots above on each segment; venter immaculate except for a distinct black spot on each pleura and laterally on each abdominal segment, except VI, in which the spot is nearly obsolete; length, 10.8-11.5 mm., width, 3.1 mm.).  
*viridipes* Blatchley 1926  
 Florida.  
 Antennal segment III *shorter* than IV ..... 3
3. Antennal segment I *subequal in length* to head; (legs and venter conspersed with large black spots; head spines short, blunt, almost like elongated acute tubercles; connexivum black-spotted; length, 10-12 mm., width, 3-3.7 mm.).  
*mendica* Stål 1870  
 Illinois, Ohio, Indiana, Minnesota, Dakota, Colorado, Oklahoma, Texas, Arizona; on *Rhus aromatica* and *Allionia nyctaginis*.  
 Antennal segment I *shorter* than the head ..... 4
4. Legs and abdomen finely black consperse; head spines thin and acute; head, pronotum and scutellum *without* a median pale stripe; length, 8-9 mm., width, 2.5-2.7 mm.  
*guttula* Fabricius 1794

Florida, Texas, Oklahoma, New Mexico, Colorado, Arizona, California, (South America); on *Xalisma ferruginea*.

Legs immaculate, abdomen consperse and clouded; head spines short and stout; head, pronotum and scutellum with a conspicuous pale median levigate stripe; (humeri rounded; rostrum reaching intermediate coxae); length, 9.3 mm., width, 2.5 mm. .... *borinquensis* Barber 1923  
Puerto Rico.

5. Humeri subacute; a distinct smooth callous pronotal carina running anteriorly to the transverse sulcus; (pleura unspotted; a large black lateral spot on abdominal segment II, followed by smaller ones on segments III, IV, and V; antennal segment I much shorter than the head; length, 11.5–12 mm., width, 3.25 mm.) .... *divergens* Barber 1926  
Florida, (Cuba, Mexico).

Humeri rounded; pronotal carina, if present, fine and *indistinct* ..... 6

6. Legs and abdomen finely sparsely consperse with small black dots; apex of antennal segment III not flavescent; length, 9–11.25 mm., width, 2.5–3 mm. .... *selector* Stål 1859  
Texas, New Mexico, Arizona, (Mexico).

Legs and abdomen consperse with conspicuous black dots; apex of antennal segment III flavescent; length, 10.5–11.5 mm., width, 2.9–3.5 mm. .... *selector* var. *texana* Stål 1870  
Texas, Oklahoma, New Mexico, Arizona, (Mexico).

Genus VII. *Ficana* Stål 1862

The structural characters following are taken from the original description: Antennal tubercles not at all produced, the distance between them and the eyes equal to the longitudinal diameter of the eye; segment I of rostrum reaching the prosternum.

The one species recorded from the United States is:

*F. apicalis* Dallas 1852

The original description of this is all by color, with no structural characters mentioned, except the length only. Stål gives (Enumeratio I: 188): Antennal tubercles apically on the outer side with an easily seen small spine. From Distant's figure in *Biologia*, we find the antennae to be as long as the head, pronotum and scutellum taken together; length, 12.5–14.25 mm., width, 4.1–4.5 mm.

Arizona, California, Colorado.

Genus VIII. *Cimolus* Stål 1862

These are selected structural characters from the original generic description: Form narrow oval or ovate, hardly depressed; head square; collum tuberculate on each side behind the eyes; bucculae quite high, half as long as the head, posteriorly abruptly cut off; rostrum hardly passing the anterior coxae, segment I hardly longer than one-half the length of the head, II and III subequal, IV hardly longer than III; scutellum equilateral; abdomen hardly wider than the hemelytra; femora unarmed; segment I of the posterior tarsi hardly longer than the two following taken together.

The one species recorded from north of Mexico is:

*C. obscurus* Stål 1870

The following are all the structural characters given in the original and only description of the species: Antennal segments I and III subequal, II longer than either, IV two-thirds the length of III; anterolateral margins of the pronotum obsoletely denticulate before the middle, or finely serrate, anterior angles with a prominent tooth; length, 12.4–14 mm., width, 4.6–5.8 mm.

South Carolina, Louisiana, Texas (sec. Stål); on *Melothria pendula*.

Genus IX. *Anasa* Amyot & Serville 1843

## KEY TO SPECIES

1. Head *without* a spine or tubercle behind the base of the antenna; (antennal segment I one-third longer than the head, II longer than I, III nearly equal to II, IV shorter than either; rostrum reaching intermediate coxae; pronotum broader than long, with a median longitudinal smooth white line; length, 12–16 mm., width, 5–7 mm.)  
*repetita* Heidemann 1905  
Massachusetts, New York, Maryland, District of Columbia, Virginia, Indiana; on wild cucumber, *Sycios angulatus*, a definite food-plant.
2. Head *with* a spine or tubercle behind the base of the antenna ... 2
2. Tubercle behind the base of the antenna very small, or prominent and blunt; femora *unarmed* below; humeri rounded, little produced, posterior angles of the pronotum rounded or subangulate; head with a median pale longitudinal line ... 3
- Head spines very prominent, longer than the diameter of an eye; femora *armed* below near the apex with one or two spines;

posterior angles of the pronotum toothed or acute; head *without* a pale line ..... 4

3. Anterior angles of the pronotum produced into a small blunt tooth, median pale line narrow, inconspicuous and obsolete behind the middle; antennal segment I *shorter* than the head; anterolateral margins of the pronotum nearly straight, thickened and reflexed, minutely serrulate; length, 13–18 mm., width, 4.2–6 mm. ....*tristis* De Geer 1773  
All over North America into Central America; extremely injurious to cucurbits.

Anterior angles of the pronotum *not* produced, median calloused smooth pale line conspicuous to near the posterior margin; (head tubercles long); antennal segment I as long as the head; anterolateral margins of the pronotum feebly crenulate; length, 13–16 mm., width, 4–5 mm.

*andresii* Guérin 1857  
(*lugens* Stål 1862)

Florida, Louisiana, Texas, New Mexico, California, (West Indies); on cotton.

4. Posterior angles of the pronotum *without* a tooth; length and width as *tristis* .....*uhleri* Stål 1857  
“Western States” (Uhler).

Posterior angles of the pronotum *with* a small tooth ..... 5

5. Antennal segment I *without* black spots, (II and III subequal, a little longer than I); length, 12–15 mm., width, 5–6 mm.

*scorbutica* Fabricius 1775

Florida, Texas, Oklahoma, (Mexico, West Indies).

Antennal segment I *with large* black spots, (I longer than the head); length, 13–17 mm., width, 4.5–6.5 mm.

*armigera* Say 1825  
(*spiniceps* Stål 1862)

Massachusetts to Iowa, South and southwest to Oklahoma and Texas; on *Sycios angulatus*; injurious to cucurbits.

- N.B.—*Anasa obliqua* Uhler 1861 (described in genus *Gonocerus*), from California, is not included in the key, although listed by Van Duzee as a species. The only structural characters Uhler gives are found also in *A. tristis*. Barber deems it a variety of the latter species.

Genus X. *Zicca* Amyot & Serville 1843

Additional characters to those in the key are: Body quite elongate; antennal segments II, III and IV of nearly equal length;

pronotum elongate trapezoidal, inclined anteriorly, humeri produced into a sharp spine; hemelytra longer than the abdomen; posterior femora swollen, with a few strong spines below.

There is one species of this north of Mexico:

*Z. taeniola* Dallas 1852

In this, the anterolateral margins of the pronotum have a few white teeth and the humeri are very prominent and acute; scutellum very thinly and finely punctured with black; corium with a small white impunctate spot on the disc; abdomen very minutely punctured laterally with a row of black points on each side and two similar points on the base of ventral segment III; sternum thickly and finely brown punctate, with two black dots on each side and two smaller ones close to the coxae; length, 7.3 mm. Doubtfully recorded from "North America" by Van Duzee.

West Indian, and may be found in Florida.

Genus XI. *Hypselonotus* Hahn 1831

(Femora unarmed; body white beneath, without numerous black spots, the sternum and venter sometimes with a few points or dots, but with the margins always immaculate.)

A. Sternum and venter marked with a few black points or spots; rostrum pale, apex of segment IV black; venter with small spots in 3 or 5 rows; length, 13 mm., width, 4 mm.

*punctiventris* Stål 1862

Texas.

B. Sternum and venter immaculate; rostral segment IV black; (vertex in front of ocelli bivittate with black); length, 13–15 mm., width, 4 mm. .... *fulvus* De Geer 1773

Texas.

N.B.—According to McAtee, *fulvus* is the full species; all the other named forms are varieties of it.

Genus XII. *Paryphes* Burmeister 1835

The following generic characters are additional to those in the key: Head short, wider than long, antennal tubercles very prominent, antennae as long as the abdomen; margin of pronotum notably dilated and elevated into broad auriculate lobes; rostrum reaching to posterior coxae, segment IV shortest, the others of equal length; legs slender, femora unarmed.

There is but one species of this genus recorded for America north of Mexico, namely:

*P. rufoscutellatus* Gray 1832

This species was listed by Stål (Enumeratio I: 205) in *Sundarus* Amyot & Serville, in which he was followed by Horváth (1913), but it was unknown in nature to the latter. The only locality mentioned down to Distant (Biologia Centrali Americana, Rhynchota I), is Mexico, hence it is best omitted from further consideration. Banks in his Catalogue records it from "Calif.," but although Van Duzee cites it in his Catalogue, he questions it.

Tribe 9. *DISCOGASTRINI* Stål 1867Genus I. *Savius* Stål 1862

The following generic characteristics are additional to the key characters given for the tribe: Body elongate, somewhat depressed; head quadrate, middle lobe filling the space between the antennal tubercles, deflexed; rostrum slightly passing the anterior coxae, segments I, II and III subequal, I a little shorter than the head, IV longer than the others; antennae somewhat shorter than the body, segment IV shorter than II and III taken together, II slightly longer than III and shorter than I; pronotum with a collar; abdomen slightly wider than the hemelytra; basal segment (I) of posterior tarsi longer than II and III taken together.

The one species reported north of Mexico is  
*S. jurgiosus* Stål 1862

Characters of the species, taken from the original description are: Antennal segment I somewhat longer than II, III slightly shorter than II, IV slightly longer than I; pronotum longer than wide, quite densely granulate, humeri straight, slightly prominent; postocular tubercle small, distinct, convex, somewhat conical; length, 16 mm., width, 5 mm.

Texas, (Mexico).

Subfamily 3. *Pseuphloeinae* Stål 1867

## KEY TO GENERA

- A. Apex of rostrum *not reaching* middle coxae; humeri rounded, *unarmed*; length, over 10 mm. .... I. *Ceraleptus* Costa 1847  
B. Apex of rostrum *reaching between* middle coxae; humeri with an acute spine or tooth; length, not over 9 mm.  
II. *Coriomeris* Westwood 1842

Genus I. *Ceraleptus* Costa 1847

## KEY TO SPECIES

- A. Apex of tylus *passing beyond* middle of antennal segment I; lateral margins of head subparallel or slightly converging anteriorly; antennal segment III *longer* than IV; anterior angles of the pronotum *not* produced anteriorly; intermediate femora with *one* small spine subapically; (antennal segments I and II subequal, III slightly longer than IV, IV slightly shorter than II); length, 7-8 mm.

*pacificus* Barber 1914

Oregon, Washington, California, Vancouver Island.

- B. Apex of tylus *not* reaching middle of antennal segment I; lateral margins of head widened anteriorly; antennal segments III and IV subequal; anterior angles of the pronotum produced anteriorly; intermediate femora with *two* small spines subapically; length, 9 mm., width, 3 mm.

*americanus* Stål 1870

New York, Florida, Texas, Arizona, California, Utah.

Genus II. *Coriomeris* Westwood 1842

## KEY TO SPECIES

- A. Segments I, II and III of antennae of equal length, IV one and one-quarter times as long as III; head as long as wide; humeri acute, *not* spined; hemelytra surpassing abdomen; length, 8.3-8.5 mm., width, 2.3-2.4 mm.

*nigricornis* Stål 1870

Colorado, (Mexico).

- B. Antennal segment I longest, II equal to [distinctly shorter than (Uhler)] III, which is slightly longer than IV; head longer than wide; humeri with an acute spine, (posterior angles of the pronotum with a long slender spine); hemelytra as long as abdomen, not surpassing it; length, 8.5-9 mm., width, 2-2.5 mm. .... *humilis* (Uhler) 1871  
Kansas, Colorado, Texas, Arizona, California, North Dakota, Vancouver Island.

N.B.—*C. nigricornis* does not appear to have been redescribed since Stål characterized it in 1870 (Enumeratio I: 219), entirely by color pattern, except for the proportions of the antennal segments and the size; and except for Distant's figure (Biologia Centrali Americana, Heteroptera I, pl. 15, fig. 12).

Family VIII. **ALYDIDAE** Amyot & Serville 1843  
(*Coriscidae* Blatchley 1926)

KEY TO TRIBES

1. Posterior femora *not* spined ..... 2  
Posterior femora armed beneath with a row of spines.
  3. *Alydini* Stål 1867  
(*Coriscini* Blatchley 1926)
2. Rostral segment IV twice as long as III, II longer than III and IV taken together ..... 1. *Micrellytrini* Stål 1867  
Rostral segment IV subequal to III, II *not* longer than III and IV taken together; (body and legs greatly elongated).
  2. *Leptocorisini* Stål 1867

Tribe 1. **MICRELYTRINI** Stål 1867

KEY TO GENERA

1. Juga exceeding tylus, contiguous above its apex; (posterior angles of the metapleura acute, more or less produced; humeri and apex of the scutellum *unarmed*) ..... 2  
Juga *not* exceeding tylus, *not* contiguous above its apex ..... 3
2. Juga, seen from the side, split at the apex and *much* longer than the tylus; antennal segments I and II subequal.
  - I. *Protenor* Haglund 1868  
Juga, seen from the side, entire at apex, *not* longer than the tylus (exceptionally passing tylus in *subvittatus*); antennal segment I about one-half or more the length of II.
  - II. *Darmistus* Stål 1859
3. Humeri *with* a spine; scutellum spined at apex; posterior angles of the metapleura more or less acute.
  - III. *Cydamus* Stål 1860  
Humeri *without* a spine; scutellum *not* spined at apex; posterior angles of the metapleura quadrate, rounded.
  - IV. *Esperanza* Barber 1906

Genus I. *Protenor* Haglund 1868

KEY TO SPECIES

- A. Head *less than* one-quarter longer than the pronotum; upper and lower pair of apical processes of juga contiguous or nearly so throughout their length; antennal segments I and II equal, III slightly shorter than either, IV less than one and one-half the length of II; rostral segment I passing base of head; length, 12-15 mm., width, 1.2-1.8 mm.  
*belfragei* Haglund 1868

Quebec and New England south to Maryland and Texas, and west to Colorado and California; in sedges and grasses in wet ground.

- B. Head one-half longer than the pronotum; upper process of the juga widely separated from the lower throughout their length; antennal segments I and III equal, II *slightly* longer, IV one and one-half length of II; rostral segment I barely reaching the base of the head; length, 11–11.5 mm., width, 1.3 mm. .... *australis* Hussey 1925  
Georgia, Florida.

Genus II. *Darmistus* Stål 1859

KEY TO SPECIES

1. Antennal segment I *one-half* the length of II, *three* times as long as its own diameter; antennae stout, heavily covered with setae which are nearly as long as the diameter of the segments; (juga not distinctly passing the tylus; rostrum reaching the posterior margin of the intermediate coxae; antennal segments III and IV subequal; length, 11 mm.).  
*crassicornis* Van Duzee 1937

Texas.

Antennal segment I *two-thirds* or slightly more the length of II, *four* times as long as its own diameter, (IV twice as long as I); antennae slender, setae not abundant ..... 2

2. Antennal segments II and III subequal, III *slightly* the longer; juga *distinctly* exceeding the tylus; length, 9.5–11.5 mm., width, 1.9–2.3 mm. .... *subvittatus* Stål 1859  
Colorado, California, Arizona.

Antennal segment II *distinctly* shorter than III, (about three-fifths the length of III); juga *not* exceeding the tylus; length, 11 mm. .... *duncani* Van Duzee 1937  
Arizona.

Genus III. *Cydamus* Stål 1860

KEY TO SPECIES

- A. Antennal segment I attaining the apex of the head, II and III subequal, IV a little shorter than the length of II and III taken together; (rostrum reaching posterior coxae, segment I reaching the posterior margin of the eye, II twice as long as III and IV taken together, IV twice the length of III); pronotum one-quarter longer than wide, humeral spines *erect*, acute; scutellum narrow, apical spine erect;

hemelytra reaching the apex of abdominal segment III; (ostiolar canal auriculate, prominent); length, 6-7 mm.

*abditus* Van Duzee 1925

Arizona; under stones.

- B. Antennal segment I surpassing the apex of the head, II and III subequal, IV as long as II and III taken together; pronotum nearly as wide, including the spines, as long; humeral spines directed *posteriorly*, acute; scutellum narrow, apical spine oblique; hemelytra reaching the apex of the abdomen; length, 9 mm., width, 2.2 mm.

*borealis* Distant 1881

Texas, (Guatemala).

#### Genus IV. *Esperanza* Barber 1906

To the key characters for the tribe and genus, these may be added, as found in Barber's original description: Head a little longer than the pronotum and wider with the eyes than the latter at the humeri, relatively large, apex of the tylus depressed, wide, exceeding the juga; rostrum reaching the base of the head, segment II longer than I, much longer than III and IV taken together; antennal segment I shorter than the antecular part of the head, slightly surpassing its apex, segment II longer than I and subequal to III, IV subequal to II and III taken together; pronotum about as wide as long, humeri not prominent, rounded, slightly tumid and unarmed; legs slender and unarmed.

The one species in the genus is

*E. texana* Barber 1906

The structural characters given in the original description are: Body narrow; prothorax coarsely punctate above and below, with a median longitudinal raised smooth line dorsally, anterolateral margins of the pronotum straight, rounded, punctured, a shallow transverse furrow one-third of the distance from its anterior margin; corium sparsely punctate with large fuscous punctures, more scattering discally and in rows along the veins; length, 7 mm.

Texas.

N.B.—This species has the aspect of a small *Alydus*, but the unarmed femora separate it at once.

#### Tribe 2. *LEPTOCORISINI* Stål 1872

##### Genus I. *Leptocorisa* Latreille 1829

In this genus—the only one of the tribe thus far known from north of Mexico—the following structural characters are additional

to the tribal ones in the key: Very slender, elongate; head relatively small and narrow; juga much longer than the tylus and contiguous anteriorly; antennae nearly as long as the body, segment I longest; rostrum reaching the intermediate coxae; anterolateral margins of the pronotum straight, smooth, the lateral carinae obsolescent on the anterior one-third of the margin; posterior coxae contiguous; posterior angles of the metapleura acute.

The one species found north of Mexico is

*L. tipuloides* DeGeer 1773

Distinguishing specific structures are: Head about two-thirds as long as the pronotum; antennal segments II and III, I and IV subequal, I and IV taken together longer than II and III taken together; pronotum with anterior one-third smooth, the remainder coarsely confluent punctate, humeri not prominent, rounded; scutellum and clavi coarsely and closely punctate, corium sparsely so; length, 14-16 mm., width 1.8-2 mm.

Florida, Mississippi, Texas.

Tribe 3 *ALYDINI* Stål 1867

(*Coriscini* Blatchley 1926)

KEY TO GENERA

1. Posterior tibiae flattened, *much curved*, produced into a distinct tooth *near* the apex; (humeri acutely spined or not; ostioles distinct, with a long canal).
  - I. *Hyalymenus* Amyot & Serville 1843  
Posterior tibiae terete, straight, subapical tooth obsolete or absent ..... 2
  2. Ostioles distinct, continued laterally in canals with calloused margins; antennal segment I surpassing the apex of the head, IV *subequal* to II and III taken together ..... 3  
Ostioles obscure or obsolescent, *without* a canal; antennal segment I *not* surpassing the apex of the head, IV *much shorter* than II and III taken together ..... 5
  3. Antennal segment I *longer* than II; ventral segment VI in the female medially split ..... 4  
Antennal segment I *shorter* than II; ventral segment VI in the female entire, *not* split .....IV. *Alydus* Fabricius 1803  
(*Coriscus* Blatchley 1926)
  4. Posterior femora *without* a tooth basally, posterior tibiae *without* a tooth; posterior tarsal segment I twice as long as II and III taken together .....II. *Megalotomus* Fieber 1861

Posterior femora *with* an obtuse tooth near bases, posterior tibiae *with* a small acute tooth; segment I of posterior tarsus as long as or longer than II and III taken together.

III. *Burtinus* Stål 1859

5. Posterior tibiae *without* spines; posterior margin of the pronotum with an *obsolete* tooth or without such tooth.

V. *Tollinus* Stål 1870

Posterior tibiae *with* two rows of strong spines; posterior margin of the pronotum *with* a median tooth.

VI. *Stachyocnemus* Stål 1870

Genus I. *Hyalymenus* Amyot & Serville 1843

(subgenus *Tiwarbus* Stål 1859)

KEY TO SPECIES

1. Humeri acute or subacute, not spined; [(rostrum reaching or nearly reaching posterior margin of the *intermediate* coxae, segments I and II equal, each twice as long as III; antennal segment IV about one-fifth longer than I and II taken together; pronotum *less* than one and one-quarter times as wide, including the spines as its median length, one and three-fifths times as long as the scutellum, and two and one-half times its width; length, 13.65–17 mm. (males, sec. Van Duzee), width, 2.75 mm. (female)].

*subinermis* Van Duzee 1923

Arizona, (Sonora, Mexico).

- Humeri produced into distinct long spines ..... 2
2. Base of pronotum *with* a small pale calloused spot medially; pro-, meso- and metapleura near the acetabula with a large smooth white or flavescent spot, sometimes absent in the propleura; posterior femora in both sexes below *without* tubercles or spines toward the base from the middle spine, male posterior tibiae serially crenulate, tuberculate or bluntly dentate below at the middle of the curve, simple in the female ..... 3
- Base of pronotum *without* a median spot; pleura *without* large smooth *pale* spots; posterior femora in the male *tuberculate* for their entire length, posterior tibiae in both sexes simple, entire at the middle, neither tuberculate, granulate nor crenulate; (posterior femora with only the *apical* one-fourth black; venter concolorous; length, 17 mm., width, 3 mm.) ..... *pulcher* Stål 1854
- Texas?, (Honduras).

3. Venter *with* a broad white or pale median vitta on segments III, IV and V; antennal segment IV more than twice the length of I ..... 4  
 Venter *without* a median vitta, concolorous; segment IV of antennae twice, or *less* than twice, the length of I ..... 5
4. Rostrum reaching to or going *slightly* beyond the *intermediate* coxae; male femora with a short, thick, high black carina, which is sometimes obsolete or shows as coarse black spines, before the apical series of spines; (pronotum *nearly* one and one-half times as broad as its median length; antennal segment IV three times as long as II or III, which are *equal*; humeral spines slender; apex of scutellum acute; pronotal teeth at the basal angles of the scutellum short, acute, white-tipped; length, 13.25–17 mm., width, 2.5–3.25 mm.) ..... *tarsatus* Fabricius 1803  
 Texas, Arizona, California, (Neotropical).

Rostrum going *much* beyond the intermediate coxae and reaching, or nearly reaching, the posterior coxae; male femora with only two black subapical spines and between them a series of short blunt black teeth, which two spines are preceded by one, two or three short spines of varying length; femoral carina, if present, low and narrow, (head *distinctly shorter* than the median length of the pronotum; pronotum, including spines more than one and three-quarters times as wide as its median length; antennal segment IV not quite two and one-eighth times the length of I; length, 10.5–14.25 mm., width, 3.5–4.2 mm.).

*longispinus* Stål 1870

Florida, (West Indies).

5. Antennal segment II *slightly* longer than III, IV *twice* as long as I; pronotum, including the humeral spines, twice as wide as its median length; length, 13–15.75 mm., width, 4.1–4.5 mm. .... *notus* Torre-Bueno 1939  
 Florida.

Antennal segments II and III *equal*, IV *one and three-quarters the length of* I; pronotum, including spines, *less than* twice as wide as its median length; length, 13.75–16.35 mm., width, 3.75–4.5 mm. .... *potens* Torre-Bueno 1939  
 Florida.

N.B.—The figure of *H. longispinus* Stål in Blatchley, Heteroptera of Eastern North America (fig. 54, p. 262), is singular in that it shows only the teeth at the posterior angles of the

pronotum, but not the smaller ones on the posterolateral margins below the humeral spine, which are present in all specimens examined by me. His generic characterization is subject to improvement, particularly as to the abdominal spines. In all the species examined by me, rarely is abdominal segment II either spined or acutely produced; the spined apical angles are in general III-VI, and are male characters nearly exclusively. If his figure is accurate, he had before him a distinct species; or else his figure is not exact.

Genus II. *Megalotomus* Fieber 1861

Structural characters in addition to those in the generic key are: Head triangular, about as long as the pronotum; antennae one-half or more as long as the body, I surpassing the apex of the head, II slightly longer than III, IV equal to or slightly longer than II and III taken together; rostrum passing intermediate coxae, segment IV longer than III; pronotum nearly square, anterolateral margins carinate, slightly sinuate; abdomen *not* wider than the hemelytra; posterior femora not greatly enlarged, with a row of stout spines beneath on outer margin.

Of the two species in the genus the one thus far recorded from north of Mexico is:

*M. quinquespinosus* Say 1825

Selected specific structures are: Humeri prominent, acute; pronotum with a wide vague longitudinal depression, disc finely and densely punctate, posterior margin sinuate, concave at middle; length, 14-16 mm., width, 3-3.7 mm.

Quebec and New England south to North Carolina and west across the continent; nymphs have been found on *Ceanothus americanus*.

Genus III. *Burtinus* Stål 1869

These are a few structural characters to distinguish the genus in addition to those in the generic key: Antennal segment IV shorter than II and III taken together; posterior tibiae beneath with a sub-apical spine.

Of the two described species the one recorded from north of Mexico is:

*B. notatipennis* Stål 1859

Specific characters are: Elongate, slender, widened posteriorly, rather thickly brown-punctate; head feebly pubescent; antennal seg-

ments I, II and III subequal; humeri subacute; posterior femora clavate, the apical half with 3 or 4 stout spines and 2 or 3 minute teeth; length, 11-13 mm.

Florida, Texas, Arizona.

Genus IV. *Alydus* Fabricius 1803  
(*Coriscus* Schrank 1796)

KEY TO SPECIES

1. Venation of membrane *simple*, veins *not* irregular and only slightly anastomosing; (male clasper *not* toothed toward apex); posterior femora *without* a pale ring ..... 2  
 Venation of membrane, or *at least* of its costal one-third, irregular, with anastomosing veins; (male clasper *with* an enlarged stout tooth near the apex); posterior femora very slender, with a pale ring; (antennal segments I, II and III subequal; scutellum deep velvety black with apex pale; length, 9 mm.) ..... *scutellatus* Van Duzee 1903  
 Montana, Colorado, New Mexico, British Columbia, Alberta.
2. Humeri *acute*, anterolateral margins of the pronotum *pale*, calloused, impunctate; (length, 9.5-14 mm., width, 2-2.7 mm.) ..... *pilosulus* Herrich-Schaeffer 1848  
 Maine to Florida and Texas, west to Kansas and Wisconsin, Oklahoma, California; on *Saponaria officinalis*.  
 Humeri *not* acute; anterolateral margins of the pronotum concolorous ..... 3
3. Claspers of male with caudomesal margins subparallel, caudal aspect narrow; female of *pluto* with the lateral plates of the hypopygium terminating in a tumid, finger-like process, ventral segment VI with a distinct median carina ..... 4  
 Claspers of male with the caudomesal margins *not* parallel; lateral plates of the female hypopygium flat, *not* tumid at tip, ventral segment VI with carina short, indistinct or absent ..... 5
4. Antennal segment IV shorter than II and III taken together, II and III subequal; body black, *not* densely pilose; length, 10.5-13 mm., width, 3 mm. .... *pluto* Uhler 1872  
 Vancouver Island south to California and Arizona, Idaho, Kansas, Louisiana, Texas.  
 Antennal segment IV over one-third longer than II and III taken together, III shorter than II; body variegated with fuscous, densely pilose; length, 10 mm., width 2.6 mm.; (rostral

segment I longest, subequal to III and IV taken together, IV one-half longer than III) .....*tomentosus* Fracker, 1918  
 Colorado, Arizona.

5. Male claspers *twisted*, *not* arcuate; lateral plates of the female hypopygium acute at apex; pronotum usually black; membrane infusate; length, 11-15 mm., width, 2.3-3 mm.

*eurinus* Say 1825

Distributed throughout America north of Mexico.

Male claspers arcuate, divaricate at base and converging at apex; lateral plates of the female hypopygium broadly rounded at apex; pronotum usually with the posterior two-thirds fulvous; membrane spotted or not ..... 6

6. Membrane pale with fuscous dots; (pronotum sparsely hairy; apex of scutellum rounded, smooth, calloused; abdomen and margins of the connexivum with flavescent spots; length, 10-12 mm., width, 2-2.3 mm.).

*conspersus* Montandon 1893

Canada to Pennsylvania, west to Alberta, Wisconsin, Dakota and Colorado.

Membrane *infusate*, *not* dotted ..... 7

7. Connexivum and margins of the venter black with flavescent pale spots; length and width as *conspersus*.

*conspersus* var. *infuscatulus* Fracker 1918

Wisconsin, Colorado.

Connexivum and margins of venter broadly rufescent to beyond the spiracules, the rufescent band sometimes slightly broken by the encroaching black coloration; (veins of membrane little branched); length, 10-11 mm.

*conspersus* var. *rufescens* Barber 1911

Arizona.

Genus V. *Tollius* Stål 1870

KEY TO SPECIES

1. Claspers of male elongate, nearly four times as long as wide, gradually twisted near the truncate apex; (antennal segment I shorter than the head, IV shorter than II and III taken together; lateral margins of the corium and often the entire disc dotted with fuscous, apical margin *not* paler; median line of the pronotum and of the scutellum obscure, at least posteriorly; length, 9.5-12 mm., width, 2.2-3.5 mm.) .....*curtulus* Stål 1859  
 New York, Illinois, Colorado, Utah, Oregon, California.

- Claspers of male short, *not over* three times as long as wide..... 2
2. Claspers suddenly *obliquely* truncate, nearly three times as long as wide, *acute at apex*; (antennal segment IV *not quite as* long as II and III taken together; apex of rostral segment I distant from anterior margin of the prosternum; length, 10 mm., width, 2.4 mm.) .....*setosus* Van Duzee 1906  
New York, Montana, Utah, Arizona, California.

Claspers very short, nearly *quadrate*, somewhat longer than wide, apex right-angled, with or without a short erect process on the outer angles ..... 3

3. Antennal segment IV *longer* than II and III taken together; rostral segment I nearly reaching anterior margin of the prosternum; length, 9 mm. ....*quadratus* Van Duzee 1921  
California.

Antennal segment IV *shorter* than II and III taken together; rostral segment I not going much beyond the posterior margin of the eyes; length, 8.5 mm., width, 2.1 mm.

*vanduzeei* Torre-Bueno 1940

California.

#### Genus VI. *Stachyocnemus* Stål 1870

Generic characters, taken from the original characterization, are: Body quite oblong, subcompressed, setose; head triangular, as long as wide, wider than the pronotum anteriorly, bucculae short, moderately high, ocelli quite elevated, eyes quite prominent; rostrum reaching intermediate coxae, segment I incrassate, III and IV short, IV longer than III; antennae somewhat short, segment I hardly passing the apex of the head, IV incrassate, hardly longer than III; pronotum distinctly narrowed anteriorly, humeri acute, slightly prominent, base sinuate; scutellum acutely triangular; apical margin of the corium straight; anterior femora unarmed, posterior femora passing the apex of the abdomen, quite incrassate, below with a double row of spines for nearly their entire length, tibiae cylindrical, without a sulcus, posterior spined below in two rows, the spines of the outer row short and very numerous, segment I of posterior tarsi nearly twice as long as II and III taken together.

Two species appear to be recognized in this genus from America north of Mexico, which may be separated by this

KEY TO SPECIES

- A. Juga projecting laterally from the tylus, so that the head appears to have three angles or points anteriorly; body with little or no gray pubescence, black, marked with gray ferruginous; head strongly depressed; median tooth of the posterior margin of the pronotum *small to minute*; length, 7.5–8 mm., width, 2–2.5 mm. .... *apicalis* Dallas 1852  
New York to Florida, west to Montana, New Mexico, California, Texas; Arizona.
- B. Juga hardly projecting, indistinct as seen from above; body covered with a fine gray pubescence, gray-flavescent; head not depressed; median posterior tooth of the pronotum *large, prominent*; length, 7.5–8 mm., width, 2–2.5 mm.  
*cinereus* Fracker 1918  
Colorado.

Family IX. CORIZIDAE Mayr 1866

KEY TO TRIBES

1. Posterior femora incrassate, *spined* below; anterior angles of the pronotum anteriorly produced into an acute tooth, or rounded and unarmed (*Xenogenus* Berg 1884).  
1. *Harmostini* Stål 1873  
Posterior femora not or scarcely incrassate, *not* spined below; anterior angles of the pronotum obtuse or unarmed ..... 2
2. Head abruptly narrowed behind the eyes into a distinct neck; anterolateral margins of the pronotum scarcely or obtusely sinuate, its transverse impressed dorsal line scarcely reaching the sinus; prosternum anteriorly *without* a transverse impression attaining the lateral margins; corium largely hyaline, its anterior apical areole *quadrangular*; (antennal segment I short, scarcely or but little exceeding the apex of the head; metapleura more or less obliquely truncate posteriorly, outwardly amplate).  
2. *Corizini* Stål 1872  
Head *not* narrowed behind the eyes; anterolateral margins of the pronotum distinctly angulate-emarginate, or incised; pronotum and prosternum anteriorly with a distinct impression attaining the marginal incisures; corium opaque, coriaceous, its interior areole *triangular*.  
3. *Leptocorini* Van Duzee 1914  
(*Serinetharia* Stål 1873)

Tribe 1. *HARMOSTINI* Stål 1873

KEY TO GENERA

1. Abdomen dilated at middle, leaving the connexivum roundedly broadly exposed; (pronotum with a distinct longitudinal median impression, limited on each side by a short ridge).  
 II. *Aufeius* Stål 1870  
 Abdomen not extended beyond the hemelytra; connexivum *not* or but slightly exposed ..... 2
2. Ocelli *not* elevated; antenniferous tubercles produced outwardly into a spine or tooth; anterior angles of the pronotum produced into spines or teeth; corium opaque or subopaque.  
 I. *Harmostes* Burmeister 1835  
 Ocelli elevated; antenniferous tubercles neither spined nor produced; anterior angles of the pronotum rounded, *not* produced; corium hyaline; (antennal segment IV not much thickened, slightly shorter than III; posterior femora with about 25 sharp spines) ..... III. *Xenogenus* Berg 1884

Genus I. *Harmostes* Burmeister 1835

1. Anterolateral margins of the pronotum distinctly crenulate, serrate or denticulate ..... 2  
 Anterolateral margins of the pronotum neither crenulate, serrate nor denticulate, either smooth or obscurely granulose ..... 5
2. Rostrum extending onto the abdomen (passing base of abdominal segment III, see Stål); (antennal segment I surpassing the head by about one-half of its own length, II slightly shorter than III, antennal tubercles acutely prominent, hardly spinose; length, 9-10 mm., width, 3 mm.).  
*nebulosus* Stål 1862  
 (Mexico, Guatemala).  
 Rostrum *not* extending onto the abdomen ..... 3
3. Rostrum nearly reaching or slightly exceeding the base of the metasternum; antennal segment II shorter than III: (antennal tubercles produced into long acute spines; length, 6-8 mm.) ..... *serratus* Fabricius 1794  
 (*perpunctatus* Dallas 1852)  
 Florida, Texas, (Mexico, West Indies, Brazil, Ecuador, Argentine Republic).  
 Rostrum nearly reaching or slightly passing posterior coxae; antennal segment II equal or subequal to III ..... 4
4. Rostrum reaching nearly to posterior coxae; antennal segment

II equal to III; length, 6.25 mm. .... *affinis* Dallas 1852  
 Florida, Texas, Arizona, (into Mexico).

Rostrum just passing posterior coxae; antennal segment II subequal to III; (antennal segment I very incrassate, about reaching apex of head; humeri *very* broadly rounded, prominent, reflexed); length, 9 mm., width, 3 mm.

*formosus* Distant 1881

Texas, (Mexico).

5. Bucculae evanescent beyond the posterior margin of the eyes toward the base of the head; (antennal segment I exceeding the apex of the head by one-half of its own length, II shorter than III, base of vertex of head with a median groove, rostrum hardly reaching posterior coxae; anterior angles of the pronotum acute; membrane *not* vittate; length, 6.25-9 mm., width, 2.2-2.7 mm.).

*reflexulus* Say 1831

(*virescens* Dallas 1852)

(*costalis* H. S. 1853)

(*bruesi* Bergroth 1913)

All over the United States, north into Canada and south into Mexico.

Bucculae *not* passing the posterior margin of the eyes ..... 6

6. Antennal segment I hardly or *but slightly* exceeding the apex of the head; (II and III subequal, IV slightly longer than I and strongly pubescent; base of vertex of the head with a median groove; bucculae not passing the anterior margin of the eyes; rostrum extending beyond the metasternum; median carina of the pronotum distinct, very prominent on the scutellum; abdominal segments II and III with a deep median sulcus; membrane bivittate; length, 6-7 mm.) ..... *fraterculus* Say 1831  
 New Jersey, south to Florida and west to California and Arizona, (through Mexico into Central America).

Antennal segment I extending much beyond the apex of the head, (II of equal thickness throughout; species averaging 7 mm. or more in length) ..... 7

7. Antennal segment II shorter than III; (segment I stout, antennal tubercles spined, tylus slightly acutely projecting beyond the juga; anterior angles of the pronotum spined; scutellum long, constricted at apex; length, 8 mm.).

*subrufus* Distant 1881

Arizona, (Guatemala).

Antennal segments II and III equal or subequal ..... 8

8. Rostrum *not* passing intermediate coxae; antennal segments II and III subequal, (segment I nearly smooth; anterior angles of the pronotum acute; length, 7–8 mm.).

*chilensis* Dallas 1852

(*minor* Spinola 1853)

Southwestern United States, (Chile, Argentine Republic).

- Rostrum passing intermediate coxae; antennal segments II and III equal ..... 9

9. Rostrum attaining the base of ventral segment II; (antennal segment I surpassing the apex of the head by one-quarter of its own length, II and III equal to each other and to the length of the head; pronotum shorter than the head; scutellum tricarinate; median areole of the corium hyaline, the inner areole partly so; venter deeply sulcate to segment IV or V); length, 7–8 mm.

*angustatus* Van Duzee 1918

Texas, New Mexico, Arizona, California; on *Hymenocloea salsola*.

- Rostrum not going beyond the metasternum; (antennal segment IV slightly longer than I, vertex of head *without* a groove; prosternum sulcate anteriorly; humeri well-rounded); length, 7–9 mm. .... *croceus* Gibson 1917
- Oregon, California, Arizona, Texas.

*Note 1*—No identifying structures are given in the description of *Harmostes bicolor* Distant, nor in the figure; Gibson records it from Colorado, New Mexico and Texas.

*Note 2*—The species carried in catalogues as ?*Harmostes obliquus* Say 1831 is omitted. It does not appear to have been recognized in the genus by any recent authors.

*Harmostes propinquus* Distant 1881 is *Aufeius impressicollis* Stål, q.v.

## Genus II. *Aufeius* Stål 1870

This monotypic genus is characterized by Stål (Enumeratio I: 222) as follows: Body oblong-ovate, depressed; head acute, a little longer than wide, subquadrate behind the antennae, triangularly produced before them, the antenniferous tubercles produced outwardly into a prominent acute tooth, postocular part of the head tumid; bucculae half the length of the head, moderately high; ocelli nearly twice as far from each other as from the eyes; rostrum reaching intermediate coxae, segment I a little shorter than the head; antennae slender, half as long as the body, segments I and IV

incrassate, I scarcely surpassing the apex of the head; anterior angles of the pronotum acute, prominent; hemelytra parallel; mesosternum longitudinally sulcate; feet short, posterior femora somewhat incrassate, slender at the base, spined below toward the base; disc of the pronotum impressed, without a median carina. The one species is

*A. impressicollis* Stål 1870

(*Harmostes propinquus* Distant 1893)

In this, abstracting the structural characters from the original description, and neglecting color; antennal segments II and IV equal, III somewhat longer than either; anterolateral margins of the pronotum sinuate before the middle, minutely crenulate; hemelytra hyaline, membranous; length, 5–6 mm., width, 1.5–2 mm.

Dakota, Kansas, Colorado, Texas, Arizona, California.

Genus III. *Xenogenus* Berg 1884

(*Darmistidus* Uhler 1893)

What follows is in substance the original generic characterization of Berg (Hem. Arg. Add., p. 45): Body quite elongate, setulose, subdepressed; head subtriangular, as long as wide, its base as wide as the apex of the pronotum, antenniferous tubercles neither produced nor spined, tylus produced and elevated, bucculae much shorter than one-half the length of the head; eyes prominent, quite remote from the pronotum; antennal segment I scarcely longer than III, slightly exceeding the head, II and III equal; rostral segment I much shorter than the head; pronotum narrowed anteriorly, distinctly impressed longitudinally and slightly carinate; anterior angles somewhat prominent, posterior rounded; corium and clavus nearly hyaline; mesosternum sulcate; posterior angles of the metasternum somewhat produced, apex rounded; abdomen scarcely wider than the hemelytra; apical half of the posterior femora biserially spined; tarsal segment I one-quarter to one-third longer than II and III taken together.

There are two species in this genus—the type-species, *Xenogenus picturatum* Berg 1884, from the Argentine; and the other our North American species

*X. extensum* Distant 1893

(*Darmistidus maculatus* Uhler 1893)

Distant's species was described from Mexico; Uhler's genus and species from St. Vincent, W. I. The structural characters for the

species are the few given in the original description: Antennal segments II and III subequal and very slightly longer than IV; anterolateral margins of the pronotum neither crenulated nor serrated; pronotum coarsely and thickly punctate with a median pale smooth line; head and scutellum finely and sparingly punctate; body beneath finely punctate; length, 8 mm. (6.5–8 mm., width, 1.75–2 mm.).

The remainder of this description is a loving enumeration of minute color changes.

Arizona (Huachuca Mountains, near the Mexican border).

Tribe 2. *CORIZINI* Stål 1872

Genus I. *Corizus* Fallén 1814

(Recte *Rhopalus* Schilling 1829)

1. *Metapleura entire*, not divided by a transverse suture or sulcus into an anterior and a posterior area, evenly and distinctly punctate, the posterior margin truncate or subtruncate and straight, or subsinuate, its posterior upper angle broadly rounded, neither expanded nor produced posteriorly; (ostioles quite obsolete or hardly distinguishable); (subgenus *Stictopleurus* Stål 1870); transverse impression of the pronotum terminating in a closed loop at each end ..... 2

*Metapleura divided* by a transverse suture or sulcus into an anterior and a posterior area, the anterior coarsely punctate and the posterior finely or obsoletely so, posterior margin oblique and sinuate, the posterior upper angle expanded and produced roundly or acutely; transverse impression of the pronotum *not* ending in a closed loop at each end ..... 3

2. Antennal tubercles prominent, angular and extending well forward, antennal segments II and III equal, IV about one-half the length of either; ocelli about twice as far from each other as from the eyes; rostral segment I not reaching base of head, II about twice as long as III, apex of IV reaching about the middle of the metasternum; lateral margins of the scutellum carinate, smooth, disc black, distinctly punctured; connexivum spotted or not; species light or dark colored; length, 6–8.5 mm., width, 2–3.5 mm.

*crassicornis* Linne 1758

(and subspecies or varieties)

New England, New York and Quebec west to the Pacific,

Texas, New Mexico, Arizona, California, (Mexico); a high altitude and latitude species, known also from Europe and Asia.

Antennal tubercles *not* prominent, small, acute, antennal segments II, III and IV equal or subequal; ocelli more than twice as distant from each other as from the eyes; rostral segment I just reaching the anterior margin of the prosternum, II about one and one-half times as long as III, apex of IV reaching intermediate coxae; lateral margins of the scutellum calloused, smooth, disc dark, moderately coarsely punctured; connexivum spotted or not; species light or dark colored; length, 5-6.5 mm., width, 1.75-2.5 mm. .... *viridicatus* Uhler 1872

(*hyalinus* Uhler 1877 nec Fabricius 1794)

District of Columbia, Kansas, Nebraska, Dakotas, Wyoming, Utah, Colorado, New Mexico, Arizona, California, British Columbia.

3. Margin of the pronotum anterior to the smooth anterior transverse ruga, callus or carina, unpunctured (or obsoletely so?); last segment of the abdomen short and broad, truncate in the female, broadly evenly rounded in the male; (antennal segment I reaching the apex of the head, II slightly shorter than III, IV longest; pronotum narrowly smooth and subcallous at the apical margin, with a very distinct raised smooth anterior transverse callus; scutellum *not* constricted at the middle, sides concave; rostrum reaching to or nearly passing the posterior coxae; ostioles distinct with two sulci, the anterior one short and quite close to the intermediate coxae and less distinct, the posterior sulcus distinct, very long, extended toward the lateral margins of the sternum, metapleura posterior to this sulcus smooth or obsoletely punctured (subgenus *Liorhyssus* Stål 1870); length, 5.5-6.5 mm., width, 1.8-2.5 mm.).

*hyalinus* Fabricius 1794

Massachusetts and Maryland south to Florida, Louisiana and Texas, and west to Arkansas, Wyoming, Nevada, New Mexico, Arizona and California; (Mexico to Chile, West Indies, East Indies, Europe, Asia, Africa); on *Lactuca scariola*, and *Abutilon theophrasti*.

Margin of the pronotum anterior to the transverse ruga, callus or carina (when present, or if absent, anterior to the transverse suture) more or less coarsely punctured; terminal

abdominal segments in both sexes long, in the female frequently pointed or acute, in the male rounded ..... 4

4. Pronotum without an anterior transverse ruga, callus or carina, head somewhat long, apex not or very slightly deflexed; rostrum reaching to, or nearly or quite passing, the posterior coxae; pronotum anteriorly punctate (subgenus *Niesthrea* Spinola 1837); antennal tubercles hardly visible and set very close to the eyes; femora and tibiae more or less dark-annulate; (scutellum small with an acute or subacute apex, much less than one-third as long as the abdomen, which is much wider than the pronotum; juga short but well defined; antennal segment I not or hardly reaching the apex of the head, II longest, III and IV subequal; pronotum with a fine smooth median line or carina, distinct throughout; length, 4.4–8 mm., width, 2–3.1 mm.

*sidae* Fabricius 1794

(*luteolus* Distant 1881)

Maryland, Georgia, Florida, Louisiana, Kansas, Oklahoma, Texas, Arizona, (West Indies, Mexico to Patagonia); on *Sida spinosa*, *Abutilon theophrasti*.

Pronotum *with* an anterior transverse ruga, callus or carina; head short, part before the antennae shorter than broad or as long as broad, apex of the tylus more or less deflexed; rostrum reaching to or beyond the *intermediate* coxae, exceptionally going beyond the posterior coxae; apex of the scutellum entire; antennal tubercles visible, although sometimes small or obsolete, not very close to the eyes; femora and tibiae concolorous or spotted; (subgenus *Arhyssus* Stål 1870) ..... 5

5. Antennal tubercles *very long* and prominent, reaching almost to the apex of the head and widely diverging; (antennal segment I passing the apex of the head; scutellum broad at apex, *rounded*; upper surface with prominent punctures; length, 6 mm., width, 2.7 mm.).

*tuberculatus* Hambleton 1908

Washington.

Antennal tubercles *small*, sometimes obsolete ..... 6

6. Scutellum *broad*, at apex, *rounded* ..... 7

Scutellum *narrow* at apex, more or less *acuminate* ..... 11

7. Pronotum *with* a complete and distinct median, more or less calloused and smooth pale longitudinal carina, sometimes obscured, terminating at the transverse suture in a small

white calloused spot, (the transverse suture a slender line margined anteriorly by a slight elevation or callus; antennal segment I not reaching the apex of the head, IV longest, antennal tubercles small and close to the eyes; length 5-6 mm., width, 2-3 mm.) ..... *bohemanii* Signoret 1859

(*nigristernum* Signoret 1859)

Quebec, Ontario and New England west to British Columbia and Colorado, south to Virginia, Florida and Texas, and west to Arizona and California; on flowers of *Cornus alternifolia*.

Pronotum *without* such a carina, or at most an incomplete one ..... 8

8. Antennal tubercles obsolete or inconspicuous; size not over 5 mm. .... 9

Antennal tubercles evident, readily visible; larger species, (although some individuals may be less than 5 mm. in length) ..... 10

9. Ocelli three times as far from each other as from the eyes; antennal segments II, III and IV subequal, IV wholly dark; median carina of the pronotum subobsolete, posterior margin of the pronotum nearly straight, narrowly pale, *without* calli behind the humeri; scutellum constricted at middle, with the entire margins raised and carinate, the apex bluntly rounded; femora black, apically pale, tibiae pale, unspotted; abdomen beneath pale except at connexival margins, which are darkened, connexivum above with a broad black transverse vitta at each segment; hemelytra with the corium nearly entirely hyaline, with the veins low, but little raised above the surface, membrane white; length, 5 mm., width, 1.75 mm.

*hirtus* Torre-Bueno 1912

Massachusetts, New York.

Ocelli more than twice (but not three times) as far from each other as from the eyes; antennal segment III shorter than II or IV, which is the longest and pale basally; median carina of the pronotum pale, smooth, subobsolete, posterolateral margins behind the humeri subcallous, smooth, pale, posterior margin of the pronotum obsoletely sinuate; scutellum constricted at about middle, the margins raised, callous, pale, the apex acuminate; legs pale, black-annulate; abdomen beneath heavily suffused with black, connexivum above with broad black segmental vittae; hemel-

etra hyaline, except for the costal margin of the corium within the two veins, where it is coriaceous with a single row of large deep punctures, veins of the corium coarse, prominent, membrane hyaline; length, 4-4.3 mm., width, 1.6-2 mm. (at humeri) ..... *parvicornis* Signoret 1859  
Texas, Arizona, California, (Mexico).

10. Antennal tubercles broad but not long; antennal segment I just reaching the apex of the head; transverse suture of the pronotum on a tubercular ridge which reaches quite to the margins; length, 7.5-9 mm., width, 3-4 mm.

*scutatus* Stål 1859

(*jactatus* Signoret 1859)

Wyoming, Oregon, California, Utah, Colorado, Arizona.

Antennal tubercles small but rather sharp; antennal segment I slightly surpassing the apex of the head; transverse suture of the pronotum obscure but forming a rather deep depression; length, 4.5-6 mm., width, 2-3 mm.

*indentatus* Hambleton 1908

British Columbia, Washington, Oregon, Wyoming, Utah, Colorado, Kansas, California.

11. Rostrum reaching *posterior* coxae or going beyond; last abdominal segment in female neither very long nor acutely pointed ..... 12

Rostrum *not* reaching *intermediate* coxae; last segment of the abdomen in the female very long, acutely pointed; (region of the transverse suture not tuberculate; eyes very prominent; antennal tubercles short, broad, rounded at the apex; antennal segment I very short, slightly passing the apex of the head; pronotum with an obsolete pale carina, terminating in a pale callous tubercle at the transverse sulcus; length, 4.5-6 mm., width, 2-2.5 mm.)

*punctatus* Signoret 1859

Florida, Texas, New Mexico, Arizona, (Mexico, West Indies, Guatemala).

12. Ocelli about twice as far from each other as from the eyes, fine longitudinal groove of the head between the eyes distinct, antennal segment IV longest, I shortest, slightly passing the apex of the head, II slightly longer than III; rostral segment I reaching about to the posterior margin of the eyes, II about reaching the anterior coxae, III reaching to about the middle of the mesosternum, IV not quite reaching the posterior coxae; pronotum with a median carina,

obsolescent anteriorly, posteriorly well-marked and widened, smooth, pale; posterolateral margins slightly explanate, posterior margin subsinuate; propleura coarsely punctured; scutellum with sides emarginate at about middle and with an irregular pale median carina at the level of the emargination, apex narrow, pale, subacute, carinate at the excavate margin, calloused thence to the apex, disc coarsely black-punctured; anterior area of the metapleura much wider and longer than the upper part of the posterior area, coarsely pitted, posterior area finely obsoletely almost rugosely punctured, upper angles not greatly prominent seen from above, rounded; legs black-annulate and irrorate, or concolorous; disc of venter pale with slightly darker spots, margins broadly darkened, connexivum above with *small* black segmental spots, or wholly pale; length, 5-7.5 mm., width, 1.75-3 mm. .... *lateralis* Say 1825 A widespread species from New England to Florida, and west to Colorado, Texas and Arizona, (Mexico); on *Cercis canadensis*; breeds on *Polygonum pennsylvanicum*.

Ocelli three times as far from each other as from the eyes; median longitudinal groove of the head very fine and short, a wide median longitudinal subsulcus (indentation) between the ocelli; antennal segment II longest, I shortest, passing the apex of the head by about one-half its own length, III slightly shorter than IV; rostral segment I nearly or quite reaching the anterior margin of the prosternum, II passing the anterior coxae, III reaching the intermediate coxae, IV passing the posterior coxae and nearly reaching to the posterior margin of the metasternum; pronotum *without* a longitudinal carina, posterolateral margins slightly expanded, whole pronotum coarsely punctured, as are the propleura; scutellum narrowed *beyond* middle, *without* a median carina, disc coarsely punctured, narrow apical area finely very obsoletely punctured, its margins carinate, smooth, calloused, apex acute; anterior area of the metapleura *very large*, over twice as wide as the posterior area and coarsely pitted, posterior area finely punctured, very narrow at middle, upper posterior angles rounded, not very prominent from above; all legs black-speckled; entire venter pale, connexivum above with a small somewhat square marginal spot at the middle of each segment; length 7-8 mm., width, 2.3-4 mm. .... *validus* Uhler 1893 Wyoming, Utah, Colorado, Arizona, California.

N.B.—The species of this group appear to be highly variable, especially as to color and dimensions. Antennal and other proportions seem to vary within the species. The characters given, however, are based on what are taken to be typical specimens; atypicals are readily placed in the species by facies and by such characters as fall within the key for a given species.

Sizes as stated are not absolute; they are either average dimensions, or maximum and minimum, as recorded.

Full synonymies are omitted; these will be found in Van Duzee's Catalogue, pp. 119/125. Varieties are also not given, as there seems to be nothing stable or regional about them.

### Tribe 3. *LEPTOCORINI* Van Duzee 1914

#### KEY TO GENERA

- A. Bucculae less than half the length of the head; head behind the eyes quite strongly callose; rostrum but slightly, if at all, passing the *posterior coxae* ..... I. *Leptocoris* Hahn 1831
- B. Bucculae reaching the base of the head; head slightly callose behind the eyes; rostrum reaching to or beyond *ventral segment II* ..... II. *Jadera* Stål 1862

Genus I. *Leptocoris* Hahn 1833

(*Serinetha* Spinola 1837)

(*Tynotoma* Amyot & Serville 1843)

In addition to the tribal characters are the following for the genus, selected from the extensive generic characterizations of Stål (1865, Hem. Afr. II: 112) and Distant (1902, Faun. Br. India, Rhynchota I: 419), both under the synonym of *Serinetha* Spinola: Body oblong, depressed; head with the eyes slightly wider than the anterior margin of the pronotum; large tubercles behind the eyes and before the antennae; bucculae seldom longer than half the length of the head; ocelli more distant from the eyes than from each other; rostrum slender, segment III as long as IV or longer, I a little longer than the head; antennae slender, segment I short, very slightly exceeding the apex of the head, IV slightly longer than III and hardly incrassate; pronotum trapezoidal, anteriorly with a linear transverse impression and with a distinct collar, lateral margins amplified and more or less convex, angularly emarginate *before* the outer angles of the collar, posterior margin subtruncate; scutellum triangular with acute apex; hemelytra broader and longer than the abdomen, coriaceous, the corium with the lateral

margins distinctly reflexed except on the apical area, membrane with numerous prominent longitudinal veins; last ventral segment of female rounded, posteriorly produced and covering the genitalia; legs moderately long and slender, unarmed, tibiae cylindrical, posterior tibiae longer than femora, segment I of the posterior tarsi slightly longer than the other two taken together.

*L. trivittatus* Say 1825

is the one species recorded from the United States. It was described as follows by its author: "Black, thorax trilineate, and hemelytra margined with rufous. Body black; eyes and stemmata sanguineous; thorax mutic; two indented transverse lines near the head, of which the anterior one is curved in the middle; three bright rufous lines, of which two are marginal; posterior edge obscurely rufous, hemelytra, coriaceous portion with a rufous exterior and posterior margin, membranaceous tip immaculate; trochanter rufous; tergum rufous with three lateral black punctures; venter, margin and middle rufous. Length, nine-twentieth inch." Length, 11-13.5 mm., width, 3-4 mm.

Missouri, Iowa, Kansas, Colorado, Utah, Arizona, California, Texas, Dakota, Minnesota, Wisconsin, Illinois, Pennsylvania, New Mexico, District of Columbia, Ohio, British Columbia; it appears to follow the distribution of its food-plant, *Acer (Negundo) negundo*, (box elder); also reported injurious to peach, plum and apple; gets into greenhouses; reported to have bitten human beings.

Genus II. *Jadera* Stål 1862

KEY TO SPECIES

1. Body above black, *not* consperse; apex of rostrum reaching *beyond* ventral segment II ..... 2  
     Body above griseous, rufescent or rufofuscous, *not* black, fuscoconsperse and granulate; apex of rostrum reaching to ventral segment II ..... 3
2. Body below flavescent or rufescent; margins of head rufescent; costal margin of the hemelytra flavotestaceous or sordid stramineous; (abdomen sparsely minutely red-irrorate; head rufescent or lutescent, with a broad black posterior vitta); antennal segment IV over five times the length of I; length, 11-15 mm., width, 3-3.9 mm.

*obscura* Westwood 1842  
 (*discolor* Stål 1862)  
 (*lateralis* Stål 1862)

(Mexico, Central America, Brazil).

Body below black or rufescent; head black, margins about eyes red; hemelytra wholly black; antennal segment IV about three and one-half times the length of I; length, 10-14 mm., width, 3-4 mm.

*haematoloma* Herrich-Schaeffer 1842

Illinois, Kansas, Colorado, Arizona, California, Texas, Alabama, Florida, (Mexico, Cuba, South America).

- 3. Costal margin of the hemelytra narrowly pale, *unspotted*; antennal segment II about three times length of I; (membrane brownish, with several brown points or dots; rostrum reaching ventral segment II); length, 11.5 mm., width, 2.8 mm. .... *aeola* Dallas 1852

(*sanguinolenta* Blatchley 1924)

Florida, Texas, (Mexico).

Costal margin of the hemelytra narrowly pale, *spotted with brown*; antennal segment II about four times the length of I; length, 10.6-12 mm., width, 2.8 mm.

*sanguinolenta* Fabricius 1775

Texas, (West Indies, Brazil).

Family X. NEIDIDAE Kirkaldy 1902

KEY TO SUBFAMILIES

- A. Head long, tylus anteriorly produced into a horn or vertical plate; scutellum *without* a basal spine or tubercle; *ostiolar process neither long nor produced into a spine-like metasternal process*; eyes very distant from base of head; venter *strongly punctured* .....1. NEIDINAE Van Duzee 1916
- B. Head short, tylus not anteriorly produced, although it may bear a fine spine or spines, or a long almost spine-like or short conical tubercle; *ostiolar process produced into a tubercle, or generally into a long canaliculate, spine-like, more or less twisted metasternal process*; eyes near to base of head; venter *not punctured*.

2. METACANTHINAE Douglas & Scott 1865

Subfamily 1. Neidinae Van Duzee 1916

KEY TO GENERA

- A. Head with a cylindrical deflexed process anteriorly (for North American species only); antennae *as long* as the body; longer than the head and pronotum taken together; rostrum long, reaching nearly to the intermediate coxae, seg-

ment I about half the length of the head; posterior femora reaching the apex of the abdomen.

I. *Neides* Latreille 1802

- B. Head with a porrect laterally compressed process anteriorly (for North American species only); antennae *shorter* than the body, shorter than the head and thorax taken together; rostrum *not* reaching intermediate coxae, segment I *less than* half the length of the head; posterior femora much shorter than the abdomen ..... II. *Berytinus* Kirkaldy 1906 (*Berytus* auctt.)

Genus I. *Neides* Latreille 1802

Supplementing the key, the following characters are taken from the generic characterization of Douglas & Scott (British Hemiptera): Antennae as long as the body (shorter in the American species), segment I very long, clavate at apex, II not half the length of II, which is about four-fifths the length of I, IV shorter than II; tylus produced in the form of a horn; rostrum reaching intermediate coxae, segments I and II subequal, together as long as the head; pronotum with a median carina on the posterior lobe, rostral groove reaching the posterior margin of the metasternum, deep; legs filiform, femora clavate.

The one described North American species is

*N. muticus* Say 1832

There seems to be no modern description of this species. That of Say is extremely brief; and the subjoined characterization is drawn up from a female specimen from the Eastern States. In passing, it may be said that possibly the western form may be specifically separable from this eastern one. Head nearly twice as long as wide at the eyes (25: 13), ocelli set behind the transverse groove, closer to the groove than to the anterior margin of the pronotum, horn down-curved about one-half the length of the front (or clypeus below it); tylus with a short fine groove above; sides of head finely punctured, above not punctured; rostrum reaching to about intermediate coxae, segment I going slightly behind eyes, apex of II slightly beyond anterior margin of prosternum; antennal segments I: II: III: IV, 75: 30: 54: 19 units respectively, IV wholly black, fusiform, the others filiform, I with a very short apical club. Pronotum about twice as long as wide at the humeri (40: 18), lateral margins calloused smooth, sometimes only faintly so; anterior lobe remotely punctured anteriorly, posterior lobe coarsely punctured, median carina only on posterior lobe, faint, rising to a conspicuous

tubercle posteriorly, humeri also raised, but not so evidently, laterally punctate, as on the upper surface; mesopleura also punctate with smaller punctures; metapleura impunctate on the evaporative area, punctate posteriorly on the acetabula; ostiolar canal slender, running to tip of ostiolar process, which terminates more or less tubercularly; scutellum small, narrow, acute, smooth; meso- and metapleura with a deep, narrow, black groove; clavus and corium linearly punctured, veins of membrane longitudinal, simple, membrane transversely rugulose, reaching apex of abdomen; abdomen below finely punctured—not black, as Say states. Legs minutely black speckled; all femora clavate apically, with short and not greatly thickened clubs; general color stramineous, apex of membrane with a dark longitudinal streak. Length, 9.75 mm., width (at humeri), 0.9 mm.

Distributed country-wide.

Genus II. *Berytinus* Kirkaldy 1906

(*Berytus* auctt.)

The characters following are abstracted from Saunders (Hem. Br. Ids.), Douglas and Scott (British Hemiptera), and Fieber (Eur. Hem.): Head anteriorly produced into a plate-like expansion; antennal segment I not as long as the head and the pronotum taken together, thickened at base so that this seems like a small basal segment, and clavate apically, II about one-eighth to one tenth as long as I, IV twice the length of II; rostrum passing the anterior margin of the pronotum, segments I and II taken together not as long as the head; median carina of the pronotum percurrent, produced beyond the anterior and posterior margins; rostral groove reaching the apex of the metasternum, widest in the mesosternum.

One European species has been recently recorded from the United States:

*B. minor* Herrich-Schaeffer 1835

Structural characters as given by the European hemipterists are: Frontal process from above obtusely pointed, from the side semicircular; club of antennal segment I gradual, short, stout, black; pronotum depressed in the middle, lateral carinae continued around the posterior angles, which are rounded and depressed, posterior margin nearly straight; in the macropterous the pronotum is much widened and raised posteriorly, in the brachypterous, shorter, flatter and nearly parallel-sided; head finely punctured, pleura

strongly punctured, anterior lobe of pronotum finely, posterior strongly and closely punctured; length, 6-7 mm.

Michigan.

Subfamily II. **Metacanthinae** Douglas & Scott 1865

*Key to Genera*

1. Pronotum spined at least on the anterior angles and sometimes thickly and more or less linearly on the disc ..... 2  
    Pronotum *not* spined ..... 4
2. Pronotum with a long semi-erect spine on each anterior angle only, disc *not* spined; (rostrum long, slender, reaching the posterior coxae, segment I not quite as long as the head; antennal segment II slender, IV shorter than III).

III. *Protacanthus* Uhler 1893  
 (?*Metacanthus* Costa 1848)

Disc of pronotum with *numerous* spines ..... 3

3. Veins of corium with numerous prominent spines; venter with hispid spines or tubercles; head with a longitudinal series of long nutant spines along the tylus; ostiolar process long, curved, cylindrical, spine-like.

V. *Acanthophysa* Uhler 1893  
 (*Saurocoris* McAtee 1919)

Veins of corium *without*, or with *very fine* spines; venter smooth; head with a single spine or tubercle on the tylus; ostiolar process a low tubercle ..... IV. *Pronotacantha* Uhler 1893

4. Ostiolar process *without* an apical spine, long, curved and twisted, with the ostiolar canal lying basally on the outer side and apically on the upper surface; antennal segment IV about as long as the head; (anterior coxae separated by a narrow sulcate area; scutellum with a short, sharp, almost erect spine; rostral sulcus expanding on the metasternum into a rhomboid basin) ..... I. *Aknisus* McAtee 1919

Ostiolar process *with* a pronounced apical spine, curve not pronounced, ostiolar canal lying entirely on the outer side; antennal segment IV longer than the head.

II. *Jalysus* Stål 1862

Genus I. *Aknisus* McAtee 1919

KEY TO SPECIES

- A. Front of vertex *with* a short but distinct pointed tubercle; connexivum unarmed) ; length, 5-6 mm.  
*multispinus* Ashmead 1887  
 (*perclavatus* Van Duzee 1908)  
 New Jersey, District of Columbia, Georgia, Florida, Alabama, Mississippi, Louisiana, Missouri, Iowa, Kansas, Texas, Arizona, and Oregon.
- B. Front of vertex *without* a pointed tubercle; length, 6-7 mm.  
*calvus* McAtee 1919  
 California.

Genus II. *Jalysus* Stål 1862

1. Sides of head before and behind eyes impunctate, smooth ..... 2  
 Sides of head before and behind the eyes with punctures, sometimes faint ..... 4
2. Vertex anteriorly with a long sharp, sometimes downwardly curved, spine, which surpasses the apex of the head; (scutellar spine not erect, almost horizontal) ; length, 9-10 mm. .... *elongatus* Barber 1911  
 Vertex *not* spined anteriorly, sometimes with a tubercle ..... 3
3. Legs *not* speckled, concolorous; ostiolar spine straight, short, pale, sharp; length 6.35-7.2 mm., width, .8-1 mm.  
*balli* Harris 1941  
 Arizona.  
 Legs speckled or annulate; ostiolar spine bent, flattish, dark, blunt; length, 5 mm., width, .5 mm. .... *tenellus* Stål 1859  
 Texas, (Mexico to Argentine).
4. Front *not* tuberculate; ostiolar process with a distinct *conspicuous* spine; median carina of pronotum obsolete; (rostrum as long as the sternum and set in a sulcus beneath) ; length, 7-9 mm., width, .9 mm.  
*spinus* Say 1824  
 Eastern North America from Ontario and Quebec south to Louisiana and Florida.  
 Front more or less distinctly tuberculate; ostiolar process with a *small* spine; posterior lobe of the pronotum strongly punctured, distinctly carinate medially and laterally, the lateral carina continued almost to the humeral angles; length, 6-6.5 mm. .... *wickhami* Van Duzee 1906  
 Oregon, California, Nevada, Utah, Arizona.

Genus III. *Protacanthus* Uhler 1893(?*Metacanthus* Costa 1848, Van Duzee 1917)

The following generic characters, taken from the original description, are additional to those in the key: Clypeus conically produced; ocelli set far behind the eyes on a distinct lobe; antennal segment I longer than II and III taken together, minutely clavate apically, II and III subequal; rostral segment I not as long as head; posterior lobe of the pronotum carinate medially, posterior margin deflexed with a reflexed edge; scutellar spine long, erect, curved; legs long and slender, intermediate and posterior femora slightly clavate. The remainder of the description is largely by color, with details of wing structure, here omitted.

The single species in the genus, is the genotype:

*P. decorus* Uhler 1893*(Metacanthus capitatus* Uhler 1894)

The original description sets forth only the following meager structural characters: Head highly polished, black; surface of the pronotum coarsely punctate, somewhat tumid behind on each side of the median line; hemelytra whitish, translucent, membrane hyaline; length, 4 mm., width, 0.75 mm. Described from St. Vincent, West Indies, where it was found on swampy land near the sea. Florida, Texas, (West Indies). *Metacanthus capitatus* Uhler 1894 was described from Grenada, B. W. I.

Genus IV. *Pronotacantha* Uhler 1893

Here we have another monotypical genus, structural characters of which, in addition to those in the key, are taken from the original description: Long erect spines on all sides of pronotum, posterior lobe convex, much elevated posteriorly, emarginated posterolaterally; scutellum small, flat, with a long slender spine; hemelytra almost entirely membranous; intermediate coxae more distant from anterior than from posterior.

Our one recorded species is

*P. annulata* Uhler 1893

In this, the head and posterior lobe of the pronotum are polished black; head short, subglobose, the tylus forming a prominent vertical ridge, bounded by the swollen juga; rostrum reaching *behind* intermediate coxae; antennal segment I longer than the head and pronotum taken together, II one-half the length of I, IV short and thick, fusiform, black and pale at apex, the other segments white,

black-annulated; pronotum stout, broad and tumid behind, black, polished, with a broad yellow band, spines yellow or pale; scutellum narrow, testaceous, with a long erect pale spine; legs slender, testaceous, black-banded, femora clavate and yellow apically; hemelytra minutely bristly along the veins; abdomen polished; length, 4 mm., width, 0.75 mm.

Arizona, California, New Mexico, Texas, Utah; on *Antirrhinum* (cultivated), and on yellow columbine.

Genus V. *Acanthophysa* Uhler 1893

(*Saurocoris* McAtee 1919)

KEY TO SPECIES

- A. Antennal segment I one and one-quarter to one and one-third times the length of III; spines of posterior lobe of the pronotum in *three longitudinal rows*; length, 3-4 mm., width, 0.75 mm. .... *echinata* Uhler 1893  
(*instans* McAtee 1919, for macropterous)  
New Mexico, Utah, Arizona, California, Oregon, Washington; under *Boerhaavia* in Arizona.
- B. Antennal segment I less than one and one-quarter times the length of III; spines of the posterior lobe of the pronotum in a *single longitudinal row*; length, 4 mm., (macropterous), 2.8-3.4 mm. (brachypterous) ..... *idaho* Harris 1941  
Idaho, Oregon.

Family XII. PYRRHOCORIDAE Fieber 1860

KEY TO SUBFAMILIES

- A. Anterolateral margins of the pronotum *not* margined or reflexed; ventral segment VI in the female cleft to the base.  
1. EURYOPHTHALMINAE Van Duzee 1916
- B. Anterolateral margins of the pronotum margined and reflexed; ventral segment VI *not* cleft in either sex.  
2. PYRRHOCORINAE Amyot & Serville 1843

N.B.—The American genera of Euryophthalminae are all in the tribe Euryophthalmini Hussey 1929, which he set up for the New World forms. Its distinguishing characters are: Lower surface of the head not grooved or sulcate longitudinally behind the bucculae; anterior femora terete or very slightly sulcate beneath at base; orifices not auriculate.

Subfamily 1. *Euryophthalminae* Van Duzee 1916.

KEY TO GENERA

1. Eyes *prominent*, pedunculate or subpedunculate, set near the base of the head, which is *triangular* or *subtriangular*; ostioles prominent (anterolateral margins of the pronotum rounded, not carinate; anterior coxae *not* spined, or with a small tubercle only) ..... 2  
     Eyes *sessile*, *not* pedunculate, remote from the base of the head, which is large and *subglobose*; ostioles not prominent ..... 4
2. Eyes very prominent, on a long peduncle, which is produced outward and upward, (bucculae slightly elevated, anteriorly obtusely rounded); form narrow, elongate; (membrane with few veins, which are longitudinal and furcate)  
     I. *Acinocoris* Hahn 1834  
     Eyes *not* very prominent, on a short, outwardly produced peduncle; form ovate or elongate ..... 3
3. Head triangular, not abruptly coarctate behind the eyes, tubercles behind the eyes distinctly prominent; form more or less ovate, widest below the apex of the scutellum; costal margins of the corium curved, veins of the membrane straight and furcate, or anastomosing and reticulate; (antennal segment I very long, longer than II, III much shorter than II, IV nearly equal in length to II and III taken together, cylindrical as the others; rostrum attaining intermediate coxae, segment I thicker and a little longer than any of the others, which are subequal).  
     II. *Euryophthalmus* Laporte 1832  
         (*Largus* Hahn 1831)  
     Head subtriangular, flattish above, suddenly coarctate behind the quite prominent subpedunculate eyes; form narrow, elongate; costal margins of the corium straight or nearly so, veins of membrane anastomosing; [head slightly narrower or equal in width to the anterior lobe of the pronotum, bucculae slightly elevated, antennae but little shorter than the body, segment I very much longer than the others, II longer than III; pronotum slightly constricted at or slightly before the middle, anteriorly noticeably narrowed, posterior lobe with a more or less distinct anterior ruga; scutellum slightly longer than wide; hemelytra parallel; ostiole with a short sulcus with callose margins directed outward; legs somewhat long, anterior femora

slightly thickened, beneath variously spined toward apex, posterior femora and anterior coxae unarmed (Stål)]

III. *Stenomacra* Stål 1870

(*Theraneis* Walker 1873, nec Spinola 1837)

4. Head about as long as wide, subequal in length to pronotum but much wider than its anterior margin, finely rugulose, (rostrum short); body and legs *without* a profuse covering of long setae, nearly nude; anterior femora *with* a small subapical tooth ..... V. *Japetus* Distant 1883

Head subglobose, convex above and below, punctate or finely rugulose, shorter than wide, subequal in width to the anterior margin of the pronotum; anterior lobe of the pronotum and below densely white tomentose; anterior femora unarmed ..... IV. *Arhapse* Herrich-Schaeffer 1853

#### Genus I. *Acinocoris* Hahn 1834

To the characters in the generic key may be added the following: Body long, narrow, the sides nearly parallel; head with the eyes wider than the pronotum, eyes on long peduncles; antennal segment I longest, II shortest; apex of rostral segment I passing the posterior margin of the eyes; anterior femora spined; ostioles auriculate, prominent.

Of the two known species of this Neotropical genus, the one recorded north of Mexico is:

*A. lunaris* Gmelin 1788

This may be briefly characterized as follows: Head, including eyes, broader than long, tylus exceeding the juga; bucculae prominent, rounded, about one-half the length of rostral segment I; antennal segments I:II:III:IV::40:20:14:32; ocelli close to the eyes, which much surpass the anterior margin of the pronotum; pronotum deeply punctate, with discal smooth areas on each side of the median line, lateral and posterior margins calloused, smooth, impunctate, the posterior callosity extending anteriorly in a median point nearly to the middle of the disc; anterior femora with one black subapical spine, posterior tarsal segment I much longer than II and III taken together, segment II very short, less than one-half of III; margins of hemelytra calloused, smooth, clavus coarsely punctate, corium narrowly punctate at the claval suture and on the disc, except for a broad, smooth, or finely punctate curved vitta-like area following the clavus and margining the membrane, corial margin narrow, smooth, calloused, impunctate; connexivum calloused, smooth, ventral segments III to VI each with a large lateral rounded



or white; pronotum anteriorly orange-yellow, anterior disc velvety black, posterior disc orange-yellow; hemelytra velvety black except for the explanate margins and a large semicircular transverse area from the middle to the apex of the clavus and half way across the corium, which are orange-yellow; venter with segments white or eburneous, narrowly black at base and apex, segment VI a little more broadly so at base only; male genital segment white or eburneous, except the basal margin and the concealed part, which are black) ..... *sellatus* Guérin 1857  
Florida, (Cuba).

Body pubescent, almost tomentose, above and below; femora pubescent; colors dull reddish to black ..... 4

4. Head, pronotum at least anteriorly, and venter, with *numerous* long black hairs; (antennal segment I one and one-third times as long as IV, more than twice as long as III; rostral segment I twice or more than twice as long as IV; length, 12.1–16.5 mm., width, 2.7–4.9 mm.).

*cinctus* subsp. *californicus* Van Duzee 1923

Washington, Oregon, Nevada, California.

Head, pronotum and venter with sparse, if any, long black hairs ..... 5

5. Antennae twice the length of the pronotum; (antennal segment I more than twice the length of III; head almost tomentose, nearly or quite one and one-third times as wide as long; rostral segments I, II and III subequal, segment I about twice the length of IV; length of commissure less than length of scutellum; veins of membrane somewhat anastomosing and forked; pronotum one and one-half times as wide as long; scutellum one and one-quarter times as wide as long; length, 10–15 mm., width, 2.75–4.4 mm.).

*davisi* Barber 1923

Florida.

Antennae *much more* than twice the length of the pronotum ..... 6

6. Veins of the membrane reticulated with numerous cells, dark on a pale ground; antennal segment I less than twice the length of II; scutellum one and one-third times as wide as long; antennae two and one-half times the length of the pronotum; pronotum about one and one-half times as wide as long; hemelytra with a somewhat square dull black spot at the inner angle of the corium; length, 13.95–14.4 mm., width, 3.75–4.1 mm. .... *bipustulatus* Stål 1861  
Texas, (Mexico, Honduras).

Veins of membrane anatomosing or connected, sometimes with complete cells, concolorous; antennal segment I twice or more than twice as long as III; rostral segments I, II and III equal or subequal, segment I more than twice segment IV; pronotum about one and one-half times as wide as long; length, 13–16.45 mm., width, 3.8–5 mm.

*succinctus* Linné 1763

New York, New Jersey, Pennsylvania, Maryland Virginia, Carolina, Florida, Mississippi, Minnesota, (? Oklahoma, Texas, New Mexico, Colorado, Arizona, California); on *Opuntia arborescens*, cotton bolls, peaches; reported precacious.

NOTE.—This key is not as precise as it should be, since many of the characters employed are more or less variable. It bears out Van Duzee's comment (Can. Ent. LV: 270, 1923) on the closeness and doubtful specificity of the forms. In what I have found, they appear to divide into three fairly homogeneous groups (This refers to the keyed species only). In one section is *E. sellatus* Guerin, brightly colored in black and yellow, with the venter eburneous or white and both it and the femora nearly glabrous and shining, in addition to the structural characters set forth in the key; in this group belong some of the other brightly colored Neotropical species. The second group contains *E. davisii* Barber and *E. bipustulatus* Stål, distinguishable at first sight by their light reddish color, confirmed by the key characters. The third group contains *E. cinctus* H. S., *E. cinctus* subsp. *californicus* Van Duzee, *E. succinctus* Linné, and *E. convivus* Stål. The last four are obviously so close together that at most they may eventually be considered no more than local races or varieties. The Key preceding will work for clearly characterized specimens; border-line specimens will always remain in doubt. Only a revision of the genus can settle these points satisfactorily; and determinations in the last group may be only temporary expedients, guided largely by origin of specimens. Meantime, the specimens from which the preceding characterizations have been drawn up will be in effect plesiotypes; they are so marked in my collection. A complete revision is demanded by the facts as developed.

N.B.—The length of the head as given in the keys is taken horizontally, and since the head is always more or less declivous in the species, this varying according to how much the head may be bent down, the actual lengths of specimens may differ from those as given by as much as 0.5 mm. Further, there is a considerable variation

in size of individuals within a species, and specimens may be found larger or smaller than the extremes of length given; likewise, absolute and proportional measurements of the pronotum and other structures are markedly variable within the species. All the figures given represent either norms or averages.

Genus III. *Stenomacra* Stål 1870

- A. Antennal segment I one and three-sevenths the length of II; IV longer than II (40:35); rostrum extending to or barely beyond the intermediate coxae; hemelytra black, orange margined; a deep well-defined groove between the anterior and posterior lobes of the pronotum, posterior lobe with two nearly square black areas, with large, deep, black pits; anterior lobe and a narrow area between the black patches smooth, rounded, orange-colored; head black; length, 11-13 mm., width, 2.5-3 mm.

*marginella* Herrich-Schaeffer 1853

Arizona, California, (Mexico to Brazil).

- B. Antennal segment I one and three-fifths the length of II, IV subequal to or slightly shorter than III (32:34); rostrum extending nearly or quite to the posterior coxae; hemelytra testaceous, fuscous in darker specimens, margined with ivory or pale stramineous; groove between the anterior and posterior lobes of the pronotum definite but not very deep, posterior lobe with two nearly square areas, darker than the general color in light colored specimens and fuscous in the darker, sparsely pitted with small shallow pits; anterior lobe smooth, as well as the narrow light-colored area between the dark areas of the posterior lobe; head fuscous; length, 12-14 mm., width, 3-3.5 mm.

*cliens* Stål 1862

New Mexico, Arizona, (Mexico. Costa Rica).

Genus IV. *Arhappe* Herrich-Schaeffer 1853

1. Head and pronotum distinctly coarsely punctate; (antennal segment I and rostral segment I subequal; II and IV equal, III about one-half the length of either, II about two-thirds the length of III or IV; rostrum attaining the intermediate coxae; anterior and posterior lobes of the pronotum subequal, posterior lobe coarsely pitted; length, 8-10 mm., width, 1.75-2.2 mm.) ..... *carolina* Herrich-Schaeffer 1853

North Carolina, Georgia, Florida, Louisiana, Texas, (Mexico).

- Head and pronotum *not* punctate, head finely rugulose ..... 2
2. Antennae much longer than length of head and thorax taken together, segments I, II and IV equal, III slightly shorter, I plainly longer than rostral segment I; rostrum going much beyond anterior coxae, or attaining intermediate; anterior lobe of the pronotum nearly twice the length of the posterior lobe, which is velvety, collar evident; corium *without* a row of fuscous punctures along the claval suture; posterior femora reaching nearly to the apex of the abdomen; length, 8.5–9.7 mm., width, 2–2.5 mm.

*cicindeloides* Walker 1873

Arizona.

Antennae shorter than the length of the head and thorax taken together, segment II longer than I, III shorter than II, IV longer than II, I subequal to rostral segment I; rostrum attaining intermediate coxae; anterior lobe of the pronotum *not* twice the length of the posterior lobe, collar *not* evident; corium *with* a row of fuscous punctures along the claval suture; posterior femora *not* reaching beyond the apex of abdominal segment IV; length, 7.3–8.25 mm.

*breviata* Barber 1924

Kansas.

#### Genus V. *Japetus* Distant 1883

These differential characters for the genus are given by Barber (1924 Can. Ent. LVI: 227); Head distinctly globose, as long as the pronotum and much wider; body and legs without a profuse coating of long setae, almost nude; posterior lobe of the pronotum not, or very sparsely, tomentose; anterior femora with a single small sub-apical tooth; rostrum short.

Of the two species in the genus, only

*J. mimeticus* Barber 1911

is recorded north of Mexico. Its chief characters are (from Barber's description): rostrum reaching anterior coxae, segment I as long as the antecular part of the head; antennal segment I longest, II three-quarters the length of I and one-third longer than III, IV slightly longer than II; pronotum much narrower than the head, anterior lobe globose covered with a very finely closely appressed tomentose pubescence, posterior lobe velvety black, flattened, about one-half the length of the anterior lobe and scarcely wider, the trans-

verse groove with a few scattered black punctures; scutellum narrow, acute, impunctate, velvety black, not pilose; corium wider than the abdomen, not pilose, velvety black, basal half and exterior apical angle pure white, subcostal area with a row of unicolorous coarse punctures; veins of abbreviated membrane imperceptible; connexivum reflexed; anterior femora thickened, with a subapical tooth (sometimes two?); length, 5.5–7 mm.

Arizona; running among dead leaves under trees.

### Subfamily 2. *Pyrrhocorinae* Amyot & Serville 1843

#### KEY TO GENERA

- A. Antennal segment IV hardly longer than III; hemelytra frequently abbreviated and without a membrane; apical margin of the corium rounded; membrane, when present, with anastomosing veins ..... I. *Pyrrhocoris* Fallén 1814
- B. Antennal segment IV much longer than III; hemelytra always long; apical angle of the corium acute; membrane with somewhat branching but *not* anastomosing veins.  
II. *Dysdercus* Amyot & Serville 1843

#### Genus I. *Pyrrhocoris* Fallén 1814

This genus is strictly Palaearctic, its species being recorded across Eurasia from west to east. Its chief distinctive characters are: Body long-oval; head longer than wide, five-sided; clypeus long, prominent, juga much shorter, deflected outward; antennal segment I passing tylus by one-half of its own length, II longer than I, III about one-half of II, IV longer than III but not as long as I; eyes prominent but not projecting beyond the anterior margin of the pronotum; rostrum reaching posterior coxae, segment I as long as the head, IV shortest; anterolateral margins of the pronotum reflexed; mesosternum with a strong median keel; anterior femora with four small teeth, tibiae weakly spined.

The common brachypterous European species is

#### *P. apterus* Linné 1767

It has been recorded from America. Its chief distinguishing characters, besides its striking scarlet-and-black coloration and its shortened hemelytra are: Head finely punctate; pronotum on the anterior lobe with a transverse quadrangular convex smooth black area, coarsely punctate anteriorly, the posterior lobe with two similar black areas divided from each other by a median fine scarlet line,



gether, and twice, or more than twice, the length of the pronotum ; scutellum about one-fifth wider than long ; (general color above griseous or stramineous, with a transverse black fascia on the corium at the level of the interior angle, not attaining the explanate corial margin, and sometimes reduced to a spot at the inner angle ; head and femora red, collar white, narrowly black-margined posteriorly ; anterior disc of the pronotum reddish ; membrane clear or pale, sometimes darker than the corium, veins concolorous ; ventral abdominal segments sordid white, basally narrowly dark ; anterior and posterior margins of the propleura sordid white, its disc reddish ; meso- and metapleura, posteriorly white margined, discs reddish ) ; length, 11-17 mm., width, 2.5-4 mm. ....*obliquus* Herrich Schaeffer 1842  
 Arizona, California, (Mexico to Ecuador).

Rostral segments I and II taken together slightly longer than segments III and IV taken together and about twice the length of the pronotum ; scutellum nearly as wide as long ; (beneath, white ; the costal and apical borders of the fuscous hemelytra with the pronotum stramineous, its anterior lobe testaceous as well as the discs of the pleura ; basal transverse spot or fascia of the pronotum black ; ventral incisures fuscous, segments V and VI fusco-sanguineous, except their apical margins) ; length, 7-10 mm., width, 2.5-3 mm. ....*mimulus* Hussey 1929 (n.n. for vars. *a* and *b* of *mimus* Say 1832)

Florida, Texas, Arizona, California, (Mexico and West Indies to Panama) ; on *Iresine paniculata*.

- 4. Antennae nearly five times the length of the pronotum, (segment I less than twice the length of II and equal or nearly equal to IV ; scutellum nearly as long as wide ; corium red, narrowly margined with white, commonly with a large transverse black spot or fascia on its apical third ; length, 8-12.5 mm., width, 2.75-4 mm.) ....*andreae* Linné 1758  
 Florida, (West Indies) ; on *Sterculia carthaginensis*, *Abutilon* sp., *Thespis populnea*, *Hibiscus elatus*, *Sida* sp., *Bidens* sp., *Vernonia menthaefolia*, *Casearia decandra*, *Parthenium hysterophorus* ; injurious to cotton ; also stated to be predacious.

Antennae about four and one-half times *or less* the length of the pronotum ..... 5

- 5. Antennal segment I twice the length of III (and a little shorter

than IV), antennae about four times the length of the pronotum; (scutellum about one and one-seventh times as wide as long; corium black, brown or fuscous with the costal and apical margins pale; scutellum dull red; ventral segments red or brown with the posterior margins white; femora red; length, 11.75–17 mm., width, 3.4 mm.).

*suturellus* Herrich Schaeffer 1842

South Carolina, Georgia, Florida, Alabama, (West Indies); on seed-pods of *Hibiscus sabdariffa*; on *Hibiscus fulgidus*, *Urena lobata*, *Solanum nigrum*, *Solanum melogena*, *Carica papaya*, oleander, roses; injurious to oranges, very injurious to cotton; notorious as the cotton-stainer of the North.

Antennal segment I less than twice the length of III, antennae distinctly *more* than four times the length of the pronotum ..... 6

6. Antennal segment IV one and one-fifth times the length of I, I one and one-quarter times the length of II; scutellum about one and one-quarter times as wide as long; (general color stramineous with a variable black fascia or spot posteriorly on the pronotum; also black, the scutellum, the median spot of the corium of variable size and frequently triangular, near the margin; membrane black, white margined; head dilute sordid coccineous; anterior pronotal callus and discs of pleura yellowish; incisures of ventral segments V and VI more or less sanguineous, the others variably whitish); length, 9–13 mm., width, 2.5–3.8 mm.

*mimus* Say 1832

(*albidiventris* Stål 1854)

Arizona, Texas, California, (Mexico to Ecuador); on *Neurolaena lobata*, *Casearia aculeata*, *Parthenium hysterophorus*, *Sida* sp., *Abutilon* sp.

Antennal segment IV one and two-fifths the length of I, I about twice the length of III; (insect about three and one-half times as long as wide); scutellum about one and one-third times as wide as long; (anterior lobe of the pronotum black with a reddish spot on each side; sternum and venter black, posterior margins of the ventral segments white); length, 12–15 mm., width, 3.6 mm. .... *obscuratus* Distant 1883  
Texas, (Mexico to Costa Rica); on seeds of *Sida* sp.

NOTE: *Dysdercus concinnus* Stål 1861, recorded from Texas, (Mexico to Ecuador), is omitted from this key, in the absence of

authentically determined specimens. In this species, the antennal segment IV, according to Hussey, is one-fifth longer than I; length, 11.5–13.2 mm., width, 3.1–4.2 mm. The colors (derived from *Biologia Centrali Americana*, Heteroptera, pl. 21, figs. 12 and 15) are as follows: Head unicolorous red or black (Hussey); collar white, pronotal callus reddish, posterior lobe of the pronotum black, its posterior margin narrowly white; hemelytra stramineous or yellowish with a large black spot at about the middle, which extends roundedly nearly to the clavus and sometimes along the margin nearly to the base; membrane black, narrowly pale-margined; femora red or dark.

*Dysdercus peruvianus* Guérin 1831 is so uncertain as to its United States record from California, that it is likewise not included.

In this genus the male genitalia are stated to be of specific value, but they have not as yet been sufficiently developed for the group as a whole.

### Family XIII. THAUMASTOTHERIIDAE Kirkaldy 1908

(*Thaumastocoridae* Kirk. 1908, T.-B. 1939 et auctt.)

#### Subfamily Xylastodorinae Barber 1920

W. L. McAtee (1926, Ent. News XXVII: 14) has pointed out that the first genus described was originally named *Thaumastotherium* by Kirkaldy (1908, Proc. Linn. Soc. N.S.W., XXII: 777), which name he replaced in the Corrigenda and on the plate by *Thaumastocoris*, with no supporting reasons given for the change. Kirkaldy's first name for the subfamily he then established in Lygaeidae to contain the new genus, was Thaumastotheriinae, in the same Corrigenda changed to Thaumastocorinae. According to McAtee, the first name proposed is not preoccupied, therefore valid, and it stands in spite of the later change. It is here adopted; and the family name Thaumastocoridae given in the family key in this Synopsis, Part I, p. 160, is changed as above. As the preceding is merely intended to be a clarification of the family name, the reader is referred for a full and valuable discussion of the family to Barber's paper later referred to (pp. 98–104).

Of the three genera in the family, namely: *Thaumastotherium* Kirkaldy 1908, *Baclozygum* Bergroth 1909 (Deutsch. Ent. Zeit. p. 332) and *Xylastodoris* Barber 1920 (Bul. B. E. S. XV: 100) only the last is found in the New World; Barber makes it the type of his new subfamily Xylastodorinae.

Genus *Xylastodoris* Barber 1920

The following are selected generic characters, from the original description: Much flattened; head nearly as wide as long, tylus and juga of equal length, parallel-sided; antennae four-segmented, less than twice as long as the pronotum, antennal tubercles visible from above and apically subtruncated; margins of head before antennal tubercles parallel sided to the rounded apex; eyes distant from the anterior margin of the pronotum, head suddenly contracted behind them, ocelli widely separated; bucculae represented by two widely separated slightly raised ridges, evanescent posteriorly; rostrum short, flattened, apparently three-segmented, its apex *not* reaching middle of the prosternum; pronotum wider than long, about as long as the head, lateral margins quite expanded and slightly raised, disc flattened, shallowly transversely depressed before middle, posterior lobe closely and coarsely punctured; scutellum a little shorter than the pronotum, slightly longer than wide, not carinate; hemelytra wider and longer than the abdomen, membrane without veins; meso- and metasternum fused and covered by a smooth subcordate shaped plate, longitudinally linearly impressed; ostioles absent; legs short, globular coxae widely separated, femora unarmed, tarsi two-segmented, with two widely separated areolate claws.

The only species so far known in the genus is

*X. luteolus* Barber 1920

described from Cuba. The generic characters are sufficient to recognize it; length, 2–2.5 mm.

Florida; on Royal Palm (*Oreadoxa regia*).

## REFERENCES

The references following are on the same plan as those in Part I (q.v.), and name only works *after* 1917. It also contains only such as refer to the families in this Part II. However, all such genera and species as will appear in later Families are also enumerated. The Miridae are omitted as before. This enumeration of genera and species therefore supplements the Van Duzee Catalogue of 1917.

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Describes: *Leptoglossus brevirostris* Barber (Arizona, California, p. 35); *Blissus occiduus* Barber (Colorado, New Mexico, p. 36); *B. leucopterus* var. *arenarius* Barber (New Jersey, New York, p. 38); *B. leucopterus* var. *insularis* Barber (Florida, West Indies, p. 38).
1924. The Genus *Arhapha* in the United States. Can. Ent. LVI: 227/228.  
Describes: *Arhapha breviata* Barber (Kansas, p. 227).
1926. Notes on Coreidae in the collection of the United States National Museum with description of a new *Catorhintha*. Jour. N. Y. Ent. Soc. XXXIV: 209/216.  
Describes: *Catorhintha divergens* Barber (Florida, Cuba, p. 214).
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Describes: *Nissoscolopocerus* Barber (p. 25); *N. apiculatus* Barber (Colorado, Alberta, p. 26).
1920. A new member of the Family Thaumastocoridae. Bul. Brooklyn Ent. Soc. XV: 98/105.  
Describes: Subfamily Xylastodorinae; *Xylastodoris* Barber, p. 100; *Xylastodoris luteolus* Barber (Cuba, p. 101).
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Describes: *Alydus tomentosus* Fracker (Colorado, p. 268); var. *infuscatus* Fracker, of *A. conspersus* Montandon (Wisconsin, Colorado, p. 271); var. *cinereus* of *Stachyocnemus apicalis* Dallas (Colorado, p. 276).
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Describes: *Jalysus balli* Harris (Arizona, Mexico, p. 106); *acanthophysa idaho* Harris (Idaho, Oregon, p. 108).
- McAtee, W. L.** 1919. Key to the Nearctic genera and species of Berytidae. Jour. N. Y. Ent. Soc. XXVII: 79/92.  
Describes: *Aknisus* McAtee (pp. 80, 81); *Aknisus calvus* McAtee (California, p. 85); *Saurocoris* McAtee (p. 89); *Saurocoris instans* McAtee (California, p. 90).
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Describes: *Hyalymenus (Tivarbus) potens* Torre-Bueno (Florida, p. 187); *H. (T.) notus* Torre-Bueno (Florida, p. 189).  
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Describes: *Tollius vanduzeei* Torre-Bueno (California, p. 159).
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Describes: *Euryophthalmus cinctus* subspecies *californicus* Van Duzee (California, p. 270).

NOTE: Through an overlooked typographical error, E. P. Van Duzee's paper "A few new Hemiptera," Pan Pac. Ent. XIII: 25/31, is dated 1927 in the References to Part I. It should be 1937.

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## A REVISION OF THE GENUS *BUPRESTIS* OF NORTH AMERICA NORTH OF MEXICO (COLEOPTERA, BUPRESTIDAE)

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This study of the genus *Buprestis* has been undertaken with the intention of putting the taxonomy on a more stable basis through a study of the male genitalia, thereby eliminating existing confusion regarding the specific, subspecific or varietal status of some of the forms. An attempt is made to interpret phylogenetic affinities existing among the various forms, and a key to the species is presented. It is hoped that the present key will prove to be more satisfactory than those previously proposed, and while admittedly incapable of reaching certain uncommon variations, it will separate the great majority of specimens.

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## CLASSIFICATION

## Family BUPRESTIDAE

## Tribe Buprestini Lac.

*Buprestini* is separated from the other Buprestidae by the following characteristics: Hind coxal plates distinctly widened interiorly, front margin straight, hind margin oblique; antennal pores concentrated in pits on the two faces of the serrate joints; front not narrowed at point of insertion of antennae, eyes scarcely approaching, often distant on vertex.

Genus *Buprestis* Linné

*Buprestis* Linné 1758, Syst. Nat. Ed., 10: 408; Solier 1833, Ann. Ent. Soc. Fr., 2: 279-281; Mannerheim, 1837, Bull. Soc. Nat. Moscou, 7: 61; Fairmaire, 1856, Faune el Col. Fr., p. 140; E. Saunders, 1871, Cat. Bup., p. 39; Waterhouse, 1877, Biol. Centr. Amer. Ins. Col., 3: 13; Casey, 1909, Proc. Wash. Acad. Sc., 11: 87-128; Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 75-109; Chamberlin, 1926, Cat. Buprestidae North America, p. 103-128; Fisher, 1925, Proc. U. S. Natl. Museum, 65: 143-160. *Ancylochira* Eschsch. 1829, Zool. Atl., 1: 9; Waterhouse, 1861, Cat. Br. Col., p. 51; Le Conte, 1861, Classification N. A. Col., p. 152. *Gymnota* Gistl., 1834, Ins. Doubl.-Graf Jenison-Walworth, p. 10. *Anoplis* Kirby, 1837, Richardson's Fauna Bor.-Amer., 4: 151-154. *Sterosa* (Subgenus) Casey, 1909, Proc. Wash. Acad. Sc., 11: 116. *Cypriacis* (Subgenus) Casey, 1909, Proc. Wash. Acad. Sc., 11: 116.

*Buprestis* is separated from other Buprestid genera by the following characters: form elongate, two and a half times to four times as long as wide, subcylindrical; head and ventral surface often pilose, elytra hairless. Eyes widely separated; antennae serrate, reaching about to hind angles of pronotum, 11 segmented; mentum pale, membranous in front, becoming corneous and metallic basally in some species; pronotum evenly rounded laterally to inflated at

base and sinuate at the middle, evenly punctate or with irregular levigated areas, evenly arched to sulcate medially; scutellum small; elytra moderately narrowed posteriorly, evenly striate with no sign of areolae, cribrate with rows of large punctures, or costate, apices truncate, rounded with a sutural spine or bispinulose, sometimes bisinuate; lateral margins smooth; mesosternal suture distinct; posterior lateral metathoracic sclerite exposed, triangular; prosternal spine obtusely angulated behind the front coxae, smooth to longitudinally medially sulcate; first ventral segment of abdomen convex to strongly longitudinally medially sulcate.

Over a hundred names have been applied to the *Buprestis* of our fauna. Casey recognized 65 species and subspecies, and two subgenera. Nicolay and Weiss recognized 18 species, five subspecies, and two named color varieties. This study recognizes 22 species and one subspecies.

Casey placed *Buprestis* between his *Texania* (*Chalcophorella*) and *Dicerca* Esch., and presented several similarities among these genera. Nicolay and Weiss gave no comparison of *Buprestis* with any other genera. The present author has observed the tendency of some species of *Buprestis* to have the elytral apices prolonged and divaricated, particularly *Buprestis confluenta* Say and *Buprestis sulcicollis* (Le Conte), somewhat as in *Dicerca*, as well as the tibial modification of many males in both genera, and subscribes to the conclusion of Casey placing *Buprestis* next to *Dicerca*.

Casey separated two subgenera from *Buprestis*. One is *Sterosa*, (Type *Buprestis decora* (Fabr.)), embracing *Buprestis decora* (Fabr.), *Buprestis salisburyensis* (Herbst), and *Buprestis apicans* Herbst. H. E. Burke<sup>1</sup> supports this subgenus on the basis of larval characters, and the present author is in agreement with this separation. The other subgenus erected by Casey was *Cypriacis*, [Type *Buprestis aurulenta* Linné (*Ancylocheira lauta* (Le Conte))], embracing *Buprestis aurulenta* Linné, *Buprestis sulcicollis* (Le Conte), *Buprestis striata* (Fab.), *Buprestis intricata* Casey, and *Buprestis adjecta* (Le Conte). Burke also supported this subgenus in his larval studies. In the author's opinion, *Cypriacis* properly includes all of the species having the males with the anterior tibiae unmodified excepting those in *Sterosa*. This shifts *Buprestis connexa* Horn, *Buprestis langi* (Mann.), and *Buprestis fasciata* (Fab.) from *Buprestis* s. str. where they have been placed by Casey and Nicolay and Weiss, into *Cypriacis*. The larvae of *B. langi* closely resemble

<sup>1</sup> H. E. Burke, Journ. of Econ. Ent., 2: 334 (Biological Notes).

the larvae of *B. aurulenta*, according to Burke; *B. connexa* usually, and *B. langi* sometimes have the side margins of the elytra cupreous as is the case with *B. aurulenta*, some forms of *B. striata*, *B. intricata*, and *B. adjecta*. The elytral sculpturing of *B. connexa* and *B. adjecta* is quite similar. The pronotum of *B. langi* is often medially impressed as in *B. aurulenta*, *B. sulcicollis*, and *B. striata*, characteristic of *Cypriacis* and not of *Buprestis* s. str. The males of *Buprestis fasciata* and *Buprestis langi* resemble each other strongly. Thus this shift in position seems to be reasonable.

*Cypriacis*, then, consists of *Buprestis sulcicollis*, which has four or five elytral costae (the short scutellar costule often rudimentary or absent); *B. aurulenta*, having five or rarely six or seven costae; *B. striata*, with five costae; *B. intricata* with seven, eight, or nine elytral costae; *B. adjecta* with seven, eight or nine costae; and *B. connexa*, *B. langi* and *B. fasciata* with nine each. *B. fasciata* and *B. langi* have true striae, not just elytral costae with thickly punctate interspaces, and the striae exhibit a distinct tendency to coalesce at the apical third or fourth, the intercostal spaces of the preceding species not exhibiting this tendency. Striate elytra are typical of *Buprestis* s. str. Also, *B. fasciata* and *B. langi* have yellow elytral maculations (often absent in females of *langi*), such markings being more in accordance with *Buprestis* s. str. than with *Cypriacis* as conceived by Casey. The larvae of *B. aurulenta*, *B. adjecta*, *B. striata*, and presumably *B. sulcicollis* and *B. intricata*, pupate in the fall and remain in the wood until spring. The larvae of *B. langi* and presumably of *B. fasciata* pupate in the spring and emerge soon after, as is typical of *Buprestis* s. str. *Buprestis fasciata* and *B. langi* may, then, be considered as possible connecting links between *Cypriacis* as typified in *B. aurulenta*, and *Buprestis* s. str. as perhaps best exemplified in our fauna by *B. maculipennis* Gory (Genotype *Buprestis octoguttata* L.). *Cypriacis* is apparently a natural group within the genus *Buprestis*, but since it grades into typical *Buprestis* so gradually through *B. adjecta*, *B. langi*, and *B. fasciata*, it is not as sharply defined as is *Sterosa* and is of secondary importance.

The remaining species fall into roughly three groups with one or two species standing alone. The first of these groups consists of *B. lineata* (Fab.) and *B. maculipennis* Gory, and is characterized by having the first ventral abdominal segment deeply longitudinally sulcated and the interspaces of the elytra about uniformly and only slightly convex.

The next group consists of *B. subornata* (Le Conte), *B. rusti-*

*corum* (Kirby), *B. nuttalli* (Kirby), *B. nuttalli* subspecies *laeviventris* (Le Conte), with *B. maculativentris* Say falling close to *B. subornata* but tending to be less typical of the group. These species have the elytral interspaces alternately more strongly convex. This characteristic is not typical of *B. maculativentris*, but both this species and *B. subornata* occasionally have broad, shallow, transverse depressions on the elytra. All these species are maculated ventrally and have the first ventral abdominal segment sulcate medially.

The next group is made up of the deciduous-boring species *B. rufipes* (Oliver), *B. gibbsi* (Le Conte), *B. viridisuturalis* Nicolay and Weiss, and *B. fremontiae* Burke. Nicolay and Weiss, and Casey placed *B. connexa*, *B. langi*, and *B. fasciata* in this group, but the present author has relegated those species to *Cypriacis*. *B. rufipes*, *B. gibbsi*, and *B. viridisuturalis* have reddish-orange pigmentation apically on the lateral elytral margins, on a majority of specimens. *B. fremontiae* has only a rufous tinge in lieu of the orange. The first ventral abdominal segment of these four species is, at most, only slightly concave. Waterhouse mentioned the possibility that this group (*B. viridisuturalis* and *B. fremontiae* were then undescribed) might represent a sub-genus.

There remains one species which is not included in any of the groups so far given. This species is *B. confluenta* Say. The males of this species have the anterior tibiae internally emarginate and armed with an internal spur, but the emargination and placement of the spur occur almost at the middle of the tibiae rather than slightly sub-apically, as is the case with *B. viridisuturalis*, *B. gibbsi*, *B. fremontiae*, and *B. rufipes*. The males of *B. confluenta*, and less often the females, have extensive ventral maculation, and the species bores in deciduous wood. The elytral maculation is unique in *B. confluenta*, consisting of small yellow specks, more or less transversely confluent, strewn irregularly over the entire surface, whereas in the species of the previous groups the maculations tend to be arranged into definite patterns, usually representative of or similar to the common three or four spot per elytron pattern. The apices of the elytra are sometimes prolonged slightly, and sometimes divaricated, and they are not bispinose or deeply emarginate as is characteristic of *B. fremontiae*, *B. viridisuturalis*, *B. rufipes*, and *B. gibbsi*. The present author considers *Buprestis confluenta* as a group by itself.

It is worthy of note that most of the species occurring in a green phase also are found in blue and purple phases. The flavate macu-

lations of the dorsal and ventral surfaces of several species vary in shade from light lemon or canary yellow to distinctly orange, and the normally orange maculations are found to vary to definitely reddish in some specimens. The dull species, normally colored black or coppery brown show a tendency to be slightly purplish to greenish in reflection both dorsally and ventrally.

The male genitalia are, on the whole, rather distinctive among the species, but some similarities will be found to exist among related species, perhaps most easily noticeable as the microspiculosity of a few of the species [*Buprestis gibbsi* (Le Conte), *B. fremontiae* Burke, and *B. rufipes* (Oliver), Pl. IV, Figs. 8, 9, and 11], and in the resemblance of the structures from *B. maculativentris* Say, and *B. rusticorum* (Kirby), Pl. IV, Figs. 3 and 5. The genitalia of *B. subornata* (Le Conte), on the other hand, are very dissimilar from any others although the adults were formerly considered as varieties of *B. maculativentris* when judged on external characters only.

#### DISTRIBUTION

The genus *Buprestis*, as generally accepted, is holartic in distribution. The species treated in this paper occur in various parts of North America, from Canada and Alaska to Texas and Florida. Some of the forms have wide ranges of occurrence from North to South. *B. nuttalli* (Kirby) has a range which extends from Alaska through Canada to the Eastern coast into Pennsylvania and Virginia, and in the West, into Colorado, New Mexico, and Arizona. In contrast, *B. fremontiae* Burke is known only from restricted mountainous areas of two or three counties in Southern California.

*Buprestis nuttalli* subsp. *laeiventris* (Le Conte) occurs in various parts of California, but is most common in the mountains of middle to northern California. A few specimens have been examined from Oregon and Arizona. *B. adjecta* (Le Conte) has a rather wide range, occurring in British Columbia, Washington, Oregon, California, Nevada, New Mexico, Wyoming, and Colorado, but is apparently uncommon excepting in a very few localities. *Buprestis fasciata* (Fab.), which occurs from Canada in the East through the great lake states to Minnesota, and along the Eastern seaboard South to Georgia, is not usually taken in numbers excepting along the shore of Lake Superior during the end of June (Nicolay and Weiss). *B. intricata* Casey is known from Colorado, Wyoming, Oregon, California, and British Columbia, but has never been taken in numbers. It seems quite possible that it is the inadequacy of our collecting methods which explains much of the seeming scarcity of such forms, and their spotted but widespread occurrence.

## BIOLOGY

Members of the genus *Buprestis* are all borers in dead, partially dead or living trees and large shrubs. Such species as *B. aurulenta* (Le Conte), and the species of the subgenus *Sterosa* bore exclusively in coniferous trees, and others, including *B. rufipes*, *B. fremontiae*, and *B. viridisuturalis* work exclusively in deciduous trees. Some, such as *B. aurulenta* work in quite a variety of host plants, whereas *B. fremontiae* is only known to work in a single species of shrubby tree. It should be noted that the phylogenetic sequence herein proposed places these deciduous-boring species together, with the possible exception of *B. fasciata* and *B. langi*, there being reason to suspect these species of boring in both coniferous and deciduous hosts.

All the species are apparently able to lay their eggs directly in crevices of the wood, and the larvae can thrive without any bark food. Eggs are, however, primarily laid on or in cracks of the bark.

At least two years are spent in the larval stage, and in some cases this time is extended to as much as 20 or more years. Probably some larvae from almost every group of eggs have retarded development and emerge as beetles from one to several years after the main brood.

The larvae of *Buprestis* s. str. have a small rugose hood around the apex of the V-shaped markings on the dorsal plate of the first segment and very slight rugose markings along the groove of the ventral plate. In this group pupation takes place in the spring and the beetles emerge soon afterwards.

The larvae of *Sterosa* have no distinct rugose hood but almost the entire dorsal and ventral plates are rugose. Pupation occurs in the summer and the beetles remain in their pupal cells until the following spring.

The larvae of *Cypriacis* have the rugose hood around the apex of the V much larger and the rugose area along the ventral marking is broader than in *Buprestis* s. str. Pupation takes place in the summer and the imagos remain in their pupal cells until the following spring.

The larvae of *Buprestis* s. str. generally prefer dead wood and do no particular damage, being quite beneficial in mining stumps on cut-over land causing them to decay rapidly and thus aiding in the clearing. The larvae of the other larval groups often attack slightly injured living trees, killing them or at least causing serious damage to the wood.

## CHARACTERS USED IN CLASSIFICATION

The sculpturing of the elytra is of great importance in the separation of the various species in this genus. The elytra may be almost smooth with rows of large punctures, they may be striate or costate, the costae may be uniformly convex or alternately more strongly convex. The intervals between the elytral costae may be wide or narrow, coarsely and thickly or finely and rather sparsely punctate. The colors of most of the species are of considerable importance in separation of forms, but the pigmentation is extremely variable and not always reliable to use. The form of the elytral apices is very important in some parts of the genus. The apices may be broadly rounded, truncate, bisinuate, entire with a sutural tooth, bidentate, multispinose, and shallowly or deeply emarginate. The punctuation of the abdomen and the prosternum is apparently fairly constant in most of the species, but the punctuation of the head and pronotum is of little value in most of the species. The punctuation of the elytra is quite variable in some of the species, and should not be considered a stable character in classification. Some of the species have the first ventral abdominal segment markedly longitudinally sulcate whereas in others this segment is uniformly convex. A few species have representatives which fall into both of these groups, but this inconsistency is dealt with in the key, and the character remains of some importance in the establishment of groups.

The pronotum may or may not be impressed in the same species in some cases, *e.g.*, *B. aurulenta*, but specimens of typical *Buprestis* never have the pronotum deeply impressed.

The character which divides the species of our fauna into two nearly equal groups is the modification of the anterior tibiae of the males of *Buprestis s. str.* Size and form of specimens is often of importance in the determination of the species but form and proportions of parts is variable in such species as *B. langi* and *B. rusticorum*. The number of elytral costae of some of the species has played an important part in confusing past workers in the genus *Buprestis*. It was supposed that the number of elytral costae remained constant in a particular species. Casey and Nicolay and Weiss apparently believed this character to be valid, and R. Hopping based a new species on this variable character. The antennae of certain species are of some value as supplementary characters, the color being more or less constant and peculiar in a few forms.

The female genitalia are membranous, but in one case were found to be valuable in specific differentiation, this being the case of *B.*

*intricata* Casey and *B. adjecta* (Le Conte). The male genitalia are of prime importance in the separation of the North American species. They display considerable differences in form and sculpturing as well as in the distribution and amount of pigmentation. These structures provide a useful criterion in establishing the validity of species, and in establishing the identities of individual specimens which are otherwise abnormal, such as immaculate specimens of normally maculated species.

The characters which are so useful in certain other Buprestid genera such as the possession or lack of carinae on the front, form of pronotum, or pigmentation are very variable in most of the species, and detailed descriptions overlap endlessly. Consequently the descriptions have been made as complete as deemed advisable with a comparison appended to each description to aid in determinations.

## KEY TO THE SPECIES

1. Anterior tibiae simple ..... 2  
    Anterior tibiae internally emarginate and armed with an  
    internal apical or subapical recurved tooth or spine... 9
2. Elytra with large punctures dispersed over surface or  
    arranged in rows, not striate, or when costae are  
    present they are widely separated by closely punctured  
    intervals ..... 3  
    Elytra striate or costate, costae never separated by wide,  
    closely punctured intervals ..... 9
3. Elytra with large punctures, dispersed or in rows, not  
    striate ..... 4  
    Elytra with four or five costae separated by closely punctured  
    intervals ..... 6
4. Apices of elytra bidentate ..... *decora* (Fabricius)  
    Pl. V, f. 1  
    Apices of elytra not bidentate ..... 5
5. Elytra green, bluish or purplish with suture and side  
    margins coppery to brilliant cupreous; small, 10-15  
    mm. .... *salisburyensis* (Herbst)  
    Pl. V, f. 3  
    Elytra unicolorous, dark coppery-brown; large, 19-22  
    mm. .... *apricans* Herbst  
    Pl. V, f. 2
- 6(3). Elytra brilliant green to blue with suture and side margins  
    cupreous ..... 7  
    Elytra coppery-brown, often with a greenish tinge ..... 8

7. Elytral costae with summits nearly impunctate, strongly convex, Western North America .....*aurulenta* Linné  
Pl. V, f. 6  
Elytral costae with summits rather thickly punctate, not strongly convex, Eastern North America.  
*(impedita) striata* (Fabricius)  
Pl. V, f. 5
- 8(6). Front angles of pronotum visible from above; elytral costae strongly convex, scutellar costule usually indistinct.  
*sulcicollis* (Le Conte)  
Pl. V, f. 4  
Front angles of pronotum not visible from above; elytral costae less strongly convex, scutellar costule distinct.  
*striata* (Fabricius)  
Pl. V, f. 5
- 9(1-3). Middle of first abdominal sternite markedly sulcate longitudinally ..... 10  
Middle of first abdominal sternite not markedly sulcate longitudinally ..... 26
10. Elytra with interstitial spaces about uniformly elevated 11  
Elytra with alternate interstitial spaces more strongly elevated ..... 21
11. Elytra maculated with yellow or orange ..... 12  
Elytra not maculated with yellow or orange ..... 16
12. Elytra green ..... 13  
Elytra black or brown ..... 14
13. Elytral costae rather narrow and rather strongly convex; form often strongly elongate; Western North America.  
*langi* (Mannerheim)  
Pl. VI, f. 4 & 5  
Elytral costae wide and rather feebly convex; form not especially elongate; Eastern North America.  
*fasciata* (Fabricius)  
Pl. VI, f. 6; Pl. VII, f. 1
- 14(12). Front of head, anterior angles of pronotum and ventral surface usually maculated with yellow or orange; pronotum often with a smooth median line and smooth areas toward sides, trapezoidal in form; elytra often with longitudinal vittae reaching from base to apex 15  
Front of head, anterior angles of pronotum and ventral surface never maculated with yellow or orange; pronotum never with a smooth median line or smooth

areas toward sides, not trapezoidal in form; elytra never with longitudinal vittae.

(dark phase) *fasciata* (Fabricius)

Pl. VII, f. 1

15. Each elytron with two orange or yellow longitudinal vittae, more or less confluent and connected, sometimes not entire ..... *lineata* (Fabricius)  
Pl. VII, f. 2
- Elytra with irregular yellowish spots, often connected but never forming longitudinal vittae.....*maculipennis* Gory  
Pl. VII, f. 3
- 16(11). Color green, blue or reddish ..... 17  
Color black or brown ..... 19
17. Apices of elytra not emarginate or bidentate, form oblong, suture and side margins of elytra often cupreous.  
*intricata* Casey  
Pl. VI, f. 2
- Apices of elytra emarginate, bidentate or at least with a sutural tooth ..... 18
18. Form short broad; suture and side margins of elytra usually cupreous ..... *adjecta* (Le Conte)  
Pl. VI, f. 1
- Form elongate; suture and side margins of elytra not cupreous ..... *langi* Mannerheim  
Pl. VI, f. 4 & 5
- 19(16). Venter of abdomen with a row of orange spots along sides and apex; elytra often with broad shallow transverse depressions ..... *maculativentris* Gory  
Pl. VII, f. 6
- Venter of abdomen without a row of orange spots along sides, occasionally with spots on tip; elytra never with transverse depressions ..... 20
20. Male genitalia about parallel from base to near apex.  
immaculate *lineata* (Fabricius)  
Pl. VII, f. 2
- Male genitalia broadest near base and narrowed to apex.  
immaculate *maculipennis* Gory  
Pl. VII, f. 3
- 21(10). Elytra maculated with yellow or orange ..... 22  
Elytra immaculate ..... 23
22. The two costae proceeding from center of base of each elytron often very prominent and usually conspicu-

ously united at apical fourth; coxae and legs usually maculated with orange or yellow; abdomen rather coarsely punctate; markings of elytra often traversed by black striae and interrupted by small transverse black specks .....*nuttalli* (Kirby)

Pl. VII, f. 5

The two costae proceeding from center of base of each elytron not particularly prominent and not or not conspicuously united at apical fourth; coxae and legs not maculated with orange or yellow; abdomen finely punctate; markings of elytra rarely interrupted or traversed by black specks or striae; California, Oregon, Arizona.....*nuttalli* subsp. *laeviventris* (Le Conte)

Pl. VII, f. 4

23(21). Elytra not black or blackish-bronzed ..... 24

Elytra black or blackish-bronzed ..... 25

24. Front of head, anterior angles of pronotum and ventral surface usually maculated with orange; suture and side margins of elytra never brilliant cupreous; form not oblong; pronotum never impressed medially but almost always with a smooth median line which is not cupreous .....*subornata* (Le Conte)

Pl. VIII, f. 1

Front of head, anterior angles of pronotum and ventral surface never maculated with orange; suture and side margins of elytra usually brilliant cupreous; form oblong; pronotum often impressed medially and often with the median impression cupreous.

*intricata* Casey

Pl. VI, f. 2

25(23). Elytral costae often rather strongly convex; color black, often with a slight greenish or purplish tinge; average size 20 mm.; form rather oblong; West coast to Idaho, Colorado, and Utah .....*rusticorum* (Kirby)

Pl. VIII, f. 2

Elytral costae never very strongly convex; color dark bronzy, sometimes slightly greenish or brown; average size 16 mm.; form not strongly oblong; East coast to South Dakota and Montana .....*maculativentris* Say

Pl. VII, f. 6

26(9). Elytra orange or yellow or marked with orange or yellow ..... 27

- Elytra with no orange or yellow, often somewhat cupreous ..... 34
27. Elytra with small and isolated or more or less confluent yellow spots disseminated over the surface.  
*confluenta* Say  
Pl. VIII, f. 5
- Elytra not with small yellow spots disseminated over the surface ..... 28
28. Elytral suture without green, blue or purple pigmentation; maculation consisting of a small dark spot on side margin near middle, this spot sometimes missing.  
*fremontiae* Burke  
Pl. IX, f. 2
- Elytral suture pigmented with blue, green or purple; maculations usually more complex than above ..... 29
29. Ventral surface extensively maculated with yellow.  
*rufipes* Oliver  
Pl. VI, f. 6
- Ventral surface with at most two small spots on last abdominal sternite, usually immaculate ..... 30
30. Elytra yellow to light brownish, irregular sutural band (sometimes very narrow) green, blue or purple, apices and apical margins often tinged with orange or reddish .....*viridisuturalis* Nicolay and Weiss  
Pl. IX, f. 1
- Elytra not predominantly yellow, or with the yellow confined to several spots ..... 31
31. Elytra with six spots (rarely divided longitudinally) ..... 32
- Elytra with two or four spots ..... 33
32. Anterior spot reaching and curving around humeral umbone; posterior spots usually touched with orange or reddish .....*gibbsi* Le Conte  
Pl. VIII, f. 4
- Anterior spot not reaching or curving around humeral umbone; posterior spots not touched with orange or reddish ..... 33
- 33(31). Elytral costae rather narrow and rather strongly convex; form often strongly elongate, Western North America .....*langi* (Mannerheim)  
Pl. VI, f. 4 & 5
- Elytral costae wide and rather feebly convex; form not especially elongate; Eastern North America.  
*fasciata* (Fabricius)  
Pl. VI, f. 6; Pl. VII, f. 1



sparsely pilose; anterior tibiae of both sexes not modified; prosternum coarsely and densely, abdomen more finely and distinctly punctate; tip of abdomen truncate in male, broadly rounded in female.

Varies somewhat in color, from dull coppery-brown to a distinct greenish; sublateral ridge of elytra is variably strong.

Recorded from North Carolina, Alabama, South Carolina, Louisiana, Florida, Texas, Georgia, Pennsylvania, New York, and New Jersey. A rather large number of specimens of this species have been taken by Manee at Southern Pines, North Carolina.

Host plant: Long-leaf pine.

*Buprestis apricans* can be readily separated from *B. decora* (Fab.) by its darker color, larger broader form, and by the elytral apices which are deeply emarginate in *B. decora*. The male genitalia (Pl. III, Figs. 1 and 3), are different in the two species. From *Buprestis salisburyensis* (Herbst) *B. apricans* may be distinguished by its darker color, far greater size, and the male genitalia (Pl. III, Figs. 1 and 2).

*Buprestis apricans* is known as the flatheaded turpentine borer in the south east where it often attacks trees which have been boxed for turpentine, greatly shortening the turpentine producing life of the trees. It has been taken among needles of long-leaf pines in April, on dead blaze of large living long-leaf pines. The adults emerge from the wood in late winter and spring. While this species is reputed to be a serious pest in certain localities, there are relatively few specimens in most collections.

*Buprestis decora* (Fab.) (Pl. V, Fig. 1)

*Buprestis decora* (Fab.) 1775, Syst. Ent. p. 217.—Cast. & Gory, 1837, Mon. Bup., p. 154, t. 36, f. 199.—Le Conte, 1859, Trans. Am. Philos. Soc., (2) 11: 210.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 127.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 88.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 9.—Knull, 1922, Can. Ent., 54: 81.—Fisher, 1925, Proc. U.S.N.M., 65 Art., 9 nr., 2522, p. 148-149-151.—Chamberlin, 1926, Cat. Bup. N. A., p. 108-109.

Green to blue above, pronotum often coppery, suture and side margins of elytra coppery; length 11-18 mm. *Head* densely and coarsely punctate, more often without a median line on front, sparsely pilose; antennae dark, first three segments light green. *Pronotum* widest at base, slightly arcuate to apex on margins; punctures separated by about their own

widths; sometimes with a faint median sulcus, more often without. *Scutellum* small, round. *Elytra* widest at apical third or almost parallel to apical third; slightly wider than pronotum at base; rounded from apical third to apices which are deeply emarginate; umbone not prominent; not striate, but with rows of large punctures, occasionally ill defined; feeble indications of costae sometimes visible at base. *Ventral surface* vivid green to cupreous; slightly more pilose in male; prosternum flattened, finely, densely punctate and sometimes feebly impressed; abdomen finely punctate; tip of abdomen truncate and subsinuate, female with tip subtruncate.

Varies in color from plain green with suture and side margins bright coppery to forms with an indigo stripe in green area, or to specimens having the green area entirely suffused with coppery color.

Recorded from Alabama, Arkansas, Florida, Georgia, Louisiana, New Jersey, Pennsylvania, North Carolina, Texas, and Virginia.

Host plant: Pines, particularly rotting wood.

*Buprestis decora* can be readily separated from *B. apicans* Herbst by its lighter coloration, smaller more slender form, and by the elytral apices which are deeply emarginate in *B. decora*. The male genitalia (Pl. III, Figs. 1 and 3), are different in the two species. Separated from *B. salisburyensis* (Herbst) by the more slender form, slightly larger size, and the apices of the elytra which are entire in *B. salisburyensis*. The male genitalia (Pl. III, Figs. 2 and 3) also serve to separate the two species.

Larvae and adults split from railroad ties in October. Observed emerging from fuel because of warmth of woodbox, in December. Among needles of young long-leaf pines from mid-March to May; in May they are found on denuded trunks of damaged and dead pines. Not uncommon in the Southern states.

*Buprestis decora* was the species chosen by Casey as the type of the subgenus *Sterosa*.

*Buprestis salisburyensis* (Herbst) (Pl. V, Fig. 3)

*Buprestis salisburyensis* (Herbst) Kafer, 1801, 9: 174, t. 98, f. 141.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 89.—Knull, 1922, Can. Ent., 59: 81.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 9.—Chamberlin, 1926, Cat. Bup. N. A., p. 104.

*B. ultramarina* Say, 1836, Trans. Am. Philos. Soc., 4: 160.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 127.

*B. decora* (Fabr.), Casey, 1909, Proc. Wash. Acad. Sc., 11: 127.

Elytra green with suture and side margins bright coppery, or with purple or blue stripe in the green, or with the surface entirely dark coppery with suture and side margins dull and more intensely dark; form short and broader than in *B. decora* (Fabr.); under surface bright cupreous to green. *Head* with or without a frontal medial line, with or without small levigated areas; closely and coarsely punctate; sparsely pilose; antennae blackish-green, first two segments bronzy. *Pronotum* widest at base, distinctly arcuately, rather evenly narrowed to apex; coarsely punctured, sparsely punctate along median line, punctures at sides separated by less than their own widths; median line sometimes slightly impressed. *Scutellum* small, round. *Elytra* widest at apical third or almost parallel from basal part to apical third; slightly wider at base than pronotum; sometimes slightly sinuate at apical fourth; apices entire, with sutural tooth; humeral umbone slightly prominent; vestigial costae apparent at base; no striae on elytra, but with longitudinal rows of large punctures, the intervals being coarsely densely punctate. *Ventral surface* of male more pilose than female; prosternum coarsely punctate, impressed medially; tip of abdomen truncate, of female subtruncate.

The coloration of this species varies considerably, but the short, broad form (elytra only about two-thirds longer than wide) is characteristic.

Recorded from North Carolina, Georgia, New Jersey, Pennsylvania, Wisconsin, New York, Massachusetts, and Tennessee.

Host plant: *Pinus rigida* (pitch pine).

*Buprestis salisburyensis* may be readily separated from *B. decora* (Fabr.), which most resembles it in color, by the form which is more slender in *B. decora*, and by the elytral apices which are deeply emarginate in *B. decora*, and also by the male genitalia (Pl. III, Figs. 2 and 3). From *B. apricans*, the only other species of the subgenus *Sterosa*, it may be easily distinguished by the size, which is much larger in that species, by the color, which is usually darker in *B. apricans*, and by the male genitalia (Pl. III, Figs. 1 and 2).

*Buprestis salisburyensis* is one of the first if not the first of the *Buprestis* to appear in the Eastern states in the spring. It has been split from a pitch pine knot, and beaten from pitch pine needles. Not common but can be beaten from the needles of young healthy pines. Greenwood Lake, New Jersey, appears to be one of the best localities for collecting this insect.

*Buprestis aurulenta* Linné (Pl. V, Fig. 6)

*Buprestis aurulenta* Linné, 1767, Syst. Nat., 12: 661.—Castelnau and Gory, 1837, Monogr. Bupr., 1: 146, t. 36, f. 200.—Le Conte, 1859, Trans. Am. Philos. Soc., (2) 11: 210.—Kerremans, 1892, Mem. Soc. Ent. Belg., 1: 94.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 120.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 82.—Garnett, 1922, Bull. Ent. Soc. Fr., p. 10.—Chamberlin, 1926, Cat. Bupr. N. A., p. 104–106.

*B. lauta* (Le Conte), 1854, Proc. Acad. Nat. Sc. Philad., 7: 17.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 120.

*B. radians* (Le Conte), 1854, Proc. Acad. Nat. Sc. Philad., 7: 17.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 121.

*B. villosa* (Le Conte), 1873, Proc. Acad. Nat. Sc. Philad., 25: 331.

*B. fabulosa* Casey, 1909, Proc. Wash. Acad. Sc., 11: 120.

*B. aemula* Casey, 1909, Proc. Wash. Acad. Sc., 11: 121.

*B. tacomae* Casey, 1909, Proc. Wash. Acad. Sc., 11: 121.

*B. nupta* Casey, 1909, Proc. Wash. Acad. Sc., 11: 122.

*B. venusta* Casey, 1909, Proc. Wash. Acad. Sc., 11: 122.

*B. prospera* Casey, 1909, Proc. Wash. Acad. Sc., 11: 123.

*B. affinis* Casey, 1909, Proc. Wash. Acad. Sc., 11: 123.

*B. adulans* Casey, 1909, Proc. Wash. Acad. Sc., 11: 123.

*B. bicostata* Dejean, 1837, Cat. Col., 3: 88.

*B. chrysochlora* (Philippi), 1864, Stett. Ent. Zeit., 25: 314.

Elytra green to blue or more rarely slightly purplish, suture and side margins bright coppery. Pronotum and head entirely bright cupreous to green, blue, or rarely purplish, this coloration not necessarily in accord with the elytral color; scutellum bright coppery to green, blue or purplish, colored like pronotum as a rule; summits of elytral costae nearly impunctate; form elongate suboval; 13–22 mm. in length. *Head* with a distinct median carina; deeply and confluent punctate; rather densely pilose in some specimens; antennae metallic green to bronzed or cupreous. *Pronotum* variable in width, usually a little narrower than base of elytra at base; evenly narrowed from base to apex and only slightly arcuate to almost evenly broadly arcuate from base to apex or about parallel from base to apical third and then strongly arcuate to apex; longitudinally impressed medially, with a smooth median line, or with no trace of either; punctures often coarse and very dense, separated by more than their widths bordering the

median depression varying toward the lateral margins until separated by only one-half to one-fourth their widths; sometimes finely pilose. *Scutellum* small, round. *Elytra* widest at apical third; slightly wider at base than pronotum, diverging a little to apical third and broadly rounded, then slightly arcuate to apices which are obliquely or squarely cut, entire, often with a sutural tooth; costae sometimes curved at humeral umbone but often there is no curve at this spot; costae five in number, including the short scutellar costule, suture and lateral margins raised; summits of costae almost entirely impunctate, occasionally with a few scattered punctures; none of the costae greatly abbreviated, shortest costae (third or fourth from suture) reaching to apical fourth; intervals wide, coarsely and closely punctate, punctures more or less confluent; more or less distinctly transversely rugulose; not pilose. *Ventral surface* with a varying degree of pilosity; prosternum coarsely and densely punctate, abdomen finely punctate, more sparingly punctate in female; tip of last segment subtruncate in both sexes. Female slightly larger and broader than male.

Varies in color as mentioned in the diagnosis, occasional dull specimens being noted also. The author has examined about a half dozen specimens of *B. aurulenta* which were coppery brown with no metallic reflection (chemicals used in killing these specimens may account for their dull color). The pronotum may be very narrow to quite broad; an antescutellar pit is often apparent on the pronotum, and one specimen was noted which had distinct depressions near the anterior angles of the pronotum. Some specimens exhibit weak or rudimentary costae in the intervals between the second and third costae (from suture), the punctures in the first full-length interval (from suture) are occasionally unusually large, two specimens have short connecting costae running between two of the longitudinal costae, occasional specimens have costae which fork at the bases of the elytra. One specimen chopped from a Douglas fir stump by the author has one elytron blue and the other green, one half of the pronotum being green and the other blue, in harmony with elytral color.

Recorded from Wyoming, Oregon, Idaho, Utah, Nevada, New Mexico, California, Montana, Arizona, Colorado, Washington, Minnesota, Mexico and British Columbia.

Host plants: Western red cedar, yellow, lodgepole, bishop, jeffreyi, sugar, and Monterey pines, Douglas fir (*Pseudotsuga taxifolia*) and white fir (*Abies grandis*).

There are three species having as few as five costae in *Cypriacis*, viz., *B. aurulenta*, *B. sulcicollis* (Le Conte), and *B. striata* (Fab.). *Buprestis aurulenta* may be separated from *B. sulcicollis* by the color which is darker in that species and of unicolorous character; by the length of the elytral costae, two of which tend to be quite short in *B. sulcicollis*, and by the male genitalia (Pl. III, Figs. 5 and 6). From *B. striata* it may be separated by the elytral costae which are less strongly convex and which are thickly punctate in that species; the color is usually darker in *B. striata*, but the variety which was described as *impedita* is colored just as in *B. aurulenta*; the male genitalia (Pl. III, Figs. 4 and 6) also will serve to separate the two species although they are similar.

Casey drew up several tautological descriptions based upon variations of *B. aurulenta*. These and the other synonyms listed above are all variations of a single species as proven by a study of the genitalia as well as of the external characters of the various forms included in a very large aggregate series containing many unusual variations and probably specimens referable to all the synonyms.

*Buprestis aurulenta* occurs from sea level to 8000 feet elevation. Mines in dead portions of living trees as well as in stumps, exposed roots, and down wood. Specimens have emerged from wood after apparently having passed from 10 to over 30 years in the wood. The growth of the larvae was, of course retarded by the drying out of the wood after milling. Injury similar to that of *Buprestis apricans* Herbst. Entrance is sometimes made through wounds in the bark. Lightning struck trees are especially subject to attack. Appears in April, and may be beaten from young pines through the summer. Common from British Columbia to Southern California.

*Buprestis sulcicollis* (Le Conte) (Pl. V, Fig. 4)

*Buprestis sulcicollis* (Le Conte), 1859, Trans. Am. Philos. Soc., 209 (2) 11: 210.—Kerremans, 1892, Mem. Soc. Ent. Belg., 1: 99.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 119.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 85.—Knull, 1922, Can. Ent., 54: 81.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 10.—Chamberlin, 1926, Cat. Bupr. N. A., p. 127.

*B. lateralis* Casey, 1909, Proc. Wash. Acad. Sc., 11: 109. 119

Surface dull, elytral costae more shining; dark coppery brown to black or greenish above, pronotum sometimes pur-

plish; ventral surface purplish cupreous to greenish; elytra often obliquely narrowed apically and with the apices slightly prolonged; elytral costa proceeding from humerus not reaching past apical third; length 11–15.5 mm. *Head* often with a median line, finely, densely punctate and with long pubescence, antennae black, metallic; *prothorax* widest at base, gradually narrowed to apical third then broadly rounded to apex, more or less deeply sulcate medially, punctures tending to converge into groups, dense at sides and in median depression, separated by more than their widths elsewhere; *scutellum* oblong, slightly concave; *elytra* usually parallel to but sometimes slightly wider at apical third, broadly rounded at apical third and obliquely narrowed to apices, sometimes gradually rounded to apices, more often slightly sinuate before apices which are rather narrow and with sutural angles right, not prolonged; apices entire; humeral umbone curving short costae which proceed from this area; costae four or five in number, short scutellar costule often missing, costae shining, strongly convex, finely punctured; intercostal spaces wide, coarsely, confusedly rugulose punctate; ventral surface pilose, more densely at prosternum, finely and densely punctate, prosternum more coarsely punctate; tip of abdomen broadly rounded in both sexes; female larger and broader, in general, than the male.

The color varies considerably<sup>1</sup> as noted in the diagnosis; one of the more striking variations is the presence or absence of the short scutellar costule, with specimens which exhibit gradual graduation from one extreme to the other; the margin of the elytra from the apical third to the apices is usually almost straight, but is sinuate in some specimens, and in one example is slightly arcuate.

Recorded from Maine, New Hampshire, Michigan, New York, New Jersey, Nova Scotia, and Quebec.

Host plants: White and pitch pines (Nicolay and Weiss).

*Buprestis sulcicollis* may be separated from *B. striata* (Fab.), one of its two closest allies, by the form which is more elongate and slender in *B. striata*, by the elytral costae which are more strongly convex in *B. sulcicollis*, in many cases by the coloration which is often green or greenish with coppery or merely darker sutural and lateral marginal color in *B. striata*, and by the male genitalia (Pl. III, Figs. 5 and 6). *Buprestis aurulenta* Linné is the other close ally of *Buprestis sulcicollis* but is bicolorous, green to blue or rarely purplish with the suture and side margins of elytra brilliant

cupreous, has the costae almost impunctate whereas they are finely punctate in *B. sulcicollis*, lacks the shortening of the costa proceeding from the humerus as in *B. sulcicollis*. and is found in the Western part of North America, whereas *B. sulcicollis* occurs from the great lakes to the Atlantic seaboard. The male genitalia (Pl. III, Figs. 4 and 5) are different in the two species. *Buprestis aurulenta* and *B. striata* both apparently always possess the short scutellar costule which is often missing in *B. sulcicollis*. *Buprestis striata* sometimes has the costae proceeding from the humerus not reaching beyond the basal third, *B. aurulenta* apparently never has this costa reaching less than to the apical third, and occasionally *B. sulcicollis* has this costa reaching to the apical third, though it usually extends only to the middle or less. The pronotum of *B. striata* sometimes has a faint median impression, and the median channel of *B. sulcicollis* is sometimes rather feeble, but in general *B. sulcicollis* is distinct from *B. striata* by this character.

*Buprestis sulcicollis* is a rather uncommon species which is generally represented in larger collections by three or four specimens. Greenwood Lake, New Jersey, appears to be one of the better localities for the collection of this insect.

*Buprestis striata* (Fabr.) (Pl. V. Fig. 5)

*Buprestis striata* (Fabricius), 1775, Syst. Ent., p. 217.—Le Conte, 1857, Rep. Pac. Exp. 47 Par. Ins. 12: 43.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 125.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 85.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 10.—Knull, 1922, Can. Ent. 54: 81.—Fisher, 1925, Proc. U.S.N.M., 65: 149, Art. 8, nr. 2522.—Chamberlin, 1926, Cat. Bupr. N. A., p. 125–126.

*B. obscura* Casey, 1909, Proc. Wash. Acad. Sc., 11: 125.

*B. impedita* Say, 1836, Trans. Am. Philos. Soc., 4: 160.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 123–124.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 87 (var. of *B. striata*).

*B. canadensis* Casey, 1909, Proc. Wash. Acad. Sc., 11: 124.

Uniform dull coppery brown above varying to specimens with elytra bright green or blue with the suture and side margins brilliant cupreous, pronotum varying to bluish, green or cupreous, ventral surface green to bright or dark coppery; elongate suboval to rather elongate parallel; elytral costae thickly punctate, not strongly convex; pronotum not or feebly impressed; length 13–20 mm. *Head* often with a vertical

median carina, densely punctate, feebly pubescent; pronotum widest at base, sometimes parallel to middle and broadly rounded to apex, more often gradually narrowed and only slightly arcuate to apex, sometimes feebly impressed longitudinally at middle, more often not, often with levigated spaces at base at about one-fourth from edges, coarsely punctate, punctures separated by a little more than their widths, often tending to form chains, or separated by two or three times their widths; *scutellum* quadrate; *elytra* widest at apical third or almost parallel from humeri to apical third, two-thirds to three-fourths longer than wide, wider than pronotum at base, parallel or slightly divergent to apical third then obliquely narrowed to apex, or more often, gradually, slightly arcuately narrowed to apices which are entire, very feebly emarginate, sutural angle right or with a small denticle; humeri noticeable by the curving of the costae proceeding from them; costae five in number counting the short scutellar costule, suture and lateral margins raised, first costae from sublateral costae sometimes abbreviated to about basal third, usually reaching to apical third, intercostal intervals broad, very closely coarsely punctate; costae rather evenly punctate, punctures separated by four or five times their widths; *ventral surface* rather sparsely pilose, prosternum coarsely and densely punctate; abdomen finely punctate; tip of abdomen broadly rounded; female with tip more broadly rounded, a little longer and broader than male.

Varies greatly in color, from uniform dull coppery brown to brilliant green or blue with suture and side margins bright coppery, as well as considerably in form and size.

Recorded from West Indies, Louisiana, Florida, Texas, Virginia, North Carolina, Georgia, New Jersey, New York, Ohio, Pennsylvania, Illinois, Indiana, Michigan, Missouri, Massachusetts, New Hampshire, Maine, Maryland, Quebec, and Ontario, Canada.

Host plants: *Pinus rigida* (pitch pine), white pine, long-leaf pine, spruce and hemlock. In sound or rotten wood.

*Buprestis striata* can be separated from its two closest allies, *B. aurulenta* Linné and *B. sulcicollis* (Le Conte), as follows: *B. aurulenta* is always apparently light-colored whereas *B. striata* is often of uniform dark coppery brown hue, *B. aurulenta* has more strongly convex almost impunctate elytral costae, and the costae are never colored differently than the intercostal intervals as is often the case

with *B. striata*, *B. aurulenta* usually has the pronotum medially, longitudinally sulcate whereas in *B. striata* the pronotum is only rarely sulcate, the male genitalia (Pl. III, Figs. 4 and 6) are different in the two species; *Buprestis striata* differs from *B. sulcicollis* in that the latter has the elytral costae more strongly convex, the pronotum usually channeled medially, the color above never green or blue with cupreous sutural and side margins, its more broadened and shortened form, and by the male genitalia (Pl. III, Figs. 5 and 6); the color differences between the two species only apply in the case of the specimens of *B. striata* which have been known as "*impedita*," other specimens being colored almost as in *B. sulcicollis*.

The form described by Say as *B. impedita* is only a color variety of *B. striata*, often being split from the same log as unicolorous specimens are split from.

Taken under bark of living tamarack. From mid March to early April among needles of young long-leaf pine; mid April to early May rather active and often above reach on denuded trunks of blasted pines where they mate and oviposit; dug from white pine stumps; remains in wood as adult from late October to early spring; sometimes found at tips of young spruce limbs.

*Buprestis striata* "*impedita*" resembles the Western *B. aurulenta* very closely in body coloration.

This is a rather common species in the East, often taken in beach drift or by beating.

*Buprestis intricata* Casey (Pl. VI, Fig. 2)

*Buprestis intricata* Casey, 1909, Proc. Wash. Acad. Sc., 11: 118-119. Nicolay and Weiss, 1918, Jour. N. Y. Ent. Soc., 26: 85 (synonym of *B. adjecta* (Le Conte)).—Obenberger, 1922, Archiv. f. Naturg., 88, Abt. A., p. 90.—R. Hopping, 1933, Pan. Pac. Ent., 9 (2): 84-85.

*Buprestis contortae* Hopping, 1933, Pan. Pac. Ent., 9 (2): 84 (new synonym).

*Buprestis murrayanae* Hopping, 1934, Pan. Pac. Ent., 10 (4): 174, new name for *contortae*; (new synonym).

Green to blue above, suture and side margins brilliant cupreous, varying to uniform reddish cupreous above, prothorax often with a cupreous line down center, beneath bright coppery to greenish; oblong oval; 16-21 mm. in length; elytral apices entire, usually broadly rounded. *Head* with a median line, sometimes with a short carina on front, closely and coarsely punctate; not pilose; antennae cupreous, sometimes obscurely.

*Pronotum* widest at base, slightly convergent and straight to middle, then broadly rounded to apex, or rather evenly arcuately narrowed from base to apex; usually broadly longitudinally impressed at sides; often with narrow smooth median line, scarcely if at all impressed; coarsely punctate, punctures separated by about their own widths. *Scutellum* small, almost round, concave. *Elytra* usually widest at apical third, sometimes at basal fourth, diverging from base to apical third, sometimes slightly sinuate at middle, then broadly rounded or almost obliquely narrowed although still slightly arcuately, to apices which are broadly rounded, sutural angle right, apices not emarginate; costate, costae usually of alternately greater and lesser strength, seven, eight or nine in number; sublateral costae strong and prominent, intercostal spaces a little wider than a costa, coarsely punctate and strongly transversely rugose; suture and side margins raised; a weak costa between what passes for the sublateral costa when viewed from above, and the side margin; interval between suture and short scutellar costule often with large pits. *Ventral surface* not pilose; prosternum flattened medially, punctate anteriorly, or sulcate medially and strongly punctate along entire length; abdomen sparsely, evenly, rather strongly punctate; last ventral segment broadly rounded; female rather broader and usually larger than male.

Varies considerably in coloration, in number of elytral costae, and somewhat in form although usually characterized by a definitely oblong oval shape. The basal part of the elytra is slightly inflated on one specimen.

Widespread in occurrence but only occasionally collected. Specimens noted from Yosemite Valley, Mt. Lassen, Deer Park Inn, Sonora Pass and Hetch Hetchy, California; Fishing bridge in Yellowstone National Park, Wyoming, Rocky Mountain National Park, 7,600 ft.; Santa Fé, New Mexico; and specimens are recorded from Mt. Mitchell, Tulare County, California, at 9,000 ft.; Midday Valley, Merritt, Kimberly, and Oliver, British Columbia.

Host plants: *Pinus contorta* and perhaps other pines.

*Buprestis intricata* may be separated from *B. adjecta* (Le Conte), the most closely related species, by the latter's smaller and broader form and usually by its emarginate to bidentate elytral apices. *B. intricata* usually has a cupreous line medially on the pronotum which this author has not noted on *B. adjecta*, and the

male and female genitalia (Pl. III, Figs. 7, 8, and 12) will separate the two species. *Buprestis aurulenta* Linné, another western species, is colored similarly to *B. intricata*, but normally has only five elytral costae. To date seven specimens of *B. aurulenta* have been noted, having rudimentary costae in the second and third full length intercostal spaces from the suture, and several with the rudimentary costae in the first interspace. The male genitalia (Pl. III, Figs. 4 and 7) as well as the body form will separate these two species, the form being more oblong and the elytra proportionately longer in *B. intricata*.

Ralph Hopping loaned a paratype of his *B. contortae* (*B. murrayanae*) to the author. This was a male specimen from British Columbia having only seven elytral costate. It should be noted that in the original description, *B. contortae* was given as possessing "six entire costae" whereas *B. intricata* Casey was given as having "eight entire costae." This indicates that the short scutellar costule was counted in one case and overlooked in the case of *B. contortae*. To be exact, one should note that there is usually a weak costa between what passes for the juxta-lateral costa from above, and the side margin which still further upsets the count. While it is, perhaps, permissible to count only the elytral costae easily discernible from above in a brief or general diagnosis, in a description of a new species such inaccuracy is at best confusing. In this section of *Buprestis* where the punctuation of the various parts is quite variable, the other morphological character supposedly separating *B. contortae*, i.e., "the large intercostal pits of the scutellar area" is of no value. There are, in the author's series, specimens of both *B. intricata* and *B. aurulenta* having large or reduced intercostal pits in the scutellar area. The male genitalia of a specimen of *B. intricata* examined was identical with the genitalia of the paratype of *B. contortae*.

In 1909 Casey described a variation of *B. nuttalli* (Kirby) under the name *B. contorta*. In 1933 Hopping described his *B. contortae*, and in 1934 had a note published in which he drew attention to the similarity of the names *B. contortae*, and *B. contorta* of Casey. He then withdrew the name *contortae* and substituted the name *murrayanae* in its place. Article 19,<sup>2</sup> of the rules of nomenclature does not permit such a change and *B. murrayana* is here placed as a

<sup>2</sup> Article 19—"The original orthography of a name is to be preserved unless an error in transcription, a lapsus calami, or a typographical error is evident."

synonym of *B. contortae* which is, in turn, also a synonym of *B. intricata*.

It has been suggested that *B. intricata* might be the female of *B. adjuncta*, and Nicolay and Weiss placed it as a synonym of *B. adjuncta*, but the validity of these opinions has been disproven by the dissection of female genitalic structures from typical specimens of *B. adjuncta*, and by the dissection of male genitalic structures from specimens of *B. intricata*.

*Buprestis adjuncta* (Le Conte) (Pl. VI, Fig. 1)

*Buprestis adjuncta* (Le Conte), 1854, Proc. Acad. Nat. Sc. Philad., 7: 17.—Kerremans, 1892, Mem. Soc. Ent. Belg., 1: 93.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 118.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 24: 84.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 10.—Chamberlin, 1926, Cat. Bupr. N. A., p. 103.—Hopping, 1933, Pan. Pac. Ent., 9, 2: 85.

*B. brevis* Casey, 1909, Proc. Wash. Acad. Sc., 11: 117–118.—Chamberlin, 1926, Cat. Bupr. N. A., p. 103.

Green or blue above with suture and side margins cupreous, sutural stripe usually much reduced and often absent, marginal cupreous sometimes obsolete, varying to uniform reddish cupreous above; pronotum green to blue, varying to bright metallic red-violet; beneath bright metallic red violet varying to greenish; form short and broad, suboval; 12–15 mm. in length; apices of elytra emarginate and often bidentate. *Head* with a distinct median sulcus, front white pilose; punctures coarse and separated by less than their widths; antennae metallic greenish to black. *Pronotum* widest at base, sometimes trapezoidal in shape with the sides slightly arcuately evenly narrowed to apex, often slightly convergent to basal third and then broadly rounded, narrowing to apex, varying to rather broadly rounded from base to apex; with or without a longitudinal median impression; coarsely punctate, punctures separated by more than their widths, tending to converge into chains of six or eight punctures; not pilose. *Scutellum* quadrate to slightly transverse, flat to concave. *Elytra* widest near base or at apical third, almost parallel or slightly divergent to apical third then broadly rounded to apices which are more or less strongly emarginate to bidentate; costae curving at humeri; costae 7, 8, 9, or 10 in number, alternately of slightly greater and lesser strength to almost uniformly elevated; a feeble juxta-

lateral costa between side margin and very strong sublateral costa; costae near suture almost impunctate on summits, other costae more or less strongly punctate; intercostal interspaces about as wide as a costa near suture, slightly broader toward sides, coarsely punctate and strongly transversely rugulose, strength of rugae variable; not pilose. *Ventral surface* sparsely pilose; prosternum and abdomen coarsely punctate, strength of punctures somewhat variable; tip of terminal abdominal segment slightly truncate; female larger than male.

Elytral color varies from brassy-green to blue or uniform reddish cupreous; elytral costae near the suture often black (as is the case with the type); sometimes an entirely green insect with no trace of cupreous sutural or lateral markings.

Recorded from California, Colorado, Wyoming, Washington, Nevada, Idaho, New Mexico, Oregon, and British Columbia, Canada.

Host plants: Yellow, jeffreyi, and lodgepole pines.

*Buprestis adjecta* is rather closely related to *B. intricata* Casey and *B. connexa* Horn as indicated by the elytral sculpturing. It may be separated from *B. connexa* by the form which is broader in *B. adjecta*, by its less regular elytral sculpturing in most cases, and by its lack, in most cases of the brilliant red-violet metallic pronotal coloring which is typical of *B. connexa*. The male genitalia (Pl. III, Figs. 8 and 9) are quite different in the two species. *Buprestis intricata* is a larger, more oblong species having the elytral apices entire, never emarginate or bidentate; usually possessing the bright cupreous sutural markings which are often lacking in *B. adjecta*. The male and female genitalia (Pl. III, Figs. 7, 9, and 12) will also serve to separate the two species.

Burke reports the adults rather abundant in the Lake Tahoe region of California, but usually, in most localities, *B. adjecta* is uncommon.

*Buprestis connexa* Horn (Pl. VI, Fig. 3)

*Buprestis connexa* Horn, 1875, Trans. Amer. Ent. Soc., 5: 148.—Kerremans, 1892, Soc. Ent. Belg., 1: 94.—Fall, 1901, Occ. Papers Cal. Acad. Sc., 7: 116.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 111.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 102.—Garnett, 1918, Ann. Amer. Ent. Soc., 11: 91.—Burke, 1924, Proc. Ent. Soc. Wash., 26: 70.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 9.—Van Dyke, 1924, Proc. Pac. Coast Ent. Soc., 2: 18.—Chamberlin, 1926, Cat.

Bupr. N. A., p. 107.—Helfer, 1939, Pan. Pac. Ent., 15, 2: 60.

Elytra metallic green to blue, with side margins suffusedly cupreous, cupreous extending from basal fourth to apex; pronotum bright metallic red-violet, varying occasionally to green laterally; head green to reddish-violet cupreous; beneath green to purplish-cupreous; elongate suboval; 13–16 mm. in length; suture often bluish; elytral costae of about uniform elevation; pronotum with only slightly arcuate sides, almost trapezoidal, never impressed medially. *Head* with a median line, stronger on vertex; densely, not very coarsely punctate; not pilose; antennae blackish, first two segments usually purplish. *Pronotum* widest at base, evenly slightly arcuately narrowed from base to apex, nearly trapezoidal; not medially impressed but with a smooth median line; punctures separated by two or three times their widths, rather coarse. *Scutellum* small, almost round, often slightly concave. *Elytra* widest a little behind middle, diverging slightly from base to before apical third, then broadly rounding and converging more or less strongly arcuately to apices; when feebly arcuately convergent, the apices tend to be subattenuate; apices emarginate, sometimes rather feebly so; humeral costae curving a little at humeri; costae about uniformly elevated; not striate in the true sense of the word; costae sparingly punctate; intercostal intervals rather strongly transversely rugulose; not pilose. *Ventral surface* finely, densely punctate; not pilose; prosternum more distinctly punctate basally, polished apically; last abdominal segment truncate; female with tip distinctly emarginate, slightly larger, and comparing from the one male specimen available, with the elytra more attenuate posteriorly.

The male specimen in the author's series has the pronotum more greenish with the elytral margins from the middle arcuately almost evenly convergent to apices, but this form may be only individual variation. The pronotal coloration is quite typical and tends to remain rather constant, varying only to greenish, and this green not observed to obliterate the reddish-violet except at the sides.

Recorded from Nevada, and Idaho (Horn), California and Oregon (Nicolay and Weiss), Blue Mountains, Wallowa Mountains, Corvallis, Crater Lake National Park, and Melhorn's Mill, near Halfway, Baker County, Oregon; Donner Lake, Pine Crest, Lake Tahoe, Alturus, and Yosemite National Park, California; one specimen from Toppenish, Washington.

Host plants: Yellow pine (*Pinus ponderosa*) and *Pinus jeffreyi*.

*Buprestis connexa* may be separated from *B. adjecta* (Le Conte) by the short, broad form of that species, usually by the pronotal color which is uncommonly like that of *B. connexa*, by the variability of the strength of the costae, often apparent on specimens of *B. adjecta*, and by the male genitalia (Pl. III, Figs. 8 and 9). *Buprestis langi* (Mannerheim) is the only other species with which *B. connexa* might ordinarily be confused, but it is generally more elongate and parallel, the pronotum is usually of a broader shape, the sides much more strongly arcuate, than in *B. connexa*, the color of the pronotum of *B. langi* apparently is never like that of *B. connexa*, and the male genitalia (Pl. III, Figs. 9 and 10) differ in the two species.

Casey placed *B. connexa* as a part of a group of forms of *B. langi*, while Nicolay and Weiss placed it between *B. gibbsi* (Le Conte) and *B. fasciata* (Fab.). Horn remarked that the elytra were somewhat as in *B. adjecta* but placed it in a group with *B. gibbsi* and *B. confluenta* Say. Burke mentioned this diversity of opinion and pointed out that no males of the species had thus far been noted (1924). The author recorded a male of this species in 1939, recording the anterior tibiae as being unmodified as they are in *Buprestis* s. str. This removes *B. connexa* from proximity with *B. gibbsi* and other species which have males with the anterior tibiae modified by an internal emargination and an apical or sub-apical tooth or spine. The elytral sculpturing of *B. connexa*, as pointed out by Horn, is suggestive of *B. adjecta*, and the present author places these species together.

*Buprestis connexa* has long been one of the scarcest species of the genus. Nicolay and Weiss stated that fewer than a dozen specimens were known up until 1918. More have since been taken but it is still a desirable species.

*Buprestis langi* (Mannerheim) (Pl. VI, Figs. 4 and 5)

*Buprestis langi* (Mannerheim), 1843, Bull. Soc. Nat. Moscou, 16: 237.—Le Conte, 1857, Rep. Pac. Expl. 47 Par., 12: 42.—Van Dyke, 1902, Jour. N. Y. Ent. Soc., 10: 172.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 112.—Garnett, 1918, Ann. Am. Ent. Soc., 11: 90–91.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 103.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 10.—Chamberlin, 1926, Cat. Bupr. N. A., p. 109–112 [subspecies of *B. fasciata* (Fab.)].—Hopping, 1933, Pan. Pac. Ent., 9, 2: 86–87.

*B. ornata* Walker, 1866, Nat. Van. Couv., 2: 324.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 112.

- B. bistrinotata* Casey, 1909, Proc. Wash. Acad. Sc., 11: 108.  
*B. angusta* Casey, 1909, Proc. Wash. Acad. Sc., 11: 108.  
*B. callida* Casey, 1909, Proc. Wash. Acad. Sc., 11: 108-109.  
*B. fastidiosa* Casey, 1909, Proc. Wash. Acad. Sc., 11: 109.  
*B. mediocris* Casey, 1909, Proc. Wash. Acad. Sc., 11: 109 (sub-species of *B. fastidiosa*).  
*B. crenata* Casey, 1909, Proc. Wash. Acad. Sc., 11: 110.  
*B. seditiosa* Casey, 1909, Proc. Wash. Acad. Sc., 11: 110 (sub-species of *B. crenata*).  
*B. leviceps* Casey, 1909, Proc. Wash. Acad. Sc., 11: 110-111.  
*B. depressa* Casey, 1909, Proc. Wash. Acad. Sc., 11: 111.  
*B. viridimicans* Casey, 1909, Proc. Wash. Acad. Sc., 11: 111-112.  
*B. incolumis* Casey, 1909, Proc. Wash. Acad. Sc., 11: 112 [sub-species of *B. langi* (Mann.)].  
*B. oregona* Casey, 1909, Proc. Wash. Acad. Sc., 11: 112-113 [subspecies of *B. langi* (Mann.)].  
*B. obliqua* Casey, 1909, Proc. Wash. Acad. Sc., 11: 113 [sub-species of *B. langi* (Mann.)].  
*B. patruelis* Casey, 1909, Proc. Wash. Acad. Sc., 11: 113.  
*B. graminea* Casey, 1909, Proc. Wash. Acad. Sc., 11: 113-114.

Green to blue or dark coppery-purple above, sometimes the elytra are green with sutural vitta blue; elytra immaculate or with two, four, or six spots, yellow to light tan in color; ventral surface green to brilliant polished light reddish cupreous; elongate parallel; 15-21 mm. elytral costae rather strongly convex and narrow, intervals nearly as wide as costae. *Head* often with light sulcus at vertex medially; coarsely and densely punctate; very sparsely pilose to not pilose; antennae dark green to bronzy. *Pronotum* broadest at base or at middle, evenly slightly arcuately narrowed from base to apex, almost parallel to middle and arcuately narrowed to apex, or broadly arcuately broadened to middle and similarly narrowed to apex, sometimes slightly sinuate before middle; sometimes with a vague longitudinal medial impression; often with broad, rather deep depressions at middle toward sides, or occasionally a pair of such depressions slightly before middle and about half way from the longitudinal median to the lateral margins; coarsely punctate, more densely punctate toward sides, punctures at middle separated by their own widths or more, but tending to coalesce into loose chains and small groups; not pilose. *Scutellum* small, quadrate. *Elytra* widest at middle or at base, sides straight

to feebly sinuate to behind middle then broadly rounded and slightly arcuately or almost straightly narrowed to apices which may be subattenuate; apices emarginate or bidentate, or with only a sutural tooth, the external angle being rounded; humeral costae curving at humeri; costae uniformly convex, uniformly elevated, feebly rugulose; striate, striae about as wide as costae; coarsely punctate varying to rugose; not pilose. *Ventral surface* more than sparsely pilose, finely, rather densely punctate; tip of abdomen broadly rounded to sinuate at sides, truncate to bidentate. Female larger than male, usually with elytra immaculate or with fewer than six elytral spots.

Varies greatly in coloration, maculation pattern, and form. The two anterior elytral spots of the males often coalescing into a roughly dumbbell-shaped vitta; female often with two apical spots, often also with two spots on elytra just behind middle, rarely with a third pair of spots just before middle, spots of males tending to be definitely larger than those of females; sides of elytra sometimes cupreous much as in *B. connexa*; elytral color varies from reddish to golden green or brassy, then through green to blue and then to purple, the purple specimens sometimes exhibiting golden shine.

*Buprestis langi* may be separated from *B. fasciata*, its nearest relative, by the somewhat more elongate form in *B. langi*, its narrower and more strongly convex costae, its wider striae, the always maculate condition of females of *B. fasciata* whereas many females of *B. langi* are completely immaculate. The male genitalia (Pl. III, Figs. 10 and 11) will serve to separate the two species. Males of *B. fasciata* are, apparently smaller and darker, on the whole, than the males of *B. langi*, and never, apparently, exhibit the purple or light brassy green often observed in *B. langi*.

Recorded from California, Washington, Oregon, Arizona, Colorado, Idaho, New Mexico, Montana, South Dakota, Nevada, Utah, British Columbia, Vancouver Island, Alberta, Rocky Mountains, Manitoba, Hudson Bay, Canada.

Host plants: Douglas fir (*Pseudotsuga taxifolia*) and probably willow.

Has been dug from Douglas fir, but according to Hopping it occurs in places at least 300 miles from any Douglas fir, there being taken on willow. Also often taken on poplar (Chamberlin). Nicolay and Weiss noted that some males of *B. fasciata* and *B. langi* are identical, but the present author has not encountered any such specimens.

*Buprestis fasciata* (Fabricius) (Pl. VI, Fig. 6; Pl. VII, Fig. 1)

*Buprestis fasciata* (Fab.), 1787, Mant. Ins., 1: 177.—Castlenau and Gory, 1837, Monogr. Bupr., 1: 145, t. 35, f. 198.—Kerremans, 1892, Mem. Soc. Ent. Belg., 1: 95.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 107.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 102.—Garnett, 1918, Ann. Amer. Ent. Soc., 11: 90–91.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 10.—Chamberlin, 1926, Cat. Bupr. N. A., p. 109–112.—Hopping, 1933, Pan. Pac. Ent., 9, 2: 87.—Helfer, 1939, Pan. Pac. Ent., 15, 2: 60.

*B. sexmaculata* Hausmann, 1799, Ent. Bemerkungen, p. 30.—Herbst, 1801, Kafer, 9: 163, t. 148, f. 5.—Dejean, 1837, Cat. Col., 3: 88.

*B. sexplagiata* (Le Conte), 1859, Trans. Amer. Philos. Soc., 9: 205.—Crotch, 1873, Proc. Acad. Nat. Sc. Philad., 25: 88.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 106.

*B. lherminieri* Chevrolat, 1838, Silbern Rev. Ent., 5: 68–69.—Fleutiaux et Sallé, 1889, Ann. Soc. Ent. Fr., (6) 9: 405, (Sept., p. 55).—Kerremans, 1903, Wytman, Gen. Ins. Fasc., 12: 142.—Leng and Mutchler, 1914, Bull. Am. Mus. Nat. Hist., 30, 33: 430.—Fisher, 1925, Proc. U.S.N.M., 65: 155, nr. 2522.

*B. fulgens* Casey, 1909, Proc. Wash. Acad. Sc., 11: 107.

*B. fortunata* Casey, 1909, Proc. Wash. Acad. Sc., 11: 107 [subspecies of *B. fasciata* (Fab.)].

*B. saturata* Casey, 1909, Proc. Wash. Acad. Sc., 11: 114.

Elytra green, more or less brassy to blue in females, blackish in males; females always with a transverse fascia back of middle, almost always with a small subapical spot, often with a small spot before the transverse fascia, spots yellow; males with fasciae just behind middle, subapical and basal spot, basal spot not curving around humeri; elytral costae not strongly convex, considerably wider than striae; elongate suboval; 11–18 mm. in length. *Head* often with shallow sulcus on vertex; coarsely punctate, more densely on front; antennae black or bronzed to greenish. *Pronotum* widest at base or at middle, broadly arcuately widened to middle and broadly arcuately narrowed to apex, or parallel to middle and rounded to apex, or evenly arcuately narrowed from base to apex; sometimes with faint longitudinal medial impression; deeply, rather sparsely punctate, punctures tending to coalesce into short chains and small groups of two or three; not pilose. *Scutellum* small, almost

round, slightly concave to plane. *Elytra* widest behind middle or parallel to behind middle from base, then rounded and arcuately to sinuately narrowed to apices which are bidentate and sometimes slightly attenuate; humeral costae curved at humeri; striate; interstices not strongly convex, distinctly broader than striae, sparsely punctate, often feebly rugulose; striae often feebly rugulose; not pilose. *Ventral surface* not pilose; densely but very shallowly and finely punctate prosternum and abdomen punctate similarly; last ventral segment truncate; female larger than male, lighter in elytral ground color, anterior yellow spot on elytra not large as in male.

Varies in form and color, and as in *B. langi*, the sexual dichromism is notable. The character "costae distinctly broader than striae" is not always reliable, a few specimens having been examined which had the interstices rather more strongly convex than usual and narrower than usual. The distinction between elytral costae and interstices is rather vague in a series of *B. fasciata*.

Recorded from West Indies, North Carolina, Georgia, Virginia, Kentucky, New Jersey, New York, Pennsylvania, Maryland, Maine, Michigan, Wisconsin, Minnesota, Indiana, Ohio, Montreal Island, Ontario and Quebec, Canada.

Host plants: Dead pine?, maple?, and poplar?

Separated from *Buprestis langi*, its nearest relative, by the more elongate form of that species, the narrower and more strongly convex elytral costae in that species, the immaculate condition of the majority of female specimens of that species, the darker ground color of the elytra of the males in *B. fasciata*, and the male genitalia (Pl. III, Figs. 10 and 11). The pronotum in *B. langi* tends to be slightly shorter in relation to the length of the elytra than in *B. fasciata*, and its body form tends to be a little narrower.

*Buprestis fasciata* is an Eastern species, not usually taken in numbers excepting along the shore of Lake Superior during the end of June. The females are often taken while ovipositing on logs, the males are less commonly taken, found accidentally on shrubbery or sometimes in copula.

The dimorphism and dichromism between the sexes of this and the preceding species, *B. langi*, as well as the variability of prominence of eyes, form of parts and punctuation has led workers in the past to erect numerous species based on individual variation. Both Nicolay and Weiss and Garnett placed *B. langi* as varieties of *B.*

*fasciata*, but recognized the fact that one is Eastern while the other is a Western form. They obviously used "variety" in a subspecific sense. Hopping placed the two forms as distinct species, and the present author's genitalic dissections show that they are distinct.

*Buprestis lineata* (Fabricius) (Pl. VII, Fig. 2)

*Buprestis lineata* (Fab.), 1775, Syst. Ent., p. 217.—Herbst, 1801, Kafer, 9: 159, t. 146, f. 5.—Castlenau and Gory, 1837, Mon. Bupr., 1.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 89.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 94-95.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 10.—Knull, 1922, Can. Ent., 54: 81.—Fisher, 1925, Proc. U.S.N.M., 65, Art. 9, nr. 2522, p. 146, 152, 154.

*B. davisii* Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 95 [subspecies of *B. lineata* (Fab.)].—Garnett, 1922, Bull. Soc. Ent. Fr., p. 10 (new synonym).

Black to brown above, often with a brassy to cupreous shine, more noticeable on pronotum; front of head or mandibles usually maculated with red-orange or yellow; pronotum with lateral margin and front angle usually marked with orange; elytra with two reddish to yellow, usually orange, vittae, one from base at side curving around humerus and extending almost to apex, the other beginning near base at about middle of elytron and extending parallelly to suture attaining apical third or fourth; underside of head and front of prosternum maculated with orange, remainder of ventral surface coppery to bronzed or greenish, last of abdominal segments usually with small orange spot on each side; elongate oval to more strongly convergent apically and broadest at base of elytra; 12-17 mm. in length; elytral vittae never broken up into distinct flavate spots. *Head* with a median sulcus which is sometimes obsolete; front often with two, feebly tumescent spots which are immaculate and sometimes joined; rather shallowly, densely punctate; not pilose; antennae coppery to bronzy green. *Pronotum* trapezoidal, broadest at base, sides only slightly arcuate to feebly sinuate; occasionally with a smooth median line, never impressed; more densely punctate at sides, punctures coarse, separated by from one to three times their widths, but not evenly distributed. *Scutellum* small, slightly transverse, almost round or roughly quadrate or triangular. *Elytra* widest at base, narrowing evenly to apical third and then more strongly converging to apices or about

evenly narrowed from base to apices which are bisinuate, the sutural and external angles produced; humeri not prominent, humeral striae and humeral vittae curving around them; striae distinct but not broad; interstices slightly convex, approximately uniformly elevated, coarsely, rather shallowly and quite sparsely punctate; not pilose. *Ventral surface* not pilose; coarsely but shallowly punctate; last segment with tip truncate; females with tip rounded, usually slightly larger than males.

Varies considerably in color, from light chocolate brown to black, brassy shine of elytra and pronotum varying to coppery or absent, elytral maculations always vittatiform but the vittae sometimes transversely confluent and united, sometimes very much broken up into little specks and streaks but never into broad transverse spots, color of vittae from cream or yellow to orange or brick-red. Markings of last ventral abdominal segment usually a pair of small spots which are occasionally large and connected; markings of front of head variable.

Recorded from West Indies, Florida, Louisiana, Virginia, West Virginia, Maryland, Georgia, Alabama, Texas, North Carolina, Massachusetts, Arkansas, South Carolina, New York, New Jersey, Rhode Island, Indiana, Pennsylvania, Tennessee, Nova Scotia, Ontario, and Quebec, Canada.

Host plants: Scrub and long-leaf pines (*Pinus strobus*, *P. rigida*, *P. taeda*, *P. virginiana*, and *P. palustris*).

*Buprestis lineata* is at once distinguishable from all other species of North American *Buprestis* by the longitudinal elytral vittae. *B. maculipennis* Gory is apparently the most closely related species, and has been considered as a variety of *B. lineata* by various workers at different times. The male genitalia (Pl. IV, Figs. 1 and 2) will serve to separate these two species. *B. maculipennis* has irregular yellowish to orange spots or bands, more or less connected but never forming vittae as in *B. lineata*.

In 1918 Nicolay and Weiss separated a Florida form of *B. lineata* having "light yellowish markings, more confluent than in *lineata*." To this variant was given the name *Buprestis lineata* var. *davisi*. There is a sentence appended to the description which reads, *verbatim et literatim*, "It [*davisi*] seems to be a distinct geographical race and as no specimens of the true *lineata* were taken in the same locality, we believe the form should receive a varietal name." This is obviously an error in terminology as the fact that they considered the form as having geographical signifi-

cance and restricted it to southern Florida automatically made it a subspecies and not a variety as they claimed. C. A. Frost has informed the author that there is a specimen of *B. lineata* answering to the description of *B. davisi* in the Boston Society of Natural History collection, labeled from Massachusetts. There is a specimen with transversely confluent vittae from New York in the author's series and there are several specimens of true *lineata* from various parts of Florida in the author's series. The intergradation between the two forms is easily demonstrated in a series and it is the author's opinion that *B. lineata davisi* cannot be maintained as a valid subspecies. While the typical *B. lineata davisi* is strikingly different from the usual forms of *B. lineata*, the male genitalia are identical in the two forms, and the differences are purely chromatic and not geographically restricted.

Dug dead out of white pine stump, prefers pine in the first year after death, mines injured, dying, and dead trees; pupates from April to June, flies from April to August.

*Buprestis maculipennis* Gory (Pl. VII, Fig. 3)

*Buprestis maculipennis* Gory, Mon. Bupr. Suppl., 4: 118, t. 21, f. 117.—Le Conte, 1857, Proc. Acad. Nat. Sc. Philad., 9: 8.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 90.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 93-94, t. 1, f. 1-2.—Knull, 1922, Can. Ent., 54: 81.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 10.—Fisher, 1926, Proc. U.S.N.M., 65, Art. 9, nr. 2522, p. 144, 145, and 146.

*B. inconstans* Melsheimer, 1846, Proc. Acad. Nat. Sc. Philad., 2: 146.—Le Conte, 1857, Proc. Acad. Nat. Sc. Philad., 9: 8.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 91.

*B. deficiens* Casey, 1909, Proc. Wash. Acad. Sc., 11: 91 (subspecies of *B. maculipennis*).

*B. fusiformis* Casey, 1909, Proc. Wash. Acad. Sc., 11: 91 (subspecies of *B. maculipennis*).

*B. reducta* Casey, 1909, Proc. Wash. Acad. Sc., 11: 92.

*B. scripta* Casey, 1909, Proc. Wash. Acad. Sc., 11: 92.

*B. leporina* Casey, 1909, Proc. Wash. Acad. Sc., 11: 92.

Dark brown to black above with more or less distinct brassy shine; ventral surface bronzed to greenish; elytra with irregular yellowish spots, often connected longitudinally but never forming two distinct elytral vittae; front of head variably maculated with red and yellow, anterior angles of elytra often touched with orange, prosternum often maculated with orange which

sometimes colors entire prosternal spine, under side of head and mandibles usually colored, last abdominal segment sometimes with small orange pair of spots; elongate suboval 9.25–14.5 mm. in length; interstices of elytra about uniformly elevated. *Head* often with a median line, rather coarsely and densely punctate; not pilose, antennae black, more or less brassy. *Pronotum* trapezoidal, widest at base, side margins slightly arcuately to slightly sinuately narrowed, sometimes a little inflated at base, sometimes with a faint longitudinal median line, more often not; coarsely, unevenly punctate; not pilose. *Scutellum* small, round to quadrate. *Elytra* widest at base or at apical third, diverging or converging slightly from base to apical third, then broadly rounded, rather obliquely narrowed to apices or, less often, more strongly narrowed to apical third and less abruptly narrowed to apices which are broadly rounded to truncate with sutural and external angles produced; humeral umbone slightly prominent in some specimens, striae curved about humeri; distinctly striate; interstices coarsely punctate, more densely and coarsely toward humeri, about uniformly elevated and not strongly convex; not pilose. *Ventral surface* rather closely and coarsely punctate; first ventral abdominal segment longitudinally sulcate; tip of abdomen truncate; female with tip of abdomen rounded, a little larger in size than male.

Varies in elytral maculation from immaculate to confluent maculate with the maculations covering all the elytra excepting the humeri. The form varies considerably, the apices being subattenuate in some specimens, not at all so in others. The pronotum varies somewhat in form, and the maculation of the ventral surface is variable.

Recorded from North Carolina, Alabama, South Carolina, Louisiana, Florida, Texas, Georgia, Pennsylvania, and New Jersey.

Host plants: Pines, hemlock (*Tsuga canadensis*), and cypress (*Taxodium distichum*).

*Buprestis maculipennis* may be separated from *B. lineata* (Fab.), the most closely related form, by the vittate elytral markings of that species, the generally somewhat larger size of that species and by the male genitalia of the two species (Pl. IV, Figs. 1 and 2). From similarly maculated forms of other species, *B. maculipennis* may be distinguished by its slightly convex and uniformly elevated interstices, its small size, its lack of a regular pattern of levigated spaces on the pronotum and the male genitalia.

*Buprestis maculipennis* was incorrectly united with *B. lineata* by Le Conte. In 1909 Casey separated it from *B. lineata* and divided it into four species and three subspecies. Two of these, *B. deficiens* Casey and *B. inconstans* Melsh. (Kerr.), he reunited with *B. maculipennis* in his memoirs.<sup>3</sup> Recently, the author has noted that specimens of *B. maculipennis* in several collections were labeled *B. lineata* var. *maculipennis*. The male genitalia demonstrate conclusively that these two forms are distinct species.

On dead pine logs, occurs with *B. lineata* but less common.

*Buprestis maculativentris* Say (Pl. VII, Fig. 6)

*Buprestis maculativentris* Say, 1824, Long's Second Explor., p. 272.—LeConte, 1882, Geol. and Nat. Hist. Survey of Can., lists 2 and 5.—Kerremans, 1892, Mem. Soc. Ent. Belg., 1: 96.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 100.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 90.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 10.—Fisher, 1926, Proc. U.S.N.M., 65, Art. 9, nr. 2522, p. 155, 156.—Chamberlin, 1926, Cat. Bupr. N. A., p. 116–118.

*B. sexnotata* Castlenau and Gory, 1837, Mon. Bupr., 1: 129, t. 32, f. 178, p. 7.—Le Conte, 1857, Proc. Acad. Nat. Sc. Philad., 9: 7.

*B. maculiventris* Gemminer and Harold, 1869, Cat. Col., 5: 1378.—Burke, 1917, Journ. Econ. Ent., 11: 336.

*B. maura* Castlenau and Gory, 1838, Mon. Bupr., 2: 131, t. 33, f. 181.

Dark bronzy to brown or greenish above; front of head and anterior angles of pronotum usually maculated with orange; ventral surface bronzed to greenish, under side of head usually, middle coxae sometimes maculated, last four abdominal segments externally maculated with small orange spots. Elongate, slightly oval; elytra immaculate, often with transverse broad depressions; interstices of elytra almost uniformly elevated; average length 16 mm. (Hopping), length 13–20 mm. *Head* often with line on front, often reaching to vertex; densely and coarsely punctate; not pilose; antennae bronzed to greenish. *Pronotum* broadest at base, trapezoidal in form, sides moderately arcuate, to sinuate at or slightly behind middle, base sometimes feebly inflated; often with a median line, never impressed; coarsely, densely but unevenly punctate, often with

<sup>3</sup> Memoirs, V, 1914, p. 355.

levigated spaces about one-fifth from sides and at base, and also with spaces at about one-third from sides and just before middle; not pilose. *Scutellum* small, round. *Elytra* widest at base or apical third; diverging or converging to apical third only slightly, then more or less strongly obliquely, slightly arcuately to distinctly though not strongly sinuately narrowed to apices which are sometimes slightly attenuate; apices rounded to truncate or oblique to suture, microspiculose; humeri never very prominent, striae curving at humeri; surface with broad transverse shallow depressions, roughly at basal third and middle; more or less distinctly striate; often with distinct costae which are often rather narrow, distinctly convex, and broken; intervals rugose to coarsely punctate; costae impunctate to sparsely punctate, shining to rather dull; not pilose. *Ventral surface* densely evenly punctate, punctures rather coarse but not deep; not pilose, or sparsely pilose on abdomen; first ventral segment deeply longitudinally sulcate; tip of terminal segment broadly rounded to truncate; female slightly larger than male; male with anterior tibiae internally emarginate and armed with a subapical spine.

Varies considerably in color as given in diagnosis, greenish to brown, the usual color being bronzy. The elytral sculpturing, form of pronotum and form of elytra vary greatly. Markings of ventral surface are rather constant.

Recorded from Maine, New Hampshire, Massachusetts, New York, Pennsylvania, Indiana, Michigan, Minnesota, Wisconsin, New Mexico, Arizona, Oklahoma, South Dakota, Colorado, Ontario, Quebec, Manitoba, and Nova Scotia. A common eastern species. The author doubts the New Mexico, Arizona, and Colorado records, and believes that these were more probably misidentified *B. subornata* (Le Conte).

Host plants: Yellow pine, balsam, and spruce.

*Buprestis maculativentris* may be separated from *B. subornata* (Le Conte) and *B. rusticorum* (Kirby), two western forms, by the male genitalia (Pl. IV, Figs. 3, 4, and 5). *B. subornata* usually is greener with the elytral costae alternately more strongly convex, and the abdominal markings more transverse. *B. rusticorum* usually is blacker, larger, more oblong, with costae of elytra more strongly alternately convex, and the levigated pattern on the pronotum more distinct.

Commonly taken on old and young spruce trees; beaten from *Pinus strobus*, and *P. resinosa*.

*Buprestis subornata* (Le Conte) (Pl. VIII, Fig. 1)

*Buprestis subornata* (Le Conte), 1859, Trans. Am. Philos. Soc., (2) 11: 208.—Van Dyke, 1902, Journ. N. Y. Ent. Soc., 10: 172.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 98.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 92.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 10.—Chamberlin, 1926, Cat. Bupr. N. A., p. 118.

*B. punctiventris* Casey, 1909, Proc. Wash. Acad. Sc., 11: 99 (subspecies of *B. subornata*).

*B. rubronotans* Casey, 1909, Proc. Wash. Acad. Sc., 11: 97.

*B. violescens* Casey, 1909, Proc. Wash. Acad. Sc., 11: 99.

*B. adonea* Casey, 1909, Proc. Wash. Acad. Sc., 11: 97-98.

*B. histro* Casey, 1909, Proc. Wash. Acad. Sc., 11: 98.

Immaculate green to blue, violet, cupreous-green, dark purplish, rarely black; ventral surface green to purplish or cupreous; abdomen usually marked with a double row of more or less transversely connected orange spots on each side; front of head and anterior angles of pronotum usually marked with orange; under side of head, but apparently not the prosternum, often marked with yellow or red; elongate, sometimes slightly oval, more often tapering from shoulders to apices more or less gradually; length: 15-21 mm. *Head* usually with a median line; coarsely and rather densely punctate on front, less coarsely on vertex; not pilose; antennae black, more or less green. *Pronotum* widest at base, trapezoidal in form, varying to sufficiently arcuate on sides to destroy trapezoidal appearance; sometimes sinuate, slightly, on sides or slightly inflated at base; a smooth median line, not depressed, and usually with levigated areas about one-fourth from sides at base, and about one-third from sides before middle; rather coarsely, unevenly punctate, punctures tending to form small groups, separated by their own widths or more between groups and chains, but very close within such groups; not pilose. *Scutellum* small, approximately round. *Elytra* widest at base, slightly narrowed to apical third and then broadly rounded and obliquely narrowed to apices, or rather gradually narrowed from base to apex with only a little increase in degree of convergence beginning at apical third; apices sometimes slightly attenuate, rounded to suture or truncate, often microspiculose; striae scarcely curved at humeri; sometimes with broad shallow transverse depressions at about basal third and middle, more often without; distinctly to obsoletely striate; costate, costae not

strongly convex, rugose and interrupted in some examples to sparsely and rather finely punctate; alternating costae usually less strongly convex, sometimes suppressed to flat intercostal spaces between the stronger ridges, being in such cases, vaguely rugose and finely, closely punctate; not pilose. *Ventral surface* sparsely pilose; first abdominal segment strongly, medially, longitudinally sulcate; all segments rather coarsely, closely and uniformly punctate; anterior tibiae of males internally emarginate and armed with a subapical tooth; tip of terminal segment truncate in both sexes; females slightly larger than males in a series.

Variations rather extensive in elytral color, abdominal transverse maculations, form of pronotum, form and sculpturing of elytra. The color of the pronotum not always like that of elytra, sometimes darker, melanic specimens uncommon.

Recorded from California, Kansas, Utah, Oregon, Montana, New Mexico, Colorado, and British Columbia, and undoubtedly occurs in Washington and Nevada.

Host plants: Yellow pine and Douglas fir (*Pinus ponderosa* and *Pseudotsuga taxifolia*).

*Buprestis subornata* may be separated from *B. maculativentris* Say and *B. rusticorum* (Kirby) by the male genitalia (Pl. IV, Figs. 3, 4, and 5). *B. maculativentris* is often slightly more depressed apically, with the sublateral elytral costa more prominent than the others, more bronzy than even the dark forms of *B. subornata*, never bright green, blue or violet as *B. subornata*, generally a little smaller on the average and with the costae of the elytra not so broad, and with the broad transverse depressions of the elytra more often present than in *B. subornata*. *Buprestis rusticorum* is larger on the average, blacker, less shining, more oblong, with the alternate elytral costae tending to be definitely more strongly convex, and the ventral abdominal maculations usually different than in *B. subornata*, being only rarely transversely connected as in that species.

*Buprestis subornata* has been treated variously as a variety and subspecies of *B. maculativentris*, as a species, and Casey split it up into several species and subspecies. The author has observed specimens of *B. subornata* mixed in series of *B. rusticorum* and vice versa in many collections, but the two species are usually rather easily separated.

*Buprestis subornata* is not usually very common in collections. The author took some specimens near Mather, California, July 25,

1936, on a dry, peeled log where they were basking in company with *B. laeviventris* (Le Conte), *Melanophila gentilis* Le Conte, and *Chrysobothris caurina* Horn. Burke has stated that the best results in collecting this species are obtained by beating small pines.

*Buprestis rusticorum* (Kirby) (Pl. VIII, Fig. 2)

- Buprestis rusticorum* (Kirby), 1837, Faun. Bor. Am., 4: 151.—Kerremans, 1892, Mem. Soc. Ent. Belg., 1: 98.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 99.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 91.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 10.—Chamberlin, 1926, Cat. Bupr., p. 119.
- B. paganorum* (Kirby), 1837, Faun. Bor. Am., 4: 152.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 100.
- B. lecontei* Saunders, 1871, Cat. Pupr., p. 40.
- B. acomana* Casey, 1909, Proc. Wash. Acad. Sc., 11: 101.
- B. morosa* Casey, 1909, Proc. Wash. Acad. Sc., 11: 101.
- B. fusca* Casey, 1909, Proc. Wash. Acad. Sc., 11: 101.
- B. sublivida* Casey, 1909, Proc. Wash. Acad. Sc., 11: 102 (subspecies of *B. fusca* Casey).
- B. caliginosa* Casey, 1909, Proc. Wash. Acad. Sc., 11: 102.
- B. nigricans* Casey, 1909, Proc. Wash. Acad. Sc., 11: 102.
- B. lyrata* Casey, 1909, Proc. Wash. Acad. Sc., 11: 103.
- B. adducta* Casey, 1909, Proc. Wash. Acad. Sc., 11: 103.

Black above, varying to obscurely greenish or purplish, sometimes slightly blue; elytra immaculate; front angles of pronotum and front of head maculated with orange; ventral surface bronzed to greenish; abdomen with a row of lateral spots, sometimes with a second row near middle on each side, sometimes transversely confluent, spots on tip usually connected; under side of head usually maculated with yellow or red. Elongate oblong oval; length averages 20 mm. (Hopping), length 15–23 mm. *Head* with a carina on front, sometimes extending to vertex, front more coarsely and densely punctate; antennae dark metallic green to bronzed; front sometimes finely pilose. *Pronotum* widest at base, a little before base, or at middle; almost trapezoidal with base slightly inflated or with sides distinctly arcuate, to distinctly inflated at base or broadly, evenly, arcuately divergent to middle and convergent to apex from middle; with a smooth median line, not depressed, and with levigated area, often separated into three parts, extending from base and one fourth from side, forward at about same distance from side to apical third and then turned abruptly inward

toward median line; punctures elsewhere coarse and irregularly arranged and separated by about their own widths; punctures sometimes with white efflorescence quite filling them; levigated areas sometimes slightly tumescent. *Scutellum* round to quadrate, often concave. *Elytra* widest at base or equally wide at base and apical third, more rapidly convergent from apical third, sometimes sinuately narrowed to apices, and sometimes feebly sinuate from base to apical third; apices sometimes slightly attenuate, truncate to broadly rounded, smooth to multipliculose or with sutural tooth; costae curved at humeri which are not prominent; striate, and with costae which are alternately more strongly convex; more elevated costae feebly punctate; suppressed costae, or as they might better be termed on certain specimens, the intercostal spaces, more roughly sculptured, coarsely rather densely punctate and feebly rugose; occasionally with white efflorescence all over surface. *Ventral surface* with rather sparse pile on abdomen, but sometimes with white efflorescence particularly about the coxae and toward the sides, but also on the abdomen; males with anterior tibiae interiorly emarginate and armed with a subapical tooth; densely, evenly, coarsely punctate; prosternum coarsely punctate anteriorly, prosternal spine impunctate; abdomen more coarsely punctate than prosternum; first segment longitudinally sulcate; terminal abdominal segment broadly emarginate; female with tip truncate, anterior tibiae simple, and form a little larger, in general.

Varies considerably in form, size, and color of shine. Most specimens exhibit no sign of efflorescence, but a series of nine specimens in the author's series, from Trinity Valley, British Columbia, C. V. G. Morgan, collector, have efflorescence distributed over the dorsal and ventral surfaces. One specimen of *B. maculativentris* Say in the author's series seems to have the tattered remnants of efflorescence on the elytra and ventrally about the legs which may show a relationship between the two species.

Recorded from Oregon, New Mexico, Texas, Colorado, California, Montana, Nevada, Washington, Idaho, Kansas, Arizona, Utah, Saskatchewan, British Columbia, and Manitoba. Abundant in the pine woods of Oregon and Washington.

Host plants: Yellow pine (*Pinus ponderosa*), Douglas fir (*Pseudotsuga taxifolia*), and white fir (*Abies grandis*).

*Buprestis rusticorum* can be separated from *B. maculativentris* Say and *B. subornata* (Le Conte) by the male genitalia (Pl. IV, Figs. 3, 4, and 5). *B. rusticorum* usually is blacker and larger as

well as more oblong in form than the two closest allies, and the elytra usually present a more deeply furrowed appearance.

Many specimens have been taken on needles of young yellow pine, basking on logs, and in copula during August.

*Buprestis nuttalli* (Kirby) (Pl. VII, Fig. 5)

*Buprestis nuttalli* (Kirby), 1837, Faun. Bor. Am., 4: 152.—Le Conte, 1850, Rem. Col. Lk. Superior, p. 227.—Kerremans, 1892, Mem. Soc. Ent. Belg., 1: 97.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 92.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 96.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 11.—Chamberlin, 1926, Cat. Buprestidae N. Am., p. 120.—Hopping, 1933, Pan. Pac. Ent., 9 (2): 86.

*B. consularis* Gory, 1840, Mon. Bup., 4 Suppl., p. 120, t. 21, f. 118.—Dejean, 1837, Cat. Col., p. 88.—Le Conte, 1850, Rem. Col. Lk. Superior, p. 227.—Kerremans, 1892, Mem. Soc. Ent. Belg., 1: 94.—Van Dyke, 1902, Journ. N. Y. Ent. Soc., 10: 72.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 96.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 97.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 11.

*B. alternans* (Le Conte), 1859, Trans. Amer. Phil. Soc., 11: 207.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 93.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 97.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 11.

*B. conicicauda* Casey, 1909, Proc. Wash. Acad. Sc., 11: 93 (subspecies of *B. alternans*).

*B. diruptans* Casey, 1909, Proc. Wash. Acad. Sc., 11: 94.

*B. contorta* Casey, 1909, Proc. Wash. Acad. Sc., 11: 95.

*B. gravidula* Casey, 1909, Proc. Wash. Acad. Sc., 11: 95.

*B. torva* Casey, 1909, Proc. Wash. Acad. Sc., 11: 96, (subspecies of *B. gravidula*).

*B. boulderensis* Casey, 1909, Proc. Wash. Acad. Sc., 11: 96 (subspecies of *B. gravidula*).

*B. flavopicta* Casey, 1909, Proc. Wash. Acad. Sc., 11: 96.

Black, often slightly purplish or greenish; the same beneath but sometimes with belly blue or bluish; front of head usually maculated with orange or yellow; pronotum with side margins and anterior angles often yellow or orange; elytra rarely immaculate, usually with four rather transverse orange to yellow bands which are usually broader at suture, basal band often reaching to humeri, second band, from basal fourth or fifth tending to curve forward, sometimes curving to outside of

humeri, broadest at suture on most specimens, third band, from apical third curving apically, often triangular in form with the base of triangle at right angles to suture, the altitude paralleling suture and the hypotenuse running apically from apex at suture to base at side margin, apical spot at about apical fourth variable, but often tending to run basally, sometimes coalescing with the third spot exteriorly; all spots subject to interruption by black striae or intercostal spaces; all under parts excepting tibiae and tarsi often maculated with yellow or orange; 12.5–21 mm. in length; sometimes a little oval, usually with apices slightly attenuated; coxae and legs maculated with orange or yellow; elytral costae proceeding from middle of base usually uniting prominently at apical third or fourth, themselves being prominent. *Head* with a median carina on front often reaching to vertex; often shallowly but noticeably depressed on front at sides of carina, depressions very closely punctate; punctation often rather confluent, irregular, rather coarse; with small irregular levigated spaces, sometimes connected; punctures separated by less than their own widths; usually pilose, sometimes not; antennae dark, more or less bronzed. *Pronotum* widest at base or nearly at middle; nearly trapezoidal in form varying to arcuate with base strongly swollen; sometimes depressed basally at sides; often with distinct smooth median line, often with median line almost entirely obscured by punctures; usually with a smooth more or less strongly tumescent area extending from base to nearly apex at lateral fourth; another levigated area extending from base to nearly apex located midway between median line and line at lateral fourth, this juxta-median line tending to be less distinct than the others, often strongly punctate and even obliterated basally, scarcely ever reaching anterior margin; coarsely punctate, punctures separated by less than their widths; not pilose. *Scutellum* small, rounded, rather concave. *Elytra* widest at base or at middle; sides sometimes sinuate at basal third to middle, more often almost straight and parallel or slightly convergent from base to behind middle, then rounded and arcuately to sinuately narrowed to apices which are usually a little attenuate, multi-dentate to bisinuate or broadly rounded, rather obliquely cut to cut right angularly with suture, often with a slight divergence of apices, not strongly marked however; humeri slightly prominent, costae curving in their proximity; surface often irregular longitudinally, with slight transverse depressed areas;

usually with five costae, counting the scutellar, rather narrower than the intervals, with a few scattered punctures; counting the scutellar as the first, the second and third costae are rather strongly prominent, and coalesce at apical third to fifth, prominently; some specimens not so, having these costae independently attaining apices; striae feeble to moderately strong; intercostal intervals rather finely punctate, the punctures not confluent and separated by around twice their widths to their own widths only, often with sparse transverse rugae, sometimes a little convex, more often flat; not pilose. *Ventral surface* very sparsely pilose; sometimes with whitish efflorescence about mesothorax, metathorax and prosternum; anterior tibiae of male inferiorly emarginate and with a slightly subapical tooth; prosternum coarsely punctate excepting spine which is impunctate from middle to apex; abdomen coarsely punctate; first ventral abdomen segment longitudinally medially sulcate; tip of abdomen truncate.

Varies greatly in size, form, maculations, and sculpturing. One specimen has the pronotum almost evenly broadly rounded from base to apex, being widest at middle. Some specimens have the sides of the pronotum strongly inflated basally and sinuate at middle. The five longitudinal levigated areas of the pronotum are about equally spaced, and in occasional specimens are scarcely interrupted, giving the pronotum a strikingly striped appearance. The elytral maculations are usually interrupted by the black striae or even by the entire breadth of the interspaces and are also often interrupted by small black specks. The ventral maculation is sometimes present in large quantity on all the parts excepting the tibiae and tarsi, but in many cases the abdomen is all but immaculate. The legs and coxae seem to be always maculate. The punctuation of the abdomen varies somewhat in strength, but tends to be rather coarse in most specimens.

Recorded from California, Washington, Oregon, New Mexico, Arizona, Colorado, Michigan, Maine, New Hampshire, Massachusetts, New York, New Jersey, Virginia, Minnesota, Pennsylvania, West Virginia, Montana, Wyoming, South Dakota, Idaho, Arkansas, Port Yukon, Alaska, Alberta, Quebec, British Columbia, and Ontario.

*Buprestis nuttalli* is rather closely related to *B. rusticorum* (Kirby), differing in most cases by its maculated elytra, although rare occurrences of immaculate *B. nuttalli* have been found. The male genitalia, (Pl. IV, Figs. 5 and 6) are quite different in the

two forms, and *B. rusticorum* is confined to the west. *Buprestis nuttalli* subspecies *laeviventris* (Le Conte) is separated from *B. nuttalli* by its less interrupted elytral maculations which often tend to unite longitudinally, by the coarser abdominal puncturation and maculated legs and coxae in *B. nuttalli*, and by the less smooth elytral and pronotal sculpturing in *B. nuttalli*. Subspecies *laeviventris* is restricted to California, Southern Oregon and Western Arizona, so far as known, whereas *B. nuttalli* occurs in the eastern states and westward through Canada to Alaska, and south to Washington and Oregon, New Mexico, etc.

Host plants: *Pinus ponderosa* (yellow pine), *Abies balsamea*, *Pseudotsuga taxifolia* (Douglas spruce or fir), *Pinus strobus*, and probably other conifers.

There occur occasional specimens which have the elytral costae very strong, the abdomen coarsely punctate and the size a little larger than usual specimens, and these forms have been separated under the name *B. alternans* (Le Conte). The eastern specimens of this species have been known as *B. consularis*. The present author, in placing all the described forms under one species, is not presenting a new interpretation of the various forms as Nicolay and Weiss expressed their opinion that *B. alternans* and *B. consularis* were one species with *B. nuttalli*, with a wide geographical distribution. Hopping has since expressed a similar opinion, based upon a study of many adults. The author has dissected genitalia from a number of the forms, including the subspecies *laeviventris*, without finding any differences to support the separation of the various forms. As Hopping pointed out, there is some variation in the punctuation of the two sexes on the abdomen, and the form of the prothorax and condition of the elytral sculpturing are very variable. Nicolay and Weiss state that certain Washington examples of this form are like the eastern specimens, and the author has an Alaskan specimen like the forms formerly known as *B. consularis*. It has been difficult in the past for workers to grasp the full extent of variation in this species because of the spotted records they possessed and the insufficient series available at those times.

Often taken by beating or while resting on logs or trees.

*Buprestis nuttalli* subspecies *laeviventris* (Le Conte) (Pl. VII, Fig. 4)

*Buprestis laeviventris* (Le Conte), 1857. Rep. Exp. 47 Par., Ins. 12: 43.—Kerremans, 1892, Mem. Soc. Ent. Belg., 1: 96.—Van Dyke, 1902, Journ. N. Y. Ent. Soc., 10: 172.—

Casey, 1909, Proc. Wash. Acad. Sc., 11: 93.—Garnett, 1918, Ann. Am. Ent. Soc., 11: 90.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 98.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 11.—Chamberlin, 1926, Cat. Bupr. N. A., p. 113.

*B. pugetana* Casey, 1909, Proc. Wash. Acad. Sc., 11: 94.

*B. dilatata* Motschulsky (Le Conte), 1873, Proc. Acad. Nat. Sc. Philad., 25: 331.

Black above, rarely immaculate; usually with four more or less transverse bands of yellow, more or less longitudinally connected, the apical spot apparently always isolated; front angles and front margin of pronotum and front of head usually maculated with orange; ventral surface coppery to greenish; legs and coxae immaculate; tip of abdomen apparently always maculated with orange; occasionally there is a double row of orange spots on each side of the abdomen; underside of head, but not prosternum maculated with yellow or red; elongate oval to more narrowed posteriorly; length 14–21 mm. Convex interstices or costae proceeding from center of base of elytra not particularly prominent or conspicuously united at apical fourth; elytral maculations usually uninterrupted by black striae, the first three spots from base often united into a very irregular longitudinal vitta on each elytron. *Head* often with median line or interruption of frontal maculation; not coarsely, densely punctate; not pilose; antennae coppery to greenish. *Pronotum* widest at base, often rather trapezoidal in form, base often inflated; sides often sinuate at about middle, sometimes evenly, arcuately narrowed from base to apex; a smooth median line, usually a little raised; levigated spaces about one-fourth from sides at base, and about one-third from sides at apical third; coarsely, rather evenly punctate, punctures separated by about their widths or a little less; sometimes with white efflorescence in punctures. *Scutellum* small, concave, quadrate to round. *Elytra* broadest at base, or less commonly, equally broad at base and apical third; tapering gradually to apical third then more strongly narrowed to apices, sometimes faintly sinuate between base and apical third; occasionally narrowed in one clean curve, but more often with apical third slightly interrupting smooth continuity of curving side margin; apices often slightly attenuate, truncate and bidentate to truncate with no dentation; humeri not prominent, but striae curving in their proximity; surface

usually shining; striate, striae coarsely punctate, not deeply; interstices alternately more strongly convex, the two more convex ones proceeding from the middle of the base not particularly prominent and not coalescing prominently at apical fourth, rather, they continue independently to the apex or coalesce inconspicuously at the apical fourth; convex interstices not more than shallowly sparsely punctate, more often almost impunctate; rarely with white efflorescence on surface. *Ventral surface* sparsely pilose; sometimes efflorescent, particularly noticeable around coxae and adjoining body parts; abdomen rather feebly punctate; prosternum excepting prosternal spine more coarsely punctate; first abdominal segment medially, longitudinally sulcate; tip of abdomen rounded and with an external tooth on each side in female, male with tip truncate; female a little larger.

Varies somewhat in form of pronotum and side margins of elytra, and in maculations of elytra and ventral surface. Varies in color of elytral shine from greenish to purplish; proportionate length and width of elytra variable; ventral surface metallic bluish or purplish to normal greenish or cupreous; elytral spots eight, six four, two or missing entirely in rare instances.

Recorded from California, Oregon, Washington, and Arizona.

Host plants: Yellow, lodgepole, digger, sugar, and Monterey pines, and Douglas fir.

*Buprestis nuttalli* subspecies *laeviventris* is separated from *B. nuttalli* (Kirby) by the coarse punctuation of the abdomen of that species, by the character of the elytral markings which are usually untraversed and interrupted in *B. laeviventris*, and more transverse in *B. nuttalli*, by the ventral maculations of *B. nuttalli* which are present on the coxae and legs as well as extensively throughout, and in many cases by the strong elytral costae of *B. nuttalli* which unite conspicuously at the apical fourth, and which are usually more strongly convex than those of *B. laeviventris*.

This form has been treated as a species and has been split into three species by workers of the past, and in the present paper is considered to be a subspecies of *B. nuttalli*. The male genitalia are identical in *B. nuttalli* and *B. nuttalli laeviventris* and many of the external characters are the same in both forms. Both mine the wood of some of the same species of trees. There are indistinguishable intermediate forms in the author's series from Arizona, Washington, Alaska, and Alberta, Canada. It seems impossible in the

face of these observations that *B. nuttalli laeviventris* and *B. nuttalli* are distinct species but it would be equally impossible to place *laeviventris* as a synonym or variety. This usually easily recognizable form is common in Northern California and ranges south into Tulare county, and is unassociated with typical *B. nuttalli* in this region. Taken in dust on roads, on old railroad ties, peeled logs, and trunks of pines.

*Buprestis rufipes* (Oliver) (Pl. VIII, Fig. 6)

*Buprestis rufipes* (Oliver), 1790, Ent. 2, Gen., 32: 16, t. 73, f. 7, a-b.—Le Conte, 1857, Proc. Acad. Nat. Sc. Philad., 9: 8.—Kerremans, 1892, Mem. Soc. Ent. Belg., 1: 98.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 105.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 99.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 9.—Chamberlin, 1926, Cat. Bupr. N. A., p. 123.

*B. vivens* Casey, 1909, Proc. Wash. Acad. Sc., 11: 105 [subspecies of *B. rufipes* (Oliv.)].

*B. elongata* Casey, 1909, Proc. Wash. Acad. Sc., 11: 105–106.

Elytra green to blue, purple or brown; apices yellow or orange; a longitudinal vitta on each elytron proceeding from inside of humeri and angling slightly toward suture to a little before middle; a spot, varying to a fascia just behind middle, sometimes attaining side margin but not suture, often roughly crescent shaped; a spot varying to a fascia at apical fourth, usually attaining side margin but not the suture, the apical and sub-median spots rarely connected exteriorly; all elytral maculations yellowish; apical spot often tinged, especially externally with orange; pronotum green to bluish or purplish, not always same as elytra, with yellow side margins; head unicolorous; mandibles with small yellow spot; ventral surface green; prosternal spine yellow; episternum with small yellow spot at side; mesosternum and metasternum marked medially with yellow; first and second abdominal segments each with median yellow spot; last three segments brown, marked at sides with yellow and black spots; tip with transverse subapical marking yellow; first abdominal segment varying to brilliant blue or purple. Elongate parallel, narrowed posteriorly; length 12–28 mm., average 17–24 mm. Head with or without median line; eyes closer in male; coarsely punctate, punctures separated by more than their widths, somewhat uneven; front sometimes slightly finely pilose; antennae pale brown. *Pro-*

*notum* widest at base and slightly arcuately narrowed to apex, or widest at middle and broadly slightly arcuately rounded from base to apex; apex not much narrower than base; no median line or impression; rather coarsely, unevenly punctate, punctures separated by more than their own widths; not pilose. *Scutellum* small, rather round to slightly transverse. *Elytra* widest at base or about equally broad at base and apical third, sides always rather gently curved, apical third usually interrupting smooth curve from base to apex; apices strongly bidentate; humeri sometimes slightly protuberant; surface regular; striae well defined; interstices scarcely convex, finely sparsely punctate to all but impunctate; not pilose. *Ventral surface* finely, not thickly pilose; legs light brown to rarely dark, anterior tibiae of males internally emarginate and armed with a tooth; prosternal spine impunctate, rest of prosternum rather coarsely punctate; abdomen thickly, finely punctate excepting on apical margins of segments which are levigated; lateral corners of apical margins of segments armed with spines; first ventral segment smooth medially; terminal segment truncate; females with tip bisinuate, anterior tibiae simple, and body form larger.

Varies somewhat in form of pronotum, shape of elytra, maculations both above and below, color of legs (dark legged specimens are uncommon) but *B. rufipes* is apparently always easily recognizable by its superficial characters.

Recorded from Arkansas, Florida, Texas, Virginia, Maryland, North Carolina, Louisiana, Kentucky, New Jersey, Pennsylvania, Indiana, Georgia, Kansas, Ohio, and Missouri.

Host plants: Oak, beech, maple, Southern yellow pines, chestnut, tulip, and hickory.

*Buprestis rufipes* may be separated from its allies, *B. gibbsi* (Le Conte), *B. viridisuturalis* Nicolay and Weiss, and *B. fremontiae* Burke, by the character of the elytral markings, the extensive ventral maculations, the others having, at most, a small pair of spots on the last ventral segment, by the yellow margin of the pronotum, the light color of antennae and legs in most cases, and by the male genitalia (Pl. IV, Figs. 8, 9, 10, and 11).

Nicolay and Weiss found that the color of the legs of this species varies considerably in a long series which placed *B. elongata* Casey in synonymy. Casey's *B. virens* is based upon the normal sexual dimorphism in the head, the head of the male tending to be narrower between the eyes with the eyes more protuberant and the median line less broad and distinct.

*Buprestis gibbsi* (Le Conte) (Pl. VIII, Fig. 4)

*Buprestis gibbsi* (Le Conte), 1857, Rep. Pac. Explor. 47 Par., Ins. 12: 42, t. 1, f. 17.—Kerremans, 1892, Mem. Soc. Ent. Belg., 1: 95.—Fall, 1901, Occ. Papers, Calif. Acad. Sc., 7: 116.—Van Dyke, 1902, Journ. N. Y. Ent. Soc., 10: 172.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 108.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 101.—Chamberlin, 1926, Cat. Bupr. N. A., p. 112.—Garnett, 1920, Can. Ent., 52: 17.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 9.

Green to blue or less commonly purple; underside green, less commonly suffused with purplish; ventral surface, head and pronotum immaculate; legs green, tibiae sometimes purple; elytra with large, rather elongate and irregular yellow spot before middle, extending in a slightly oblique direction from near suture to humeri, dividing at and sometimes encircling humeri, more often curving around outside of humeri, but not completely encircling them; a yellow fascia behind middle, usually attaining side margins but not suture, rarely divided into two spots, usually tinged externally with orange; an apical spot from side margin transversely to near suture, usually externally tinged with orange; apices not light; 14.5 to 19.5 mm. in length; elongate, parallel; six distinct elytral spots, ventral surface immaculate. *Head* often with sulcus on vertex, smooth line on front becoming a carina on many specimens; front narrower on males; coarsely and closely punctate, punctures separated by less than their widths; eyes more prominent in males; not pilose, to sparsely pilose; antennae dark metallic green to purplish or blue. *Pronotum* widest at middle, from base almost straight to slightly arcuate to middle, then rounded and more arcuately narrowed to apex, or almost evenly slightly arcuately rounded from base to apex and widest at middle; apex not much narrower than base; often with a fine, longitudinal median groove; usually narrowly bordered by impunctate area; coarsely, slightly irregularly punctate, punctures separated by less than to three times their widths, somewhat denser toward sides; not pilose. *Scutellum* small, round with front truncate to slightly transverse with front truncate. *Elytra* slightly wider at base to slightly wider at apical third, sides from apical third almost straight to slightly arcuately narrowed to apices which are bidentate; humeri not prominent; striate; interstices finely sparsely punctate and only slightly convex; not pilose. *Ventral surface* finely, sparsely pilose; anterior tibiae of males

internally emarginate and armed with a subapical tooth; prosternum finely punctate, prosternal spine smooth; mesosternum and metasternum rather coarsely and closely, abdomen rather finely sparsely punctate, more coarsely on last segment; first ventral segment smooth medially, not sulcate; tip of terminal segment truncate in both sexes; female a little larger, with front of head wider and eyes conforming more closely to curvature of head.

Varies in elytral color and maculations, sometimes having the median and apical spot untinged with orange, but not nearly as plastic as many of the species of *Buprestis*.

Recorded from Tulare County, Sonoma County, Garberville, Nevada City, Lake Ellann, San Diego County, Palm Springs, Yosemite Valley, Sequoia National Park, Chico, Hetch Hetchy, Yorkville in Mendocino County, Confidence, Auburn, Modoc County, and Onion Valley, California; Philomath, Corvallis, and Blue Mountains, Oregon; Steilacoom, Washington.

Host plants: Black oak (*Quercus californicus* (Torr.) Cooper) and Garry oak (*Q. garrayana* Hooker).

A Colorado record is open to some doubt as neither of the known food plants occur in Colorado, according to Sudworth, and no specimens are known from the intervening states, Arizona or Nevada. The record, "Manitou, July 6 (Neubarth), Colorado" was given by Nicolay and Weiss. If this record proves to be correct, then *B. gibbsi* probably attacks some oak other than black or Garry oak.

Separated from *B. rufipes* (Oliver) by the more elongated form of that species, the anterior elytral spot vittaform and sides of pronotum and undersurface maculated in that species, and by the male genitalia (Pl. IV, Figs. 8 and 9); from *B. viridisuturalis* Nicolay and Weiss, by the six distinct elytral spots of *B. gibbsi* and by the male genitalia (Pl. IV, Figs. 9 and 10). The males of *B. viridisuturalis* are smaller, narrower, and have far less metallic coloration on the elytra than *B. gibbsi*. *B. langi* (Mann.) and *B. fasciata* (Fab.) have similar elytral markings but the anterior spot never curves around the humerus as in *B. gibbsi*, and the apical and middle spots do not have any tinge of orange. The striae of these species are transversely rugulose and the anterior tibiae of the males are unmodified by any internal emargination and subapical tooth such as found in *B. gibbsi*. The male genitalia (Pl. III, Figs. 10 and 11, Pl. IV, Fig. 9) also separate these species.

The host plant record given by Nicolay and Weiss is only partly correct. The cottonwood records indubitably refer to *B. viridi-*

*suturalis*. The original record as given by Burke reads “*Buprestis gibbsi* Lec.—Southern Oregon, sierran California; on black cottonwood (*Populus trichocarpa*) and black oak (*Quercus californica*); flies from July to August, rare; has not been reared; varies a great deal in the amount of yellow and red on the elytra.” The concluding statement clearly refers to the then existent confusion of *B. viridisuturalis* with *B. gibbsi*, and cottonwoods are the food plant of the former. The author knows of no recent records of *B. gibbsi* excepting from oak. Burke took some specimens in Tuolumne County, Calif., along the old Sonora-Mono road near Confidence at elevations of from 4000 to 6000 feet and at Onion Valley, El Dorado County at an elevation of 4500 feet. He states that Mr. Albert Wagner took one specimen in Southern Oregon at 2000 feet, ovipositing in a crevice in the wood of a scar on the trunk of a living tree. “All the specimens cut from the wood were taken from the solid heartwood of old fire scars on the trunks of the black oak.” Mr. E. R. Leech took three fragmentary adults from an old log near Yorkville in Mendocino County, California, some years ago, and the author has found mines, larvae and adults in and on both black and Garry oaks at Yorkville. *Buprestis gibbsi* is rather widespread in occurrence, but rarely taken and represented in only a limited number of collections.

*Buprestis viridisuturalis* Nicolay and Weiss (Pl. IX, Figs 1 and 3)

*Buprestis viridisuturalis* Nicolay and Weiss, 1918, Journ. N. Y.

Ent. Soc., 26: 100, Pl. 6, Figs. 1 and 2.—Garnett, 1918, Ann.

Am. Ent. Soc., 11: 91.—Garnett, 1922, Bull. Soc. Ent. Fr.,

p. 9, 11, and 12, Figs. 1, 2, and 4.—Chamberlin, 1926, Cat.

Bupr. N. A., p. 128.

*B. parallella* Kerremans in litt.—Obenberger, 1922, Archiv. f.

Naturg., 88, Abt. A, p. 92.

var. *Lesnei* Garnett, 1922, Bull. Soc. Ent. Fr., p. 9, 12, and 13,

Figs. 3 and 5.

Head and pronotum green to blue or rarely purple; elytra yellow to light yellow brown with sutural band metallic green, blue or rarely purple, sometimes very narrowly metallic on suture, varying to specimens having the sutural band expanded just behind middle and attaining the side margin which is often green regardless of proximity of sutural expansion, and with another lesser expansion at apical fourth, sometimes nearly reaching side margin, nearly coalescing with marginal green to almost form an enclosed apical spot at apical third; some

specimens with only the apical expansion; often with humeri green and sometimes with small isolated green spots usually related to the points of usual expansion; head and pronotum immaculate, ventral surface immaculate excepting for some specimens which have a pair of yellow spots on the last abdominal segment; ventral surface green to blue or purplish; apical fourth of lateral margin of elytra often tinged with orange; elongate parallel; male 11–15 mm., width 4 mm., female 15–22 mm., width 7 mm. *Head* often with a median line; densely punctate and with pile on front; front narrower in males and eyes more prominent; antennae metallic green to purple. *Pronotum* widest at middle or a little behind middle; often inflated basally in female; usually with sides about evenly arcuate from base to apex, widest at middle and more quadrate in general in male; often with a median line; coarsely, unevenly punctate, more closely at sides, punctures separated by less than to four times their widths; usually pilose at sides. *Scutellum* round and truncate at front varying to slightly transverse, or becoming pointed behind. *Elytra* broadest at base, nearly parallel from base to apical third and arcuately narrowed to apices, or with a long gentle curve from base to apex, often interrupted by apical third where it takes on more curve; apices truncate with an external tooth only to bidentate, or emarginate; humeri not very prominent; striate, punctures of striae coarse and sometimes dark making them very noticeable; interstices finely, scarcely punctate, not very convex; not pilose. *Ventral surface* with silvery pile, longer on prosternum; anterior tibiae of males internally emarginate and with an internal tooth, females with tibiae simple; first ventral segment of abdomen convex medially, not sulcate; prosternum sparingly punctate, more closely toward sides; abdomen finely, very sparsely punctate; tip of abdomen bisinuate to truncate. Surface more depressed apically in male.

Varies considerably in elytral maculation; usually there is considerable metallic coloration along suture, but sometimes this is reduced to a very narrow line down the suture. Never forms six distinct spots although a spot may be formed in some instances, at the apical third.

Recorded from California and Oregon. Three Rivers, Tulare County, 800 feet, Red Bluff, Tehama County, 300 feet. In May, 1939, the author and Mr. André Helfer found larvae, pupae and

fragmentary adults in the cottonwoods bordering the Mojave River near Barstow and Daggett, San Bernardino County, in the Mojave desert, California. These were in dead limbs on living trees, and sound down wood. M. A. Cazier collected dead adults of typical *B. viridisuturalis* near Yermo, in San Bernardino County, California, and there are specimens in the author's series from Visalia, Tulare County, California (F. T. Scott, collector) from cottonwood; Davis, Yolo County, California (O. H. Schwab, collector); and from Travers and Llanada, California. Recorded from Dilley, Oregon.

*Buprestis viridisuturalis* var. *Lesnei* Garnett, was erected for a variation which occurs in normal stock. The type specimens were from Oro Grande, California, a few miles from where the author took typical specimens of *B. viridisuturalis*. The author has typical specimens of the variety from Visalia, California. There is no geographical significance to this form, and all intermediates between it and typical *B. viridisuturalis* may be found in a series.

In the past few years numerous dead but perfectly conditioned specimens have been chopped from their pupal cells in dead cottonwoods, and adults have been successfully reared from infested wood.

Host plants: Cottonwoods (*Populus fremontii*, *P. trichocarpa* and *P. deltoides*), and White Alder (*Alnus rhombifolia* (Burke)).

*Buprestis viridisuturalis* may be separated from *B. fremontiae* Burke, by the metallic sutural band, and in the case of the males, by the form which is narrow and parallel-sided in *B. viridisuturalis*. *Buprestis rufipes* (Oliver) has the ventral surface extensively maculated as well as the sides of the pronotum. The male genitalia will also serve to separate the species (Pl. IV, Figs. 9, 10, and 11). *B. fremontiae* is more orange, and has the pronotum less brilliantly colored than *B. viridisuturalis*.

This species exhibits the most sexual dimorphism of any of the North American species. The width of head, truncature or emargination of tip of abdomen, modification of anterior tibiae, and slight difference in size and broadness are about the extent of the dimorphic manifestations in other species, but in this species the sexes are markedly different in size and form as well as in maculation pattern, emargination of tibiae, width of head, and protuberance of eyes.

*Buprestis fremontiae* Burke (Pl. IX, Fig. 2)

*Buprestis fremontiae* Burke, 1924, Proc. Ent. Soc. Wash., 26: 70-72.—Chamberlin, 1926, Cat. Bupr., p. 112.

Elytra orange, with a lateral dark spot becoming a fascia

in some specimens, sometimes missing entirely; apical fourth usually externally tinged with orange to rufous; pronotum dark, obscurely greenish to purplish; ventral surface bronzed, immaculate; elongate, sometimes suboval; length 12.5–20 mm. Suture of elytra not metallic. *Head* with line on front, not reaching vertex; also with irregular small calli on front; coarsely punctate, punctures separated by about their own widths; front with long white pile; antennae bronzy. *Pronotum* widest at middle; broadly, arcuately rounded from base to apex; sometimes slightly angularly narrowed from middle; a little narrower at apex than at base; with a median line, often feebly impressed; coarsely, rather unevenly punctate, punctures separated by about their own widths but uneven; not pilose. *Scutellum* rounded, slightly transverse in some cases, small. *Elytra* widest at base or at apical third, narrowed gradually to rather obliquely from apical third to apices which are emarginate and bidentate; humeri somewhat prominent; striae punctures often darker than surface making striae appear quite strong; interstices scarcely punctate, only feebly convex; not pilose. *Ventral surface* clothed with long white hairs; prosternum coarsely punctate anteriorly and laterally, prosternal spine only feebly and sparsely punctate; abdomen finely and sparingly punctate; tip of abdomen broadly emarginate; first ventral abdominal segment very shallowly concave, not strongly sulcate; female with anterior tibiae simple, tip of abdomen bisinuate and bidentate, slightly broader in form.

Varies in color of pronotum, from plain shiny black, to greenish or purplish, elytral maculation never consisting of more than the one transverse spot or fascia just behind middle, but this spot sometimes divided or absent; dark purple to black or dark coppery, reduced in male to small round spot isolated from margin. Varies also in width as compared to length, from 7 to 8 mm. wide in specimens of equal length.

Recorded from middle to southern California. The type locality is about six miles west of Northfork, Madera County, California (Burke). In May, 1939, the author, accompanied by Mr. Albert Wagner of Northfork and Mr. André Helfer, drove to a point about ten miles east of Northfork, and collected wood of *Fremontiae californica* Torr. (flannel bush) which was infested with the larvae of *Buprestis fremontiae*. The larvae and mines were found in scars and other dead portions of living shrubs as well as in stumps where the mines often ran below the level of the ground. Burke and

Hartman collected larvae and fragmentary adults in the Swartout Valley, San Bernardino County, California, in September of 1922. There are five specimens in the author's series reared from infested wood collected by Mr. F. T. Scott, 1931, 1932, and 1933, in Sequoia National Park. Dr. E. G. Linsley of the University of California informed the author that in several attempts to collect *B. fremontiae* by beating flannel bush, he was unable to get more than one specimen in a day of beating.

Separated from *B. viridisuturalis* Nicolay and Weiss by the more orange color of its elytra and the lack of any metallic color on the suture, and by the male genitalia (Pl. IV, Figs. 10 and 11). *Buprestis rufipes* (Oliver) and *B. gibbsi* (Le Conte) are also somewhat similar structurally but may be separated by the maculation patterns of the elytra, the obscurely metallic color of the pronotum of *B. fremontiae* and the male genitalia (Pl. IV, Figs. 9, 10, and 11).

*Buprestis fremontiae* is one of the most uncommon of the North American species of *Buprestis* and is also strikingly beautiful. It is represented in only a few collections and by a total of probably fewer than fifty adults in all.

*Buprestis confluenta* Say (Pl. VIII, Figs. 3 and 5)

*Buprestis confluenta* Say, 1823, Journ. Acad. Philad., 3: 159.—Kerremans, 1892, Mem. Soc. Ent. Belg., 1: 94.—Casey, 1909, Proc. Wash. Acad. Sc., 11: 104.—Garnett, 1918, Ann. Am. Ent. Soc., 11: 91.—Nicolay and Weiss, 1918, Journ. N. Y. Ent. Soc., 26: 98.—Garnett, 1922, Bull. Soc. Ent. Fr., p. 9.—Chamberlin, 1926, Cat. Bupr. N. A., p. 106.

*B. confluens* (Le Conte), 1859, Trans. Am. Philos. Soc., 11: 206.

*B. tessellata* Casey, 1909, Proc. Wash. Acad. Sc., 11: 104 (subspecies of *Buprestis confluenta*).

Head, pronotum, and elytra golden green to blue or purple, apices of elytra occasionally narrowly margined with cupreous, not reaching to apical fourth; pronotum sometimes with four basal marks; elytra with small yellow spots, more or less confluent, irregularly strewn over the elytra, often tending to be sparser along suture and at apices; head immaculate; ventral surface green to coppery; prosternum often yellow, (usually indicating a male specimen), coxae, legs, and sides of mesosternum and metasternum sometimes maculated with yellow and abdomen sometimes with a double row of yellow spots on

each side, first ventral being sometimes heavily marked, the yellow being interrupted longitudinally along the middle; elongate, sometimes suboval; length 13–17 mm; the elytral maculation is unique in this species. *Head* sometimes with a median carina, more distinct at vertex, often with small calli on front; coarsely, rather thickly punctate; clothed with short white pile; antennae green to cupreous. *Pronotum* widest at base or at middle; usually narrowing distinctly from base to apex, sometimes as wide at apex as at base; sides almost evenly arcuately narrowed to apex varying to more strongly arcuate basally, or evenly rounded to middle which is widest and then equally rounded to apex; often with a distinct smooth median line, often with levigated spaces, usually arranged roughly in pairs, one on each side of middle; rather coarsely rather evenly punctate, punctures separated by less to more than their own widths; often pilose at sides. *Scutellum* small, round, flat. *Elytra* widest at base or at middle to equally wide at base and middle; sides slightly divergent from base to middle then broadly rounded and obliquely to slightly arcuately or distinctly sinuately narrowed to apices which are truncate, sometimes obliquely or with sutural angles right, sometimes with a slight sutural tooth, or sides may converge slightly to middle then round and narrow to apices; striae usually interrupted at humeri which are not prominent; surface convex as usual, often depressed apically, interstices rather broad and feebly convex at base but often rather narrow and strongly convex at apical quarter, the alternating interstices being sometimes more strongly convex; rather finely and very sparsely punctate; striae distinct, deeper apically, and also broader apically; not pilose. *Ventral surface* often pilose, more distinctly toward sides and anteriorly; anterior tibiae of males internally emarginate and armed with a distinctly subapical tooth; prosternum coarsely punctate, more densely toward sides, abdomen sparsely and finely punctate; first ventral segment of abdomen convex to flattened, not longitudinally sulcate medially; tip of abdomen deeply emarginate or notched to slightly broadly arcuate, more often truncate; female a little larger and with anterior tibiae unmodified, ventral surface usually immaculate.

Varies considerably in color and form. W. S. Fisher has informed the author that there are specimens of *Buprestis confluenta* in the National Museum collection having the elytra purplish and

the pronotum green. The ventral markings are sometimes present in the females, but usually are not as extensive as in the males. One specimen loaned to the author by Mont Cazier has the yellow markings of the elytra obscuring about 90% of the surface (Pl. VIII, Fig. 5). This is a female specimen from Montana, (Ex. Leng Collection). The elytral apices are sometimes a little attenuate and divaricated. There is sometimes a transverse area at apical third of elytra which is immaculate, and the suture and side margins often tend to be very sparsely maculated.

Recorded from Kansas, California, Oregon, Nevada, Montana, Colorado, Indiana, Illinois, North Dakota, Utah, Washington, Nebraska, Wyoming, Texas, Manitoba, Alberta, Quebec and British Columbia. Taken in good series at Lake Tahoe and Carrville, Trinity County, California. Sea level to 4,000 feet.

*Buprestis confluenta* subsp. *tesselata*, erected by Casey for a Texas variety is not a constant variation, in the author's opinion, and should not be considered as anything more than a normal variation. Nicolay and Weiss state that specimens from the north are more elongate and less spotted than specimens from the south, but the present author has not found this to be consistently the case, and hence places no geographical significance on such forms.

Host plants: Injured, dead or dying aspen (*Populus tremuloides*), and cottonwood (*P. deltoides*); attacks planted cottonwoods (Burke).

*Buprestis confluenta* is separated from all other species of North American *Buprestis* by the elytral maculation which consists in this species only, of small yellow spots strewn over the surface in an irregular manner. The placement of the tooth on the anterior tibia of the male is more strongly subapical than in other N. A. species.

*Buprestis confluenta* is one of the most attractive as well as one of the less common species, despite its rather wide range of occurrence.

LIST OF THE SPECIES AND SUBSPECIES OF AMERICAN BUPRESTIS,  
NORTH OF MEXICO

- |   |  |
|---|--|
| <i>B. apicans</i> Herbst, Pl. V, f. 2     | <i>B. salisburyensis</i> (Herbst), Pl. V, f. 3 |
| <i>nigricornis</i> (Sturm)                |  |
| <i>aciculata</i> Dejean                   | <i>ultramarina</i> Say                         |
| <i>Bosci</i> Castlenau and Gory           | <i>B. aurulenta</i> Linné, Pl. V, f. 6         |
| <i>cribripennis</i> Casey                 | <i>lauta</i> (Le Conte)                        |
| <i>B. decora</i> (Fabricius), Pl. V, f. 1 | <i>radians</i> (Le Conte)                      |

- villosa* (Le Conte)  
*fabulosa* Casey  
*aemula* Casey  
*tacomae* Casey  
*nupta* Casey  
*venusta* Casey  
*prospera* Casey  
*affinis* Casey  
*adulans* Casey  
*bicostata* Dejean  
*chrysochlora* (Phillipi)  
*B. sulcicollis* (Le Conte), Pl. V,  
     f. 4  
     *lateralis* Casey  
*B. striata* (Fabricius), Pl. V, f. 5  
     *obscura* Casey  
     *impedita* Say  
     *canadensis* Casey  
     *fortunata* Casey  
     *saturata* Casey  
*B. lineata* (Fabricius), Pl. VII,  
     f. 2  
     *davisi* Nicolay and Weiss  
*B. maculipennis* Gory, Pl. VII,  
     f. 3  
     *inconstans* Melsheimer  
     *deficiens* Casey  
     *fusiformis* Casey  
     *reducta* Casey  
     *scripta* Casey  
     *leporina* Casey  
*B. maculiventris* Say, Pl. VII,  
     f. 6  
     *sexnotata* Castlenau and  
         Gory  
     *maculiventris* Gemminer  
         and Harold  
     *maura* Castlenau and Gory  
*B. subornata* (Le Conte), Pl.  
     VIII, f. 1  
     *punctiventris* Casey  
     *rubronotans* Casey  
     *violescens* Casey  
     *adonea* Casey  
     *histro* Casey  
*B. rusticorum* (Kirby), Pl. VIII,  
     f. 2  
     *paganorum* (Kirby)  
     *lecontei* Saunders  
     *acomana* Casey  
     *morosa* Casey  
     *fusca* Casey  
     *sublivida* Casey  
     *caliginosa* Casey  
*B. intricata* Casey, Pl. VI, f. 2  
     *contortae* Hopping  
     *murrayanae* Hopping  
*B. adjecta* (Le Conte), Pl. VI,  
     f. 1  
     *brevis* Casey  
*B. connexa* Horn, Pl. VI, f. 3  
*B. langi* (Mannerheim), Pl. VI,  
     fs. 4 & 5  
     *ornata* Walker  
     *bistrinotata* Casey  
     *angusta* Casey  
     *callida* Casey  
     *fastidiosa* Casey  
     *mediocris* Casey  
     *crenata* Casey  
     *seditiosa* Casey  
     *leviceps* Casey  
     *depressa* Casey  
     *viridimicans* Casey  
     *incolumis* Casey  
     *oregona* Casey  
     *obliqua* Casey  
     *patruelis* Casey  
     *graminea* Casey  
*B. fasciata* (Fabricius), Pl. VI,  
     f. 6; Pl. VII, f. 1  
     *sexmaculata* Hausmann  
     *sexplagiata* (Le Conte)  
     *therminieri* Chevrolat

- fulgens* Casey  
*nigricans* Casey  
*lyrata* Casey  
*adducta* Casey  
*B. nuttalli* (Kirby), Pl. VII, f. 5  
*consularis* Gory  
*alternans* (Le Conte)  
*conicicauda* Casey  
*diruptans* Casey  
*contorta* Casey  
*gravidula* Casey  
*torva* Casey  
*boulderensis* Casey  
*flavopicta* Casey  
*B. nuttalli* subsp. *laeviventris*  
 (Le Conte), Pl. VII,  
 f. 4  
*pugetana* Casey
- dilatata* Motshulsky (Le  
 Conte)  
*B. rufipes* (Oliver), Pl. VIII,  
 f. 6  
*virens* Casey  
*elongata* Casey  
*B. gibbsi* (Le Conte), Pl. VIII,  
 f. 4  
*B. viridisuturalis* Nicolay &  
 Weiss, Pl. IX, f. 1 & 3  
*parallella* Kerremans in litt.  
*Lesnei* Garnett  
*B. fremontiae* Burke, Pl. IX,  
 f. 2  
*B. confluenta* Say, Pl. VIII, f.  
 3 & 5  
*confluens* (Le Conte)  
*tesselata* Casey

EXPLANATION OF PLATES (*Buprestis*)

Plate III—Genitalia (Figs. 1 to 11 are of males, Fig. 12 is of females).

- Fig. 1. *B. apricans* Herbst.
- Fig. 2. *B. salisburyensis* (Herbst).
- Fig. 3. *B. decora* (Fabricius).
- Fig. 4. *B. aurulenta* Linné.
- Fig. 5. *B. sulcicollis* (Le Conte).
- Fig. 6. *B. striata* (Fabricius).
- Fig. 7. *B. intricata* Casey.
- Fig. 8. *B. adjecta* (Le Conte).
- Fig. 9. *B. connexa* Horn.
- Fig. 10. *B. langi* (Mannerheim).
- Fig. 11. *B. fasciata* (Fabricius).
- Fig. 12a. *B. intricata* Casey.
- Fig. 12b. *B. adjecta* (Le Conte).

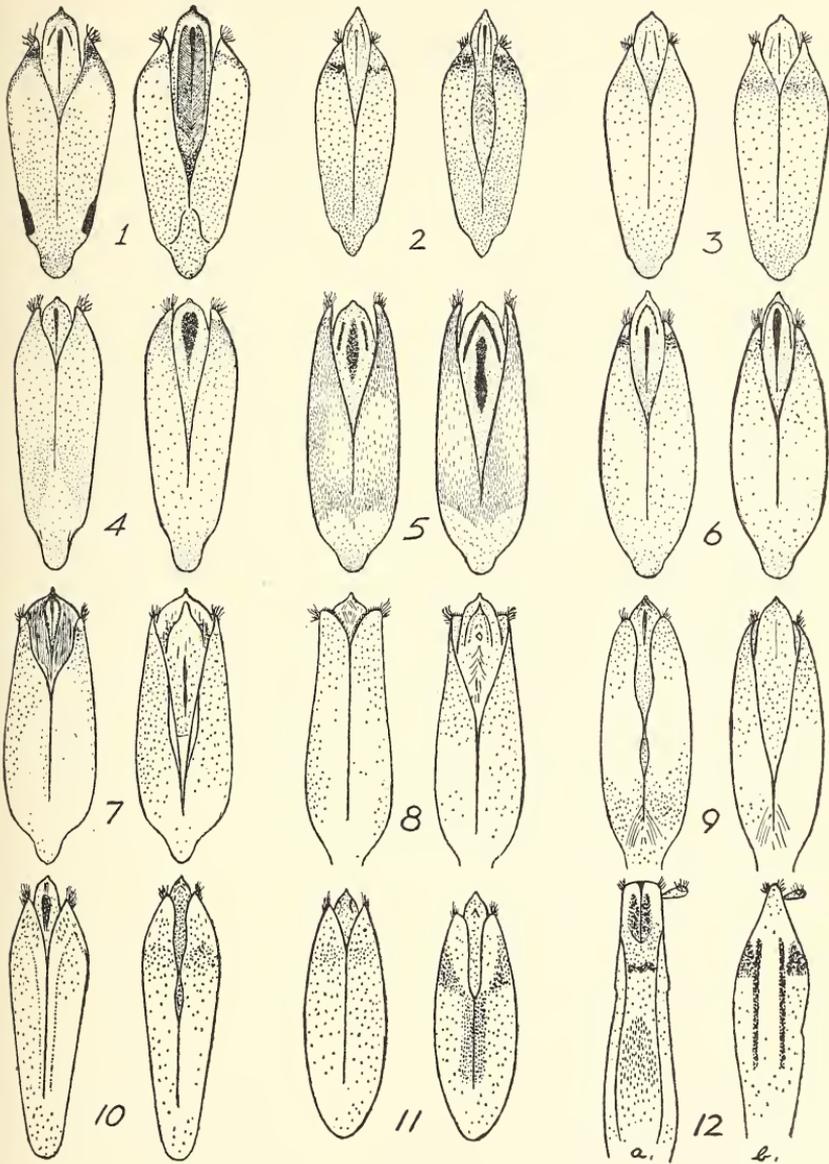


Plate IV—Genitalia (all figures are of male structures).

- Fig. 1. *B. lineata* (Fabricius).
- Fig. 2. *B. maculipennis* Gory.
- Fig. 3. *B. maculativentris* Say.
- Fig. 4. *B. subornata* (Le Conte).
- Fig. 5. *B. rusticorum* (Kirby).
- Fig. 6. *B. nuttalli* (Kirby) and same as subspecies *laeviventris* (Lec.).
- Fig. 7. *B. confluenta* Say.
- Fig. 8. *B. rufipes* (Oliver).
- Fig. 9. *B. gibbsi* (Le Conte).
- Fig. 10. *B. viridisuturalis* Nicolay and Weiss.
- Fig. 11. *B. fremontiae* Burke.

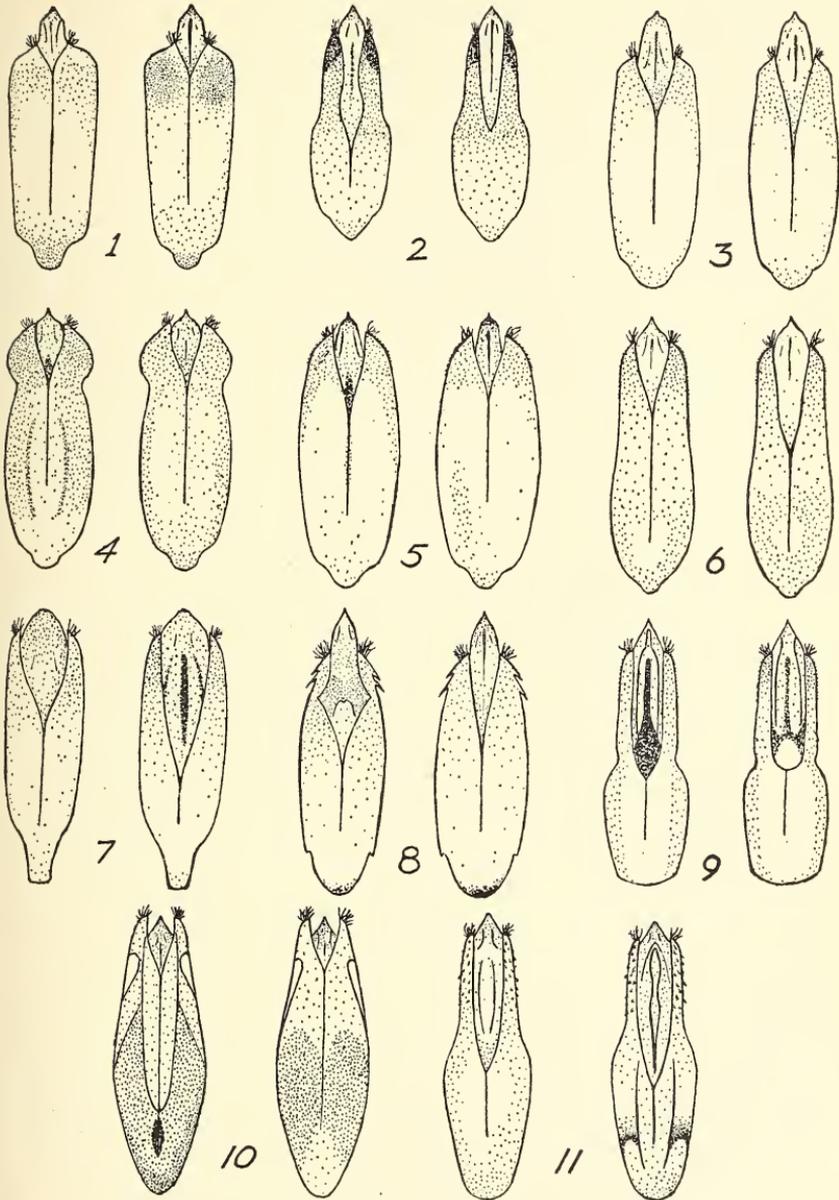


Plate V—Adults of *Buprestis*.

- Fig. 1. *B. decora* (Fabricius).
- Fig. 2. *B. apricans* Herbst.
- Fig. 3. *B. salisburyensis* (Herbst).
- Fig. 4. *B. sulcicollis* (Le Conte).
- Fig. 5. *B. striata* (Fabricius).
- Fig. 6. *B. aurulenta* Linné.

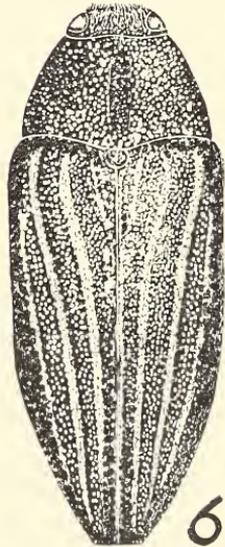
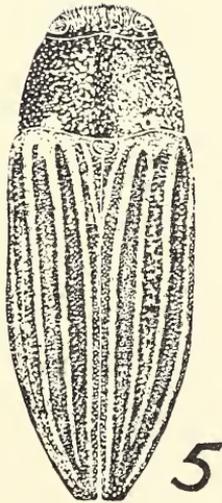
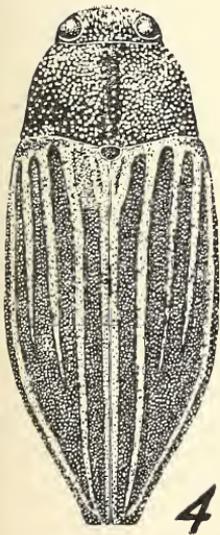
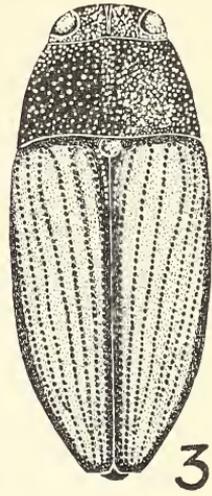
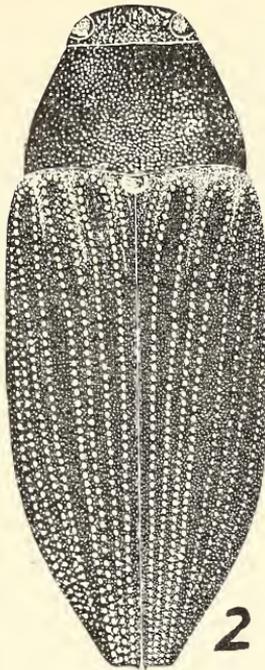
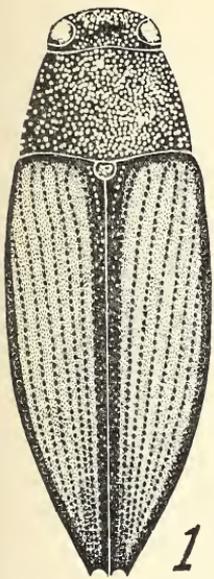


Plate VI.

- Fig. 1. *B. adjecta* (Le Conte).
- Fig. 2. *B. intricata* Casey.
- Fig. 3. *B. connexa* Horn.
- Fig. 4. *B. langi* (Mannerheim) male.
- Fig. 5. *B. langi* (Mannerheim) female.
- Fig. 6. *B. fasciata* (Fabricius) female.

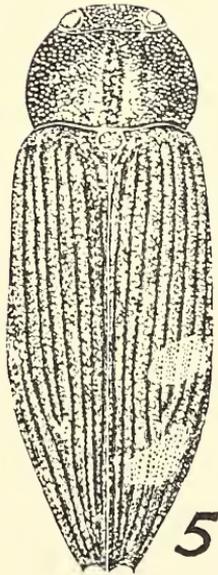
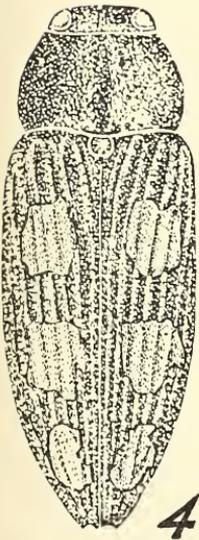
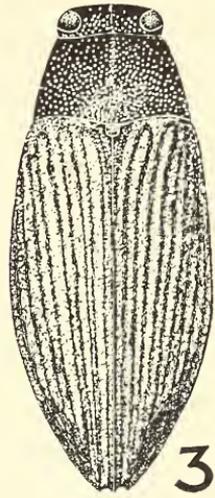
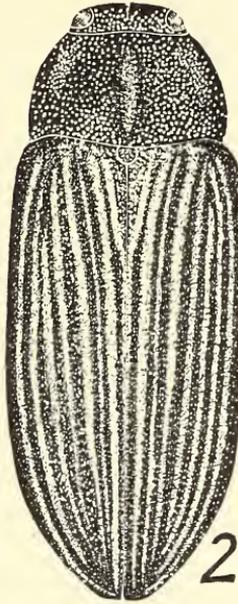
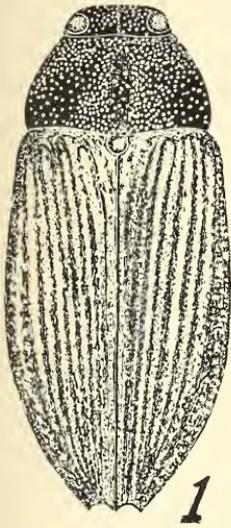
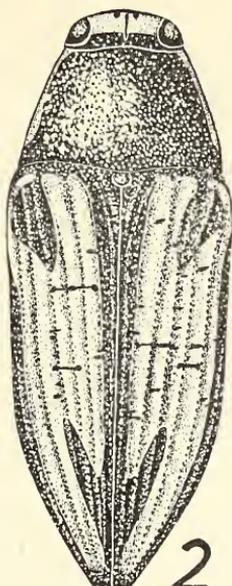


Plate VII.

- Fig. 1. *B. fasciata* (Fabricius) male.
- Fig. 2. *B. lineata* (Fabricius).
- Fig. 3. *B. maculipennis* Gory.
- Fig. 4. *B. nuttalli* subspecies *laeviventris* (Le Conte).
- Fig. 5. *B. nuttalli* (Kirby).
- Fig. 6. *B. maculativentris* Say.



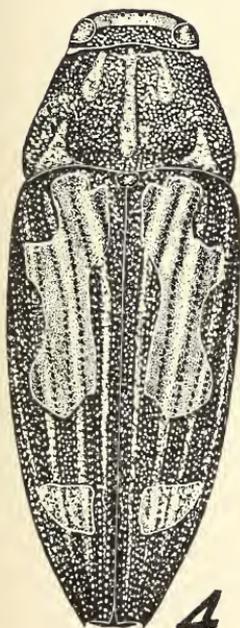
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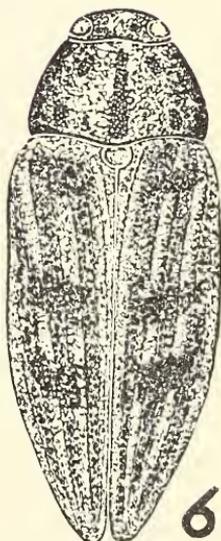
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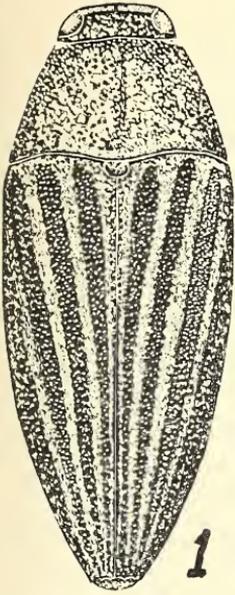
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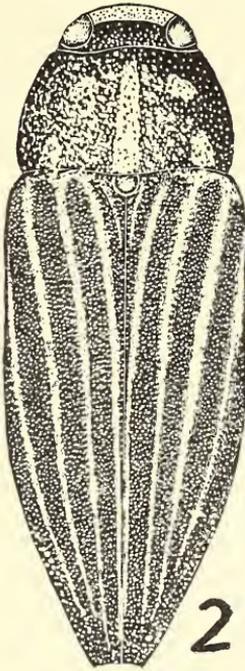
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Plate VIII.

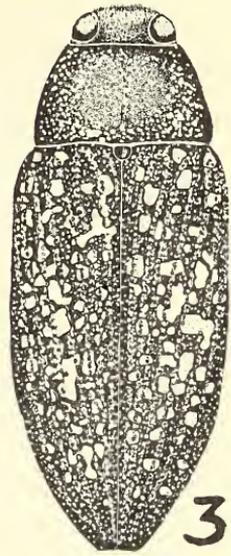
- Fig. 1. *B. subornata* (Le Conte).
- Fig. 2. *B. rusticorum* (Kirby).
- Fig. 3. *B. confluenta* Say.
- Fig. 4. *B. gibbsi* (Le Conte).
- Fig. 5. *B. confluenta* Say (Heavily maculated variety).
- Fig. 6. *B. rufipes* (Oliver).



1



2



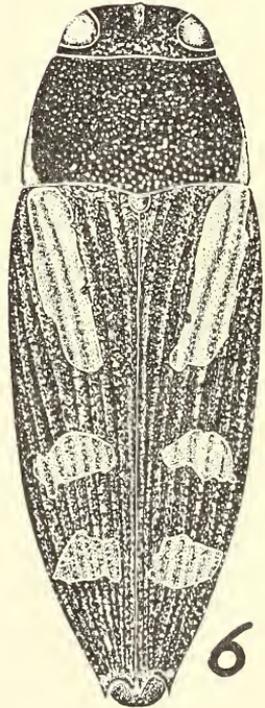
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4



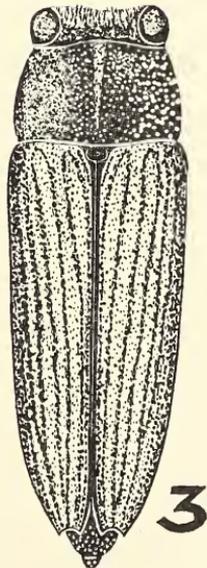
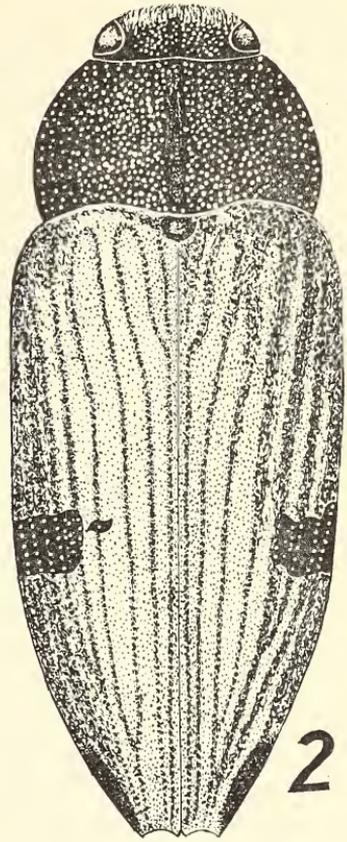
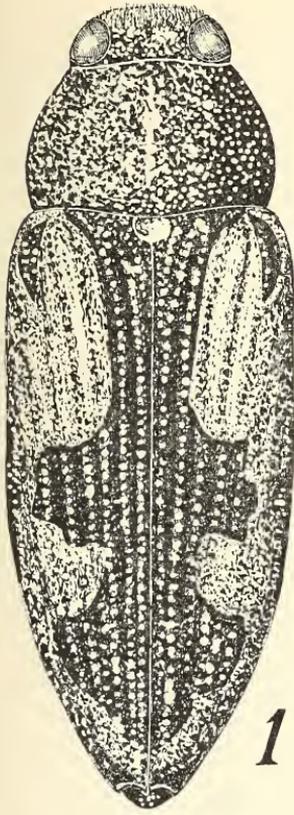
5



6

Plate IX.

- Fig. 1. *B. viridisuturalis* Nicolay and Weiss (female).
- Fig. 2. *B. fremontiae* Burke.
- Fig. 3. *B. viridisuturalis* Nicolay and Weiss (male).





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No. 4

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# ENTOMOLOGICA AMERICANA

VOL. XXI

OCTOBER, 1941

No. 4

## A MONOGRAPH OF THE GENUS *CHYPHOTES* (HYMENOPTERA, MUTILLIDAE, APTERO- GYNINAE) OF NORTH AMERICA\*

BY ALBERT WALTER BUZICKY  
ST. PAUL, MINN.

### INTRODUCTION

During the past fifteen years, Dr. Clarence E. Mickel has been accumulating specimens of Mutillidae in the collection of the University of Minnesota. An extensive series of the genus *Chyphotes* Blake is included in this large body of material. This collection is probably the most representative and complete in existence, numbering several thousand specimens from western United States, northern Mexico, and southwestern Canada. Dr. Mickel has long recognized the inadequacy of existing keys to species, the existence of new species, and the consequent need of a revisional treatment of the genus. He has been kind enough to suggest this study and to place at my disposal the collection of *Chyphotes* and *Apterogyna* of the University of Minnesota.

The two sexes of the genus *Chyphotes* are dimorphic like other Mutillids, the males being winged and the females wingless. This situation required that males and females be described separately as different species, and up to the time of this study, there was no case in which the two sexes of a single species had been correlated. Twelve species of males and only four species of females were de-

\* Paper No. 1902, Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul.

scribed heretofore, and the existing keys to those species were not entirely satisfactory because certain valid specific characters had been overlooked. The male genitalia of *Chyphotes* had never been figured or studied. Nothing is known regarding the biology or habits of the species of this genus other than the fact that both males and females are attracted to lights at night.

The types of all previously described species in the genus except *punctatus* Fox have been seen and studied. I am indebted to the late Miss Grace A. Sandhouse of the United States National Museum for comparing specimens with the holotype of *punctatus* and pointing out morphological characters which could be used for differentiating that species in a key which had been prepared to include all other known species. The study of type material was essential for an accurate delineation of the described and undescribed species because at the time the majority of the descriptions and keys were published, many characters now considered valid and significant were not mentioned. A number of doubtful taxonomic points have been clarified through the examination of types.

Thanks and appreciation are gratefully expressed to the officials of the following institutions for the privilege of examining type material in their custody: Academy of Natural Sciences, Philadelphia, Pennsylvania; Cornell University, Ithaca, New York; Pomona College, Claremont, California; United States National Museum, Washington, D. C.; Washington State College, Pullman, Washington.

The following persons and institutions have helped make this study possible through the loan of material:

- |        |   |
|--------|---|
| A.B.K. | A. B. Klots, New York City, New York.   |
| A.E.S. | American Entomological Society, Philadelphia Academy of Sciences, Philadelphia, Pennsylvania. |
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U.S.N.M. United States National Museum, Washington, D. C.  
W.S.C. Washington Agricultural College, Pullman, Washington.  
W.W.J. W. W. Jones, Douglas, Arizona.

The data on all specimens studied are itemized in full in the copy of the writer's thesis in the library of the University of Minnesota. In the interest of economy of space, a section on genitalia mounting technique and the specimens examined lists of previously described species have been deleted. In the later cases, distribution is indicated by states with the total number of specimens examined given in parentheses immediately following. Complete records of all type material are included in this treatise, the present location of each specimen being indicated by the capital initial letters in brackets following other data on the specimen.

The writer acknowledges his deep indebtedness to Dr. Clarence E. Mickel for suggesting this problem and for his constant encouragement, suggestions, and ready aid during all phases of this study. His good humor, enthusiasm, and forbearance with the author during the years of this study have made this work especially enjoyable.

#### APTEROGYNINAE

The subfamily Apterogyninae was proposed by Andre (1899)

to include the single old world genus *Apterogyna* Latreille. In 1903 Andre divided the Mutillidae into five subfamilies, assigning *Chyphotes* to the Methocinae and retaining *Apterogyna* in the Apterogyninae. Ashmead (1899) established the family Myrmosidae and in 1903 subdivided it into the subfamilies Bradynobaeninae, Myrmosinae (including *Chyphotes*), and Apterogyninae (including *Apterogyna*). Fox (1899) in his classification of the North American Mutillidae divided the family into the subfamilies Mutillinae and Thynninae, including *Chyphotes* in the later group. Bradley and Bequaert (1928) considered that both *Apterogyna* and *Chyphotes* were Mutillids and placed each in a separate subfamily, the Apterogyninae and Chyphotinae respectively. In discussing the affinities of the Myrmosinae, Krombein (1939) separates the Myrmosinae from the Mutillidae chiefly by the absence of a pair of felt lines on the second abdominal segment in both males and females. He considers that “. . . genera such as *Chyphotes* Blake . . . seem to be more allied to the true Mutillids on the basis of the ‘felt’ lines on the second abdominal tergite rather than to some other family.”

The subfamily Apterogyninae (in the sense of this paper) is considered a subfamily of the Mutillidae containing the two genera, *Apterogyna* Latreille and *Chyphotes* Blake on the basis of the felt lines on the second abdominal tergite. The following characters separate *Apterogyna* and *Chyphotes* from other Mutillids; the presence of an anal lobe on the hind wings of the males with the exception of the old world genus *Pseudophotopsis*, which also has anal lobes on the hind wings in the males; the presence of a subterete first abdominal sternite anterior to the tergite in both the males and females; the hypopygium of the males unciform, with two smaller lateral aculei; the fusion of the metapleura and the propodeum in the males; the presence of a movable suture between the prothorax and the fused posterior segments of the thorax in the females; the presence of a tooth or tubercle anterior to and between the hind coxae; a distinct similarity between the male genitalia.

*Apterogyna* occurs only in the old world and may be readily distinguished from *Chyphotes*, found only in western North America, by the distinct constriction between the second and third abdominal segments of both males and females and by the much reduced venation of the anterior wings of the males. The two lateral aculei of *Apterogyna* arise separately from the posterior edge of the hypopygium adjacent to the central aculeus. In *Chyphotes*, the two lateral aculei have fused with the shaft of the central aculeus three-fourths of its length from the tip.

Genus *Chyphotes* Blake

- Mutilla* (species *nubecula*) Cresson, 1865, Proc. Ent. Soc. Phil. 4: 440.
- Agama* (species *belfragei*) Blake, 1871, Trans. Amer. Ent. Soc. 3: 263-264.
- Agama* (species *attenuata*) Blake, 1872, Trans. Amer. Ent. Soc. 4: 76.
- Agama* (species *albipes*) Cresson, 1874, Trans. Amer. Ent. Soc. 5: 99.
- Photopsis* (Groups A, B, C, in part.) Blake, 1886, Trans. Amer. Ent. Soc. 13: 263-286.
- Chyphotes* (species *elevatus*) Blake, 1886, Trans. Amer. Ent. Soc. 13: 276.
- Photopsis* (Groups A, B, C, in part.) Cockerell, 1895, Trans. Amer. Ent. Soc. 22: 289-291.
- Sphaerophthalma* (species *frugala*) Cameron, 1896, Biol. Centr. Amer. 2: 394.
- Chyphotes* Ashmead, 1896, Trans. Amer. Ent. Soc. 23: 181.
- Mutilla* (in part.) Dalla Torre, 1897, Catalogus Hymen. 8: 5.
- Chyphotes* Fox (in part.) 1899, Trans. Amer. Ent. Soc. 25: 275-278.
- Typhoctes* (species *attenuatus*) Ashmead, 1899, Jour. N. Y. Ent. Soc. 7: 53-54.
- Chyphotes* Andre, 1903, Genera Insectorum, i fasc. 11: 1-77.
- Chyphotes* Ashmead, 1903, Canad. Entom. 35: 201-202.
- Typhoctes* (male, nec. female) Ashmead, 1903, Canad. Entom. 35: 201-202.
- Chyphotes* Melander, 1903, Trans. Amer. Ent. Soc. 29: 326-327.
- Chyphotes* Baker, 1903, Invertebrata Pacifica 1: 116-119.
- Chyphotes* Bradley, 1917, Trans. Amer. Ent. Soc. 43: 283-288.

Genotype: *Chyphotes elevatus* Blake, monobasic, female, sole species originally included.

Diagnostic characters of the males: Head sub-ovate from above, somewhat wider than prothorax but distinctly narrower than mesothorax; ocelli very large, compound eyes ovate, prominently hemispherical, distinctly faceted, blackish, with an emargination along outer margin and a smaller emargination along inner margin; mandibles bidentate, distal one third smooth, reddish hyaline, edentate at the tip and with a small tooth within near the apex; middle coxae widely separated; mesosternum without a pair of laminate plates overlying the

middle coxae; a transverse carina immediately anterior to each middle coxa; a more or less mamilliform process anterior to and between each hind coxa; parapsidal furrows absent; propodeum generally rugose or reticulate medially; first abdominal tergite punctate, expanded, extending anteriorly from the posterior margin one half to one third the length of the sternite; the anterior portion of first sternite not covered by the tergite, subterete, rugose or punctate; second abdominal tergite with a felt line on each side near the lateral margin; hypopygium unciform, the aculeus with a pair of proximal, short lateral spines directed obliquely caudad; hind tibia with two calcaria, unequal in length; hind wings with a well developed anal lobe; stigma of front wings large, distinct; front wings with two or three submarginal cells and one or two discoidal cells.

Diagnostic characters of the females: width of the head distinctly less than the widest part of thorax; eyes very small, faceted, blackish, ovoid, the ventral margin weakly truncate; mandibles bidentate, distal two thirds smooth, reddish hyaline, edentate at the tip and with a small tooth near the apex; middle coxae widely separated; mesothorax much wider than the prothorax, completely fused with the metathorax and propodeum; metasternum with a pair of flattened teeth anterior to and between hind coxae; first abdominal tergite inflated, broadly joining second tergite dorsally but covering only posterior one third of first sternite, the latter slender, short, terete, very weakly punctate; middle tibia with two calcaria, unequal in length; middle tibia with two rows of spines on the outer distal surface, one row composed of four or five spines and the other of two or three.

#### HISTORICAL DISCUSSION

The earliest known species of *Chyphotes* was described by Cresson (1865) as *Mutilla nubecula*. Blake (1871) included *nubecula* and a new species, *belfragei*, in his new genus *Agama*. *Attenuata* was described by Blake (1872) and *albipes* by Cresson (1874), both species being assigned to *Agama*. Blake (1886) substituted *Photopsis* for *Agama*, due to the fact that the latter was preoccupied in the Reptilia. The female sex of *Photopsis* was unknown to Blake, and he suggested that his new genus *Chyphotes*, which was erected to include the single female *elevatus*, might represent the female sex of *Photopsis*. Subsequently, two males were described, but not being recognized as males of *Chyphotes*, were assigned to *Photopsis* by Cockerell (1895) and to *Sphaerophthalma* by Cameron (1896).

Ashmead was the first to recognize that certain males assigned to *Photopsis*, that is, *albipes*, *belfragei*, *melaniceps*, *attenuata*, and "two or three other species" actually represented the male sex of *Chyphotes*. Dalle Torre (1897) in his Catalog of Hymenoptera placed all the described species of *Chyphotes* in the genus *Mutilla*. Fox (1899) accepted Ashmead's correlation of the male and female sexes of *Chyphotes*, described several new species of both sexes, and presented the first published key to species in the genus. He also included in *Chyphotes* the female *Mutilla peculiaris* Cresson, which Ashmead the same year designated as the genotype of his new genus *Typhoctes*. Ashmead, in proposing the genus *Typhoctes*, presented keys to both sexes of *Chyphotes*, *Typhoctes*, and related genera. Although the female *peculiaris* Cresson was the only species definitely mentioned in relation to *Typhoctes*, the genus was diagnosed in the male section of the key without any reference to an included species. *Chyphotes attenuatus* Blake agrees with the characters in Ashmead's key and subsequent authors have considered *attenuatus* as representing the male sex of *Typhoctes*. Andre (1903), in commenting on this situation states, "The placing of these males (*attenuatus*) in *Typhoctes*, which does not appear to me to be based on observation to accompany it, remains then uncertain." All the evidence from external morphology and comparative study of male genitalia indicate to the writer that *attenuatus* is a true *Chyphotes* and that the male sex of *Typhoctes* still remains unknown. Additional new species were described by Melander (1903), Baker (1903), and Bradley (1917), the latter two authors also presenting modified keys to the species of males.

#### GEOGRAPHICAL DISTRIBUTION

The genus *Chyphotes* occurs only in western North America, the center of distribution of species being Arizona, New Mexico, and southern California. The eastern limit of distribution as determined from specimens examined is central Texas and western Kansas. Several species should eventually be taken from western North and South Dakota, Nebraska, and Oklahoma. One species is found in southwestern Canada and northwestern United States. It is not known exactly how far south in Mexico *Chyphotes* occurs, but specimens were examined from the extreme southern tip of Lower California. Detailed distribution records are included in the list of specimens examined accompanying each specific discussion.

#### TAXONOMIC CHARACTERS

The most important morphological characters useful in separat-

ing the males are as follows: the presence or absence of a comb of stiff, erect, bristles at the posterior margin of the fourth and fifth abdominal sternites; the presence or absence of a dense tuft of short, erect hairs on the ventral inner margin of the middle and hind coxae; the tubercles or teeth anterior to and between the hind coxae are important; a few species have these processes in the form of peg-like teeth, in others they are mamilliform processes, and in still others they are very low, indistinct tubercles; the transverse carinae immediately anterior to the middle coxae may be present or absent; in some species the mesosternum is medially, longitudinally, depressed; in one species this mesosternal depression is closed anteriorly by a pair of horizontal teeth arising from each side of the depression and almost contiguous at the midline; the globose form of the first abdominal tergite has been used to characterize *caloxicensis*; the presence in the front wings of two or three submarginal cells and the presence or absence of the second discoidal cell is useful in differentiating groups of species but the venation of the wings is otherwise of little specific value. The following color variations have been found useful; the legs vary in color from light yellow to piceous; the ocellar area and antennae may be concolorous with the head or infuscated; the head is infuscated in two species and the abdomen in one; in some cases the third abdominal tergite is infuscated.

The most important morphological characters useful in separating the females are as follows: the relative lengths of the first and second segments of the flagellum; the angle between the inner edges of the teeth anterior to and between the hind coxae; the punctation of the anterior half of the anterior face of the mesopleura; the punctation or striation of the posterior face of the propodeum; the character and degree of punctation of the body; the presence of either an obtuse, or of an acute or right angle at the dorsal junction of the first abdominal tergite and sternite; the presence or absence of a deep transverse notch on the first abdominal sternite at the junction with the first abdominal tergite; color variations such as pale yellow, testaceous, or infuscated legs, a concolorous or infuscated third abdominal tergite, and the presence of golden instead of buffy pubescence, have proved useful.

#### SUBGENERIC GROUPINGS

The males of the genus *Chyphotes* fall into three groups of species, based chiefly on differences in wing venation. The *nubeculus* group is characterized by possessing two discoidal and three submarginal cells in the anterior wings and the *belfragei* complex with

two discoidal and two submarginal cells in the fore wings. The complement of cells presented by the *attenuatus* group, which has only the first discoidal and two submarginal cells in the front wings, represents the greatest reduction of wing venation within the genus.

The females of *Chyphotes* also can be arranged in three groups. The *elevatus* group differs from the two others in having the first segment of the flagellum equal to or longer than the second segment, the anterior one-half of the anterior face of the mesopleura punctate, and the angle at the junction of the first abdominal tergite and sternite ninety degrees or less. Both the *nubeculus* and *striatus* groups have the first segment of the flagellum shorter than the second, a glabrous area on the anterior one-half of the anterior face of the mesopleura, and a distinctly obtuse angle at the junction of the first abdominal sternite and tergite. The posterior face of the propodeum is transversely striate in the *striatus* group and punctate throughout in the *nubeculus* series.

The *nubeculus* and *belfragei* groups of males have been correlated in part with the *nubeculus* and *elevatus* groups of females respectively. The correlation between the *attenuatus* series of males and the *striatus* group of females is entirely tentative, as it is based only upon elimination. A more detailed discussion of these relationships is presented hereafter. The list of known species which follows has the specific groups arranged in a possible phylogenetic sequence, proceeding from the generalized to the more specialized forms on the basis of the reduction in wing venation.

- |   |  |
|---|--|
| <p>A. <i>nubeculus</i> group<br/> <i>similis</i> (Baker)<br/> <i>nubeculus</i> (Cresson)<br/> <i>heathii</i> Melander<br/> <i>bruscus</i> n. sp.<br/> <i>albipes</i> (Cresson)<br/> <i>mickeli</i> subsp. <b>mickeli</b><br/> n. sp. and n. subsp.<br/> <i>mickeli</i> subsp. <b>polingi</b><br/> n. sp. and n. subsp.<br/> <i>epedaphus</i> n. sp.</p> | <p>C. <i>attenuatus</i> group<br/> <b>subulatus</b> n. sp.<br/> <i>attenuatus</i> (Blake)<br/> <b>pallidus</b> n. sp.</p>  |
| <p>B. <i>belfragei</i> group<br/> <i>calexicensis</i> Bradley<br/> <i>melaniceps</i> (Blake)<br/> <i>belfragei</i> (Blake)<br/> <i>peninsularis</i> Fox<br/> <i>jugatus</i> n. sp.<br/> <i>californicus</i> Baker</p>   | <p>D. <i>elevatus</i> group<br/> <i>elevatus</i> Blake<br/> <i>testaceipes</i> Fox<br/> <b>auripilus</b> n. sp.<br/> <i>petiolatus</i> Fox<br/> <b>pilosus</b> n. sp.</p> <p>E. <i>striatus</i> group<br/> <b>pixus</b> n. sp.<br/> <b>striatus</b> n. sp.<br/> <i>punctatus</i> Fox<br/> <b>segregatus</b> n. sp.</p> |

KEY TO SPECIES OF CHYPHOTES

Males

1. Front wings with second discoidal cell present ..... 2  
 Front wings with second discoidal cell absent ..... 14
2. Front wings with three submarginal cells ..... 3  
 Front wings with two submarginal cells ..... 9
3. Fourth and fifth abdominal sternites with a comb of several  
 stiff erect bristles at the posterior margin ..... 4  
 Fourth and fifth abdominal sternites without a comb of several  
 stiff erect bristles at the posterior margin ..... 5
4. Head piceous ..... *similis* Baker  
 Head concolorous with body ..... *nubeculus* Cresson
5. Mesosternum without distinct transverse carinae before middle  
 coxae; ventral, inner margins of middle and hind coxae  
 with a small brush of short, thick, erect hairs; ocellar area  
 infuscated ..... 6  
 Mesosternum with a very distinct transverse carina interrupted  
 medially immediately in front of middle coxae; ventral  
 surface of middle and hind coxae with only the usual sparse  
 long hairs ..... 7
6. Femora and tibiae infuscated, darker than body.  
*heathii* Melander  
 Femora and tibiae concolorous with or lighter than body.  
**bruscus** n. sp.
7. Metasternum with a pair of strong erect teeth immediately in  
 front of and between the hind coxae ..... *albipes* Cresson  
 Metasternum without a pair of strong erect teeth immediately  
 in front of and between the hind coxae, or if present,  
 low ..... 8
8. Legs very pale yellow, much paler than body.  
**mickeli** subsp. **mickeli** n. sp. and n. subsp.  
 Legs testaceous, concolorous with body.  
**mickeli** subsp. **polingi** n. sp. and n. subsp.
9. First abdominal tergite globose ..... *calericensis* Bradley  
 First abdominal tergite enlarged but not hemispherical ..... 10
10. Clypeus and mouthparts ferruginous, remainder of head  
 piceous ..... *melaniceps* Blake  
 Entire head concolorous with body ..... 11
11. Femora and tibiae partially infuscated ..... *belfragei* Blake  
 Femora and tibiae entirely yellow or concolorous with body 12
12. Posterior half of mesosternum flat or slightly convex, excepting

a narrow median longitudinal sulcus; distinctly punctate throughout; propleura closely, confluent punctate.

*peninsularis* Fox

Posterior half of mesosternum distinctly and broadly concave, either sparsely punctate medially or concavity almost entirely impunctate; propleura with distinct separated punctures ..... 13

13. Mesosternal concavity closed anteriorly by a pair of horizontal teeth whose apices meet or almost meet at the mid-line; surface of concavity distinctly punctured laterally, sparsely or not at all punctured medially; each lateral margin of concavity defined by a weak oblique carina; posterior two-thirds of mesosternite shallowly concave.

*jugatus* n. sp.

Mesosternal concavity open, without horizontal teeth anteriorly; entirely glabrous, impunctate throughout, each lateral margin defined by distinct oblique carinae; posterior two-thirds of mesosternite deeply concave.

*californicus* Baker

14. Abdomen much darker than thorax, entirely piceous except anterior half of petiole more or less testaceous.

*subulatus* n. sp.

Abdomen for the most part concolorous with the thorax, either dark testaceous or pale yellow ..... 15

15. Third abdominal tergite blackish, remainder of abdomen dark testaceous and concolorous with the head and thorax; legs usually paler than body, sometimes infuscated.

*attenuatus* Blake

Body, antennae, and legs pale yellow, except abdominal segments posterior to second gradually becoming pale testaceous; third tergite not blackish ..... *pallidus* n. sp.

#### KEY TO SPECIES OF CHYPHOTES

##### Females

1. First segment of flagellum equal to or longer than the second segment; anterior one-half of anterior face of mesopleura punctate; angle at junction of first abdominal tergite and petiole ninety degrees or less ..... 7
- First segment of flagellum shorter than second segment; anterior one-half of anterior face of mesopleura glabrous; angle at junction of first abdominal tergite and petiole much greater than ninety degrees ..... 2

2. Posterior face of propodeum transversely striate ..... 3  
 Posterior face of propodeum punctate, not transversely  
 striate ..... 6
3. Propodeal striations very weak, almost obsolete, punctation on  
 head and thorax light but regular; body light yellow ex-  
 cept last two abdominal segments slightly testaceous; ves-  
 titure light golden yellow; 3.8 mm. .... **pixus** n. sp.  
 Propodeal striations distinct; punctation on head and thorax  
 deep and coarse; body testaceous ..... 4
4. Third abdominal tergite with a distinct blackish band; body  
 dark testaceous; interspaces between thoracic punctures  
 shiny; punctation of first abdominal tergite as coarse as  
 that of the second tergite ..... **striatus** n. sp.  
 Third abdominal tergite dark testaceous but not blackish; mar-  
 gins of thoracic punctures not clearly defined, interspaces  
 aciculate and rather dull; punctation of first abdominal  
 tergite lighter than that of the second tergite ..... 5
5. Body reddish testaceous; femora dark, mahogany testaceous.  
**punctatus** Fox  
 Body light testaceous; femora light yellow.  
**segregatus** n. sp.
6. Femora and tibiae piceous or infuscated ..... **albipes** n. comb.  
 Femora and tibiae testaceous or light yellow.  
**epedaphus** n. sp.
7. Femora and tibia piceous or infuscated; third abdominal ter-  
 gite infuscated or darker than remainder of abdomen.  
*elevatus* Blake  
 Femora and tibiae testaceous or light yellow; abdominal ter-  
 gites concolorous ..... 8
8. Inner edges of metasternal teeth sub-parallel or acutely  
 V-shaped ..... *testaceipes* Fox  
 Inner edges of metasternal teeth not sub-parallel but broadly  
 V- or U-shaped ..... 9
9. Pubescence on dorsal part of head, thorax, and first three  
 abdominal tergites bright golden yellow.  
**auripilus** n. sp.  
 Pubescence on dorsal part of head, thorax, and first three ab-  
 dominal tergites buff or dull grayish yellow ..... 10
10. Petiole without a deep transverse notch at junction with first  
 abdominal tergite ..... *petiolatus* Fox  
 Petiole with a deep transverse notch at junction with first  
 abdominal tergite ..... **pilosus** n. sp.

*Chyphotes similis* Baker

Plate XI, Figure 6

1903. *Chyphotes similis* Baker, Invertebrata Pacifica 1: 116. male.

1917. *Chyphotes similis* Bradley, Trans. Amer. Ent. Soc. 43: 286. male.

Holotype.—Male, Claremont, California (no date) (C. H. Baker), in collection of Pomona College, Claremont, California.

Allotype.—Male, Claremont, California (no date) (C. H. Baker), in collection of Pomona College, Claremont, California.

Distribution.—California (25), Utah (1), Mexico (8) (Lower California).

Baker states that *similis* is related to *nubeculus* in general characters, "but it lacks entirely the ventral tufts said to be most strikingly characteristic of that species." My examination of Baker's holotype of *similis* reveals that the ventral tufts or stiff erect bristles on the fourth and fifth abdominal sternites are present. Bradley (1917), in couplet three and four of his key to species of *Chyphotes* males, erroneously separates *heathii* as having these ventral tufts and *similis* as lacking them, when the opposite is true. Unfortunately, these errors in the keys have led to many misidentifications.

The cuspis of the genitalia possess a characteristic longitudinal row of blunt peg-like spines which vary in number from two to six. Only the normal scattered pointed spines are present on the cuspis of *nubeculus*.

*Chyphotes nubeculus* Cresson

Plate X, Figure 3

1865. *Mutilla nubecula* Cresson, Proc. Ent. Soc. Phil. 4: 440. male.

1871. *Agama nubecula* Blake, Trans. Amer. Ent. Soc. 3: 264. male.

1886. *Photopsis nubecula* Blake, Trans. Amer. Ent. Soc. 13: 266. male.

1897. *Mutilla nubecula* Dalla Torre, Cat. Hymen. 8: 67. male.

1898. *Chyphotes nubeculus* Fox, Trans. Amer. Ent. Soc. 25: 276. male.

1917. *Chyphotes nubeculus* Bradley, Trans. Amer. Ent. Soc. 43: 286. male.

Holotype.—Male, Colorado (no date) (E. T. Cresson), type no. 1889, in collection of American Entomological Society, Philadelphia, Pennsylvania.

Distribution.—Arizona (144), New Mexico (6), Colorado (6), Montana (1), Kansas (4).

In the holotype of *nubeculus* cell  $R_4$  is cuboidal, veins  $R_4$  and  $R_5$  being parallel. Examination of a series of this species reveals that cell  $R_4$  varies from cuboidal to rectangular. In the experience of the author, piceous head color is a valid character in the separation of *similis* from *nubeculus*.

The male genitalia of this species possess a rounded, cushion-like structure covered with short stout spines on the ental portion of the basiparamere adjacent to the base of the digitus. No comparable structure is present on the male genitalia of *similis*.

*Chyphotes heathii* Melander

Plate XI, Figure 7

1903. *Chyphotes heathii* Melander, Trans. Amer. Ent. Soc. 29: 326. male.

1917. *Chyphotes heathii* Bradley, Trans. Amer. Ent. Soc. 43: 284. male.

Holotype.—Male, Pacific Grove, California, May, 1901 (H. Heath), in collection of Washington State College, Pullman, Washington.

Distribution.—California (3).

*Heathii* and *bruscus* can be separated from related species by the brush of short, thick, erect hairs on the ventral, inner margins of the meso- and metacoxae and by the absence of a transverse carina before the mesocoxae. The femora and tibiae of *heathii* are infuscated, while those of *bruscus* are concolorous with the body. The genitalia of the two species are distinct, and although the shape of the paramere of *bruscus* is subject to some variation, the structures figured are typical and adequate for separation.

*Chyphotes bruscus* n. sp.

Plate XI, Figure 8

Male: head testaceous, except ocellar region infuscated; area inclosed by ocelli darkest, shading into testaceous laterally at margin of compound eyes and anteriorly almost to base of antennae; flagellum slightly infuscated; scape and pedicel light testaceous, the latter with sparse uneven setae; compound eyes relatively large, emarginate anteriorly around bases of mandibles, frontal and genal margins slightly concave; a deep pit on front between bases of mandibles and antennae; a slight dimple-like pit on frontal midline anterior to anterior ocellus; head subglabrous, sparsely micropunctate, vestiture uneven, light yellow.

low; thorax entirely pale testaceous; pronotum sparsely punctate dorsally becoming impunctate laterally; propleura glabrous with a tuft of setae adjacent to coxae; mesonotal punctation irregular; punctation of mesopleura antero-ventrad regular, sub-contiguous, becoming sparser adjacent to propodeal margin; scutellum impunctate medially, lightly punctate laterally; propodeum sparsely and irregularly punctate, each puncture with a short carina along anterior margin; a raised carina along mid-ventral line between middle and hind coxae, mesosternum and metasternum glabrous; legs pale yellow throughout; middle and hind coxae with a brush of short, thick, erect hairs on ventral, inner margins; first abdominal sternite longer than hind femora, shallowly rugose ventrad; punctation of first abdominal tergite denser and slightly deeper than on second tergite; third abdominal tergite with a piceous or brownish transverse band interrupted medially; entire abdomen covered with moderately dense long, light yellowish pubescence; wings hyaline, with three submarginal cells; cell  $R_5$  receiving both  $m-cu$  and  $M_{3+4}$ ; cell  $R_4$  widest anteriorly; stigma testaceous, wings slightly infumated beyond; length 7.2 mm.

Holotype.—Male: Piñon Flat, California, May 30, 1939 (E. G. Linsley), in collection of Citrus Experiment Station, Riverside, California.

Paratypes.—California: male, Nesperia, Sept. 26, 1937 (E. G. Anderson) (U.M.); 2 males, Piñon Flat, May 30, 1939 (E. G. Linsley) (C.E.S.); male, Riverside, July 7, 1936 (G. P. Engelhardt) (K.V.K.); male, Tehachapi, Aug. 11, 1935 (G. D. Hanna) (C.A.S.); male, Los Gatos, Aug. 1, 1933 (J. A. Kusche) (C.A.S.). Arizona: male, Axtec, Mar. 27, 1934 (P. H. Timberlake) (C.E.S.).

Distribution.—California, Arizona.

Paratypes vary in length from 7.0 to 8.2 millimeters but otherwise agree very well with the holotype. Among the paratypes there is a slight variation in the degree of infuscation of the antennae. The difference in leg color was found to be a valid character in separating *heathii* from *bruscus*. The basiparamere of the male genitalia of *bruscus* is quadrangular, while that of *heathii* is ovoid in outline. Differences in the shape and vestiture of the paramere can also be seen in figures 7 and 8 on plate XI.

*Chyphotes albipes* Cresson

Plant XII, Figure 10

1874. *Agama albipes* Cresson, Trans. Amer. Ent. Soc. 5: 99.  
male.

1875. *Agama albipes* Cresson, Rept. Geogr. and Geol. Explor. and Surv. 100th Merid. 5: 711. male.  
 1886. *Photopsis albipes* Blake, Trans. Amer. Ent. Soc. 13: 268. male.  
 1897. *Mutilla albipes* Dalla Torre, Cat. Hymen. 8: 7. male.  
 1899. *Chyphotes albipes* Fox, Trans. Amer. Ent. Soc. 25: 278. male.  
 1903. *Chyphotes nevadensis* Baker, Invert. Pacifica 1: 118. male.  
 1917. *Chyphotes ablipis* Bradley, Trans. Amer. Ent. Soc. 43: 286. male.

Holotype.—male: Nevada, 1874 (Cresson), type No. 1888.1 in collection of American Entomological Society, Philadelphia, Pennsylvania.

Paratype.—male: Colorado (no date) (Cresson), type No. 1888.2 in collection of American Entomological Society, Philadelphia, Pennsylvania.

Distribution.—Montana (1), Utah (4), Colorado (1), Washington (3), Oregon (3), California (2), Canada (2) (Alberta).

Female: body testaceous, becoming slightly darker toward apex of abdomen; legs infuscated; head testaceous, punctate throughout except for small glabrous area in gular region; punctures shallow, disconnected, interspaces dull; pubescence of head dense, decumbent, buffy yellow; second segment of flagellum very distinctly longer than first, pedicel darker testaceous than flagellum; eyes flattened ventrally, one and one-quarter times as long as wide; thorax entirely testaceous; propleura sparsely, lightly punctate, with a tuft of erect setae adjacent to front coxae; punctures on pronotum circular, deep, separated; anterior half of anterior face of mesopleura glabrous; posterior face of propodeum glabrous, very sparsely punctate; punctation of dorsal, anterior portion of propodeum deep, coarse with a raised carina along posterior edge of each puncture; punctation of mesonotum strong, well defined, similar to pronotum; punctate portion of thorax sparsely clothed with erect and decumbent pubescence; mesosternum with a diagonal carina anterior to and between the middle coxae; a deep pit on mid-ventral line between middle coxae; a raised transverse carina on metasternum anterior to hind coxae; mesosternum and metasternum lightly punctate; anterior portion of first abdominal sternite not covered by tergite, glabrous, terete, slightly curved, meeting the tergite at an obtuse angle; ab-

domen testaceous cephalad, becoming darker testaceous caudad; punctation on second tergite shallow, elongate, well separated; abdominal vestiture semi-erect, decumbent, buffy-yellow; legs infuscated, lightly punctate, sparsely covered with pale, semi-erect setae; length 7.7 mm.

Allotype.—female, Medicine Hat, Alberta, Canada, Aug. 18, 1939 (J. L. Carr), in collection of University of Minnesota, St. Paul, Minnesota.

Although the allotype female was not observed in copulo, it was taken from the same locality as an *albipes* male. Inasmuch as *albipes* is the only species of *Chyphotes* with a distribution which includes Medicine Hat, Alberta, Canada, this female is tentatively designated as the allotype of that species. The males and female are dimorphic but have identical coloration.

I have examined the holotypes of both *albipes* Cresson and *nevadensis* Baker and like Bradley (1917) have been unable to find any significant points of difference between them. The indecision in the literature regarding the identity of *albipes* males has been due to insufficient definition of this species resulting in confusion with *mickeli* subsp. *mickeli* and *mickeli* subsp. *polingi*. Judging from available distribution records, *albipes* seems confined to northwestern United States and southwestern Canada, while *mickeli* is found in southwestern United States. The male genitalia of *albipes* are very distinct from the two subspecies of *mickeli*.

*Chyphotes mickeli* subsp. *mickeli* n. sp. and n. subsp.

Plate XII, Figure 9

Male: head, including ocellar area, entirely testaceous; compound eyes large, emarginate anteriorly around base of mandibles; margin of eyes slightly concave adjacent to front and deeply indentate along genal margin; ocelli very large, posterior ocelli closer to compound eyes than to each other; vestiture of clypeus denser than front; punctation on head very sparse and shallow, surface glabrous; thorax entirely testaceous; pronotal punctation moderately dense dorsally, becoming sparser and irregularly spaced laterally; posterior and ventral margins impunctate; propleura glabrous except for a tuft of setae immediately before coxae; mesonotum with scattered irregular punctures; punctation on mesopleura aciculate, dense, confluent, rather deep anteriorly from base of wings to mid-ventral line, becoming more sparsely punctate adjacent to coxae and propodeum; propodeum irregularly reticulate medially,

with a fine seta arising from anterior edge of each mesh; laterally, propodeal reticulation fuse into deep punctures; mesosternum with a transverse carina before each middle coxa; tooth or tubercle before and between hind coxae absent or vestigial, not peg-like; legs pale yellow throughout, lighter than body; abdomen testaceous; first abdominal sternite distinctly longer than hind femora, with weakly defined, elongate meshes caudad; first abdominal tergite strongly, confluent punctate, each puncture surrounded by a raised lip, higher along anterior margin; punctation on second abdominal tergite very shallow but regularly spaced; abdominal segments posterior to second lightly and shallowly punctate; abdominal pubescence moderately dense, grayish white; wings hyaline, slightly infumated beyond stigma, with three submarginal and two discoidal cells; vein  $R_5$  divergent above, making cell  $R_5$  widest anteriorly; stigma infuscated; length 10.8 mm.

Holotype.—Male, Palm Springs, California, March 3, 1933 (T. Zschokke), in collection of University of Minnesota, St. Paul, Minnesota.

Paratypes.—California: Palm Springs, 3 males, March 3, 1933; 46 males, March 28, 1933; 32 males, April 9, 1933; 15 males, April 13, 1933; 19 males, April 15, 1933; 24 males, April 23, 1933; 5 males, April 26, 1933; 2 males, April 29, 1933; at light, 19 males, May 1, 1933; 5 males, May 2, 1933; 13 males, May 4, 1933; 7 males, May 6, 1933; 7 males, May 7, 1933; 2 males, May 12, 1933; 8 males, May 13, 1933; 14 males, May 14, 1933; 9 males, May 15, 1933; 24 males (May), 1933; 2 males, Nov. 22, 1932; 14 males, Fall, 1932 (T. Zschokke) (U.M.); male, Indio, May 1–2, 1918 (S. C. Bradley) (C.U.); male, Riverside Co., Snow Creek Canyon, March 25, 1935 (C. Brown) (C.B.); male, Benton, 56,000 ft. elev., Sept. 1, 1937 (E. G. Anderson) (U.M.); male, Omo Ranch, July 18, 1925 (C. C. Wilson); male, Kramer Hills, April 7, 1934 (S. W. Haver) (C.B.S.); male, Victorville, May 19, 1935 (C. M. Dammers) (U.M.). New Mexico: male, Mesilla Park, at light, Sept. 22 (Cockerell) (U.M.). Arizona: 4 males, Yuma, April 15, 1938; 2 males, Wellton, April 14, 1938 (F. H. Parker) (U.M.); male, May 5, 6, 1918 (J. C. Bradley) (C.U.); 2 males, Willton, April 23, 1935 (F. H. Parker); male, June 23, 1935 (U.M.); male, Maricopa, Pinal Co., Oct. 17, 1927 (J. A. Kusche) (C.A.S.). Mexico: Lower California: male, 45 miles north of San Ignacio, July 27, 1938 (Michelbacher, Ross) (C.A.S.).

Distribution.—California, New Mexico, Arizona, Mexico (Lower California).

The presence of a pair of peg-like teeth anterior to and between the hind coxae readily distinguish *mickeli* from *albipes*, its closest relative. The male genitalia of the two species are very distinct. In addition, *albipes* seems confined to northwestern United States and southwestern Canada, while *mickeli* is found only in Texas and southwestern United States and northern Mexico. This species has been respectfully dedicated to Dr. Clarence E. Mickel.

***Chyphotes mickeli* subsp. *polingi* n. sp. and n. subsp.**

Male: head and antennae testaceous; ocelli large, posterior two closer to compound eyes than to each other; punctation of head shallow, sparse, irregular; thorax entirely testaceous, sparsely covered with grayish white pubescence; legs testaceous, concolorous with body; a low transverse carina before middle coxae; a tooth or tubercle in front of and between hind coxae; abdomen light testaceous cephalad, becoming slightly darker caudad; length 9.8 mm.

Holotype.—male: Ft. Davis, Texas, Jeff Davis Co., 6000 ft. (elev.), Davis Mts. Nov. 1–15, 1927 (O. C. Poling), in collection of Oregon Agricultural College, Corvallis, Oregon.

Paratypes.—Ft. Davis, Texas, Jeff Davis Co., 6000 ft. (elev.), Davis Mts., 38 males Nov. 1–15, 1927; 4 males “July–Aug. 1927 and 1928” (O. C. Poling) (O.A.C.); male, Nov. 1–15, 1927 (O. C. Poling) (K.V.K.).

Distribution.—Texas.

*Polingi* differs from the subspecies *mickeli* only in that the legs of the former are testaceous and concolorous with the body, while the legs of the latter are pale yellow and lighter than the body. The teeth or tubercles anterior to the hind coxae show slightly greater development in *polingi* than in *mickeli*, but are not peg-like as in *albipes*. Available distribution records indicate that these two subspecies have distinct geographical distributions. As the male genitalia of *mickeli* subsp. *mickeli* and *mickeli* subsp. *polingi* are identical, only the former has been figured. All the *polingi* type material was collected by Mrs. O. C. Poling, to whom this subspecies is dedicated.

*Chyphotes calxicensis* Bradley

1927. *Chyphotes calxicensis* Bradley, Trans. Amer. Ent. Soc. 43: 284. male.

Holotype.—male: Calxico, California, Aug. 11, 1914 (J. C.

Bradley), in collection of Cornell University, Ithaca, New York, type No. 127.1.

I have examined the holotype of *calexicensis* and agree with Bradley that it is worthy of specific rank. This unique is considered most closely related to *melaniceps*, but I have been unable to find additional specimens in a long series of the latter species. The globose first abdominal tergite is very distinctive and adequately separates this species from *melaniceps*. The genitalia of *calexicensis* have not been examined.

*Chyphotes melaniceps* (Blake)

Plate XI, Figure 5

1886. *Photopsis melaniceps* Blake, Trans. Amer. Ent. Soc. 13: 264. male.  
 1895. *Photopsis belfragei* var. *melaniceps* Cockerell, Trans. Amer. Ent. Soc. 22: 291. male.  
 1897. *Mutilla melaniceps* Dalla Torre, Cat. Hymen. 8: 60. male.  
 1899. *Chyphotes melaniceps* Fox, Trans. Amer. Ent. Soc. 25: 277. male.  
 1903. *Chyphotes piceiceps* Baker, Entomologica Pacifica 1: 116. male. (New synonymy).  
 1917. *Chyphotes melaniceps* Bradley, Trans. Amer. Ent. Soc. 43: 287. male.

Holotype.—Male: Arizona (type locality as given by Blake but type specimen bears no locality label) (C. A. Blake), in collection of American Entomological Society, Philadelphia, Pennsylvania.

Distribution.—California (158), Arizona (461), New Mexico (6), Texas (90), Utah (4), Nevada (1), Idaho (1), Oregon (1), Mexico (Coahuila) (3).

The holotype of this species and *Chyphotes piceiceps* Baker have been examined and as no essential differences between the two could be found, I am forced to the conclusion that the two species are synonymous. Unfortunately Baker (1903) did not have the holotype of *melaniceps* at hand when describing his species. Bradley (1927) does not include *piceiceps* in his discussion of the species of *Chyphotes*. The characters employed in the key to species of males very adequately separate it from all related species. The male genitalia of this species are distinctive, and the structure figured on plate XI is typical. A large series of genitalia was extracted, mounted, and studied, but no variation outside that considered normal was detected.

*Chyphotes belfragei* Blake

Plate XIII, Figure 11

1871. *Agama Belfragei* Blake, Trans. Amer. Ent. Soc. 3: 263. male.  
 1886. *Photopsis Belfragei* Blake, Trans. Amer. Ent. Soc. 13: 263. male.  
 1895. *Photopsis belfragei* Cockerell, Trans. Amer. Ent. Soc. 22: 291. male.  
 1896. *Sphaerophthalma frugala* Cameron, Biol. Centr. Amer. 2: 394. male.  
 1897. *Mutilla Belfragei* Dalla Torre, Cat. Hymen. 8: 15. male.  
 1899. *Chyphotes Belfragei* Fox, Trans. Amer. Ent. Soc. 25: 277. male.  
 1903. *Chyphotes Belfragei* Melander, Trans. Amer. Ent. Soc. 29: 326. male.  
 1917. *Chyphotes belfragei* Bradley, Trans. Amer. Ent. Soc. 43: 287. male.

Holotype.—Male: Texas (no date) (Belfrage), type no. 4590 in the collection of the American Entomological Society, Philadelphia, Pennsylvania.

Distribution.—Texas (112), Arizona (106), New Mexico (11), Mexico (4), Kansas (7), Colorado (2).

*Belfragei* is the only species in the *belfragei* group (front wings with two submarginal cells) which has infuscated femora and tibiae. Specimens from Texas had, in most cases, both the femora and tibiae quite dark, while those specimens from New Mexico and Arizona were more testaceous. However, all gradations were noted, and the distinction was not considered adequate for subspecific ranking.

*Chyphotes peninsularis* Fox

Plate XIII, Figure 12

1899. *Chyphotes peninsularis* Fox, Trans. Amer. Ent. Soc. 25: 277. male.  
 1917. *Chyphotes peninsularis* Bradley, Trans. Amer. Ent. Soc. 43: 284. male.

Holotype.—Male, Lower California (no date), type no. 4664 in collection of American Entomological Society, Philadelphia, Pennsylvania.

Distribution.—California (30), Arizona (8), Mexico (31) (Lower California).

Although *peninsularis*, *jugatus*, and *californicus* are closely related, the former can be separated from the latter two species by the characters given in the key. In the male genitalia, differences are found in the shape of the paramere, digitus, and cuspis. The most striking difference occurs in the size of the genitalia, that of *peninsularis* being about three-fifths as long as that of *jugatus* and *californicus*.

### *Chyphotes jugatus* n. sp.

Male: head testaceous, antennae light yellow, pedicel with sparse irregular setae, scape and flagellum with short, dense, semi-erect pubescence; punctation on head moderately deep, evenly spaced; gular area shining, glabrous; compound eyes ovate, posterior ventral edge sharply immarginate, anterior edge reaching bases of mandibles; ocelli prominent, posterior two closer to compound eyes than to posterior margin of head; vestiture of head sparse, long, whitish; thorax testaceous; pronotum and mesonotum evenly, moderately densely punctate, becoming slightly coarser laterally; propleura glabrous anteriorly, posterior portion with a tuft of whitish erect hairs; mesopleura with deep, coarse, but even spaced punctation; propodeal reticulations large, irregular, with high margins medially, becoming smaller, more rounded and puncture-like laterally; posterior two-thirds of mesosternite shallowly concave; anterior edge of concavity closed by two horizontal teeth extending from each side of the mesosternum apices of teeth meet at mid-ventral line; lateral margins of concavity defined by a pair of weak oblique carinae; punctation sparser, less coarse in concavity than on surrounding mesosternum; very sparsely punctured to glabrous medially; transverse carina anterior to mesocoxae very weakly defined; a deep pit present on mid-ventral line just anterior to transverse carina; teeth anterior to and between hind coxae weakly developed; medio-ventral carina between meso- and meta-coxae well developed; punctation on metanotum confluent, moderately coarse, metapleura irregularly reticulate; legs light testaceous, covered with long, whitish, irregularly erect setae; abdomen dark testaceous throughout, covered with long, erect whitish hairs, becoming denser toward apex of abdomen; first abdominal tergite inflated, densely covered with coarse confluent punctures; first abdominal sternite coarsely punctate throughout with a distinct longitudinal carina along mid-ventral line of posterior one-sixth of segment; punctation

on second abdominal segment evenly spaced, moderately deep but elongate, with the anterior edge of each puncture higher than the posterior edge; sternite with wide central longitudinal groove; third abdominal segment lightly, irregularly, punctate and segments posterior to third glabrous; wings hyaline, with two submarginal cells.

Holotype.—Male, 25 miles south of Santa Rosalia, Lower California, Mexico, July 25, 1938 (Michelbacher and Ross), in collection of California Academy of Sciences, San Francisco, California.

Paratypes.—California: Male, Riverside, at light, July 11, 1933; male, Sept. 9, 1933 (S. Flanders) (C.E.S.); 6 males, San Diego (no date) (L. E. Ricksecker) (U.S.N.M.). Mexico: Lower California: 9 males, Mesquital, July 28, 1933; 5 males, Miraflores, July 8, 1938; 2 males, 5 miles south of Miraflores, July 10, 1938; 7 males, 5 miles west of San Bartolo, July 13, 1938; 5 males, Triunfo, July 7, 1938; 2 males, 25 miles south of Santa Rosalia, July 25, 1938; 2 males, Santiago, July 8, 1938; male Chapala Dry Lake, June 21, 1938; male, 7 miles south of El Marmol, June 18, 1938; male, 15 miles north of El Refugio, July 4, 1938; male, Venancio, July 17, 1938 (Ross and Michelbacher) (C.A.S.).

Distribution.—California, Mexico (Lower California).

This species is most closely related to *californicus*, from which it has been distinguished on the basis of morphological characters on the mesosternum. The male genitalia of *jugatus* have not been figured because they are essentially identical with *californicus*. Some variation occurs in the shape of the paramere, and there seems to be a general tendency for the spines on the distal, ental surface of the squamae to be longer in *jugatus* than in *californicus*. In spite of the similarity between the male genitalia, the external morphological differences between the two groups have been considered sufficient to justify delineating *jugatus* as a separate species.

### *Chyphotes californicus* Baker

#### Plate XIII, Figure 13

1903. *Chyphotes californicus* Baker, Invert. Pacifica. 1: 117. male.

1917. *Chyphotes californicus* Bradley, Trans. Amer. Ent. Soc. 49: 287. male.

Holotype.—Male, Claremont, California (no date) (C. F. Baker) (Type No. 4047 in collection of Pomona College, Claremont, California).

Distribution.—California (29), Mexico (22) (Lower California).

*Chyphotes subulatus* n. sp.

## Plate X, Figure 1

Male: head testaceous except ocellar area slightly infuscated; compound eyes shiny black, oval, distinctly faceted, approaching base of mandibles apicad; antennae infuscated, pedicel with sparse uneven whitish pubescence; a deep pit on front between antennal socket and base of mandibles; a pit on mid-frontal line anterior to anterior ocellus; ocelli prominent, lateral ocelli equidistant from compound eyes and posterior margin of head; punctation of head shallow and sparse, each puncture bearing a short pale yellow seta; punctation on pronotum shallow, moderately dense, propleura glabrous, with a tuft of erect whitish setae adjacent to coxae; interspaces between punctures on mesonotum greater than on pronotum; pubescence similar to pronotum but shorter and sparser; mesopleura densely and regularly punctate; propodeal reticulations weak, meshes elongate, imperfectly defined, sparsely pubescent; mesosternum with a transverse carina anterior to each coxa; a weak carina on mid-ventral line between middle and hind coxae; vestigial tubercles anterior to and between hind coxae; first abdominal sternite testaceous, as long as proximal segment of middle tarsus; first abdominal tergite infuscated, only slightly inflated, punctation light; except for first sternite, abdomen piceus, pubescence decumbent, whitish longer than that of thorax; second abdominal sternite with a median longitudinal groove; middle and hind tibiae piceus, all tarsi and forelegs dark testaceous; legs clothed with short decumbent and longer erect whitish setae; wings hyaline, with one discoidal and two submarginal cells; vein r confluent with  $R_5$ ; stigma piceus.

Holotype.—Male, Santa Rita Mountains, Arizona. June 21, 1935 (F. H. Parker), in collection of the University of Minnesota, St. Paul, Minnesota.

Paratypes.—2 males, Carr Canyon, Huachuca Mountains, Cochise Co., Arizona, Aug. 1905 (H. Skinner) (A.E.S.); 2 males, Bar Foot Ridge, Cochise Co., Chiricahua Mts., 8500–9700 ft. elev., Aug. 5, 1927 (J. A. Kutsche) (C.A.S.).

Distribution.—Arizona.

This species can readily be differentiated from *attenuatus*, its closest relative, by the black abdomen. The distribution of this species as determined from the small number of specimens on hand is limited to Arizona.

The male genitalia of *subulatus* and *attenuatus* are distinct and may be distinguished as follows: the basiparamere of the male genitalia of *subulatus* is as wide as or wider than it is long, while the basiparamere of *attenuatus* is distinctly longer than wide. *Attenuatus* has four stout sickle or "question mark" shaped hairs on the distal, ental margin and a series of eight short, curved spike-like spines on the distal, ental surface of each paramere. The short, spike-like spines are absent from the paramere of *subulatus*, and the stout hairs along the distal, ental margin number ten to twelve and are straight or irregularly curved.

*Chyphotes attenuatus* (Blake)

Plate X, Figure 2

1872. *Agama attenuata* Blake, Trans. Amer. Ent. Soc. 4: 76. male.  
 1886. *Photopsis attenuata* Blake, Trans. Amer. Ent. Soc. 13: 264. male.  
 1886. *Photopsis mellipes* Blake, Trans. Amer. Ent. Soc. 13: 262. male.  
 1895. *Photopsis picus* Cockerell, Trans. Amer. Ent. Soc. 22: 292. male.  
 1897. *Mutilla picus* Dalle Torre, Cat. Hymen. 8: 73. male.  
 1897. *Mutilla tenula* Dalle Torre, Cat. Hymen. 8: 91. male.  
 1899. *Chyphotes attenuata* Fox, Trans. Amer. Ent. Soc. 25: 278. male.  
 1903. *Chyphotes attenuatus* Melander, Trans. Amer. Ent. Soc. 29: 326. male.  
 1903. *Typhoctes attenuatus* Andre, Genera Insect. fasc. 11: 11. male.  
 1917. *Typhoctes attenuatus* Bradley, Trans. Amer. Ent. Soc. 43: 288. male.

Holotype.—Male, Texas (no date) (Belfrage), type No. 4592 in collection of American Entomological Society, Philadelphia, Pennsylvania.

Distribution.—Arizona (343), New Mexico (21), Texas (38), Nevada (1), Kansas (8), Oregon (2), California (1), Mexico (4).

The holotype of *Chyphotes attenuatus* (Blake), *mellipes* (Blake), and *picus* (Cockerell) have been examined and the justification for the inclusion of the latter two in the synonymy of *attenuatus* by earlier authors has been confirmed. The generic affinities of this species have been discussed in a previous section of this paper. The key to species of males adequately separates this species from

related forms. *Attenuatus* has a wide distribution, ranging from Oregon on the north, through California to northern Mexico on the south, and east to Texas and western Kansas.

The male genitalia of *attenuatus* most closely resembles those of *subulatus*, and characters aiding in their separation have been given under the discussion of the latter species.

### *Chyphotes pallidus* n. sp.

#### Plate X, Figure 4

Male: head and antennae pale yellow; compound eyes ovoid, anterior margin touching bases of mandibles; a slight emargination on compound eye adjacent to front, and a deeper, more angulate emargination along genal margin; ocelli prominent, very pale orchid, with area enclosed by ocelli slightly raised; head very sparsely covered with shallow punctures, each bearing a yellowish semi-erect or decumbent seta; interspaces glabrous; a shallow pit on front anterior to anterior ocellus; a pit on each side of front between base of mandibles and antennae; pronotum with very sparse shallow punctation, carinae defining edges smooth, impunctate; punctation on mesonotum slightly denser than on pronotum; propleura glabrous, with a tuft of pale yellow setae before coxae; anterior portion of mesopleura densely covered with irregular punctures becoming elongate adjacent to propodeum; propodeal surface weakly reticulate, meshes elongate; mesosternum with a transverse carina produced to a tubercle before each mesocoxa; metasternum with a tubercle before each metacoxa; a weak carina along mid-ventral line between middle and hind coxae; entire thorax light yellow and sparsely clothed with fine, light yellow pubescence; first abdominal tergite only moderately inflated, punctures shallow, contiguous, sloping obliquely caudad; vestiture rather dense, long, erect, light yellow; abdominal segments posterior to first with irregular shallow oblique punctures; vestiture of abdomen very pale yellow, moderately dense; abdomen light yellow, apical four segments slightly darker than terminal segments; legs very light yellow throughout, clothed with decumbent and semi-erect, pale pubescence; wings hyaline, stigma pale yellow, with first discoidal cell only; length 9.2 mm.

Holotype.—Male, Palm Springs, California, at light, May 13, 1933 (T. Zschokke), in collection of University of Minnesota, St. Paul, Minnesota.

Paratypes.—California: male, Palm Springs, light trap. Sept. 15–Oct. 15, 1932; male, April 15, 1933; male, April 23, 1933; 4 males, May 4, 1933; 2 males, May 13, 1933; 2 males, May 14, 1933; male, May 15, 1933; 2 males, Fall, 1932 (T. Zschokke) (U.M.); Vallecitos, San Diego Co., 4 males, Sept. 27, 1936 (C. M. Dammers) (C.M.D.); male, Piñon Flat, San Jacinto Mts., May 29, 1939 (M. A. Cazier) (M.A.C.); 2 males, Dead Indian Creek, at light, April 25, 1936 (P. H. Timberlake) (C.E.S.); male, Das Plumas River, April 24, 1933 (G. E. Bohart) (G.E.B.); male, Coachella, May 2, 1918 (J. C. Bradley); male, Thermal River Co., 100 ft. below tide, Aug. 17–18, 1927 (C.U.). Arizona: 11 males, Ajo, April 25, 1935; 25 males, Coldwater, April 17, 1938; 19 males, Gila Bend, April 14, 1938; 4 males, April 25, 1935; male, Ehrenberg, June 2, 1938; male, June 4, 1938; male, July 28, 1938; male, April 19, 1939; male, April 21, 1939; 8 males, April 27, 1939; male, Prescott, Aug. 16, 1939; 2 males, Yuma, April 15, 1938; 2 males, Willton, April 23, 1935; male, Palo Verde, April 21, 1935; 5 males, Wellton, April 14, 1938 (F. H. Parker) (U.M.); 31 males, Wellton, Yuma Co., May 5–6, 1918 (J. C. Bradley); male, Aug. 9, 1917; male, Palomas, Yuma Co., Aug. 8, 1917 (Cornell Univ. Biol. Exp.) (C.U.); male, Phoenix, July 15, 1939 (A. H. Caldwell) (A.H.C.); male, Maricopa, Pinal Co., Oct. 17, 1927 (J. A. Kusche) (C.A.S.). New Mexico: male, Jemez Springs, 6400 ft. elev., Aug. 24, 1916 (J. Woodgate) (C.U.). Texas: male, Uvalde, May 19, 1918 (J. C. Bradley) (C.U.).

Distribution.—California, Arizona, New Mexico, Texas.

*Pallidus* is more distantly related to *attenuatus* than *subulatus*, and in this respect stands alone in the *attenuatus* group of males. The most outstanding characteristic of *pallidus* is its general lack of pigmentation. The paratypes vary in length from 7.2 to 10 millimeters and agree very well with the holotype.

The male genitalia of *pallidus* possess a rather large, thick cuspis and a brush-like pad of short, straight hairs, hooked at the tip, at the base of each digitus. No long hairs are present on the distal, ental margin of the paramere, but a group of ten to twelve short, stout hairs with slender curved tips are present on the distal, ental surface of each paramere.

### *Chyphotes pixus* n. sp.

Female: body pale testaceous throughout; head subovate, slightly narrower than widest part of thorax; compound eyes ovate, one and a half times as long as wide, width equal to length

of pedicel; first segment of flagellum distinctly shorter than second segment; head irregularly covered with sparse, shallow punctures; propleura impunctate, with a tuft of pale erect setae adjacent to anterior coxae; pronotum irregularly punctate; mesothorax completely fused with metathorax and propodeum; anterior face of mesopleura impunctate; posterior face of propodeum faintly striate, striae parallel to posterior edge of propodeum and fading laterally above middle coxae; dorsal and lateral surface of fused posterior segments of thorax exclusive of striate portions, sparsely punctate, each puncture bearing a pale erect seta; punctation on pronotum and on dorsal portion of fused posterior segments of abdomen, similar; anterior portion of first abdominal sternite slender, sub-terete, angle at junction of first abdominal tergite and sternite obtuse; first tergite lightly, irregularly punctate; second abdominal segment with more regularly spaced punctures, coarser than on other abdominal segments; vestiture of abdomen sparse, pale yellow; abdomen light testaceous anteriorly, becoming slightly darker posterior to second segment; legs pale yellow, sparsely covered with pale semi-erect setae; length 3.8 mm.

Holotype.—Female, Gila Bend, Arizona, April 16, 1938 (F. H. Parker), in collection of University of Minnesota, St. Paul, Minnesota.

Unfortunately this species is known only from a single specimen, but characters given in the key to species of females are adequate for separating it from *segregatus*, its nearest relative. This species may prove to be the female of *pallidus*.

### *Chyphotes striatus* n. sp.

Female: body dark testaceous, third abdominal tergite infuscated, legs concolorous with body; second segment of flagellum shorter than first; compound eyes ovoid, one and a quarter times as long as wide; entire head coarsely, confluent punctate, covered with short, pale yellow, semi-erect and decumbent pubescence; propleura with a tuft of erect setae adjacent to the anterior coxae; entire pronotum coarsely, confluent punctate; anterior one-half of anterior face of mesopleura impunctate; extreme posterior face of propodeum very distinctly striate, striae parallel with posterior edge of propodeum, extending laterally to the region dorsad of the middle coxae; striations composed of six ridges along mid-dorsal line, and

eight ridges laterad; non-striate dorsal portion of the fused segments of the thorax very coarsely, confluent punctate, similar to pronotal punctation; punctate portions of thorax covered with moderately dense, short, light, semi-erect and decumbent vestiture; striate areas without setae; anterior portion of first abdominal sternite glabrous, terete, fusing with tergite at an obtuse angle; punctures on first abdominal tergite coarse and subcircular; second abdominal segment with punctures distinctly elongate, the deepest portion of each puncture at its anterior end, becoming gradually shallower caudad; punctation shallower and sparser on third abdominal segment and obsolete from fourth to last segments of abdomen; abdominal vestiture moderately dense, pale yellowish; abdomen testaceous except third tergite very dark brown to blackish; legs testaceous, slightly lighter than body; length 4.7 mm.

Holotype.—Female, Tucson, Arizona, Oct. 10, 1939 (O. Bryant), in collection of University of Minnesota, St. Paul, Minnesota.

Paratype.—Female, Wickenburg, Arizona, Aug. 20, 1938 (D. J. Knull and J. N. Collrs) (O.S.U.); female, Ft. Grant, Arizona, Oct. 7 (H. G. Hubbard) (A.E.S.).

Distribution.—Arizona.

This species may easily be distinguished from any other member of the *striatus* group of females by the distinct black band on the third abdominal tergite. The paratypes are 4.3 and 4.8 millimeters long, with the black band on the third abdominal tergite of the Ft. Grant paratype slightly lighter than in the holotype.

### *Chyphotes punctatus* Fox

Holotype.—Female, Chirix Mts., Arizona, July 29 (H. H. Hubbard), in the collection of United States National Museum, Washington, D. C.

The holotype of this species has not been examined, but Miss Grace Sandhouse of the United States National Museum was kind enough to compare this type with specimens of related species which were supplied. Miss Sandhouse suggested characters which could be used to place *punctatus* in a key which had been prepared to include all known species of *Chyphotes* females. Unfortunately no other specimens of this species were available for study.

### *Chyphotes segregatus* n. sp.

Female: body light testaceous, third abdominal tergite slightly darker than remainder of abdomen; head light testa-

ceous, sparsely covered with light decumbent pubescence; second segment of flagellum slightly longer than first; compound eyes ovoid, one and a third times as long as wide, greatest diameter equal to length of pedicel; punctures on head separated, shallow, with margins poorly defined, interspaces dull; thorax light testaceous throughout; pronotum densely covered with coarse, deep punctures; margins and interspaces between punctures dull; ventral, lateral margins of pronotum impunctate; anterior one-half of anterior face mesopleura impunctate; striae along posterior edge of propodeum not continuous and only roughly parallel with posterior edge; total width of striated area less along mid-dorsal line than laterad above middle coxae; lateral striae terminate above middle coxae; non-striate portion of fused posterior segments of thorax coarsely punctate, similar in character and intensity to punctation of pronotum; dorsum of thorax sparsely covered with long, erect and short, decumbent, whitish hairs; abdomen light testaceous except third abdominal tergite slightly darker testaceous; anterior portion of first abdominal sternite glabrous, terete, with a sparse ring of short, light setae adjacent to propodeum; first abdominal tergite fusing with first sternite at an obtuse angle; second abdominal segment with shallow, somewhat elongate punctures, much finer than those on thorax; punctation of first tergite slightly lighter than that of second tergite; abdomen covered with moderately dense long erect and short decumbent, silky whitish hairs; legs light yellow, slightly paler than body; length 4.2 mm.

Holotype.—Female, Sierra Blanca, Texas, July 8, 1917 (J. C. Bradley), in collection of Cornell University, Ithaca, New York.

Paratypes.—4 females, Sierra Blanca, Texas, July 8, 1917 (J. C. Bradley) (C.U.); female, Prescott, Arizona, under stone, Aug. 30, 1936 (O. Bryant) (O.B.); female, Santa Rita Mts., Arizona, May 21 (E. A. Schwarz) (U.S.N.M.).

Distribution.—Texas, Arizona.

*Segregatus* has a light testaceous body, distinguishing it from *striatus* and *punctatus*, which have reddish-testaceous bodies. The legs of *punctatus* are reddish-testaceous, while those of *segregatus* are pale testaceous, lighter than the body. The paratypes range in length from 3.7 to 5.1 millimeters, and other than a slight variation in the degree of infuscation of the third abdominal tergite, are in agreement with the holotype.

*Chyphotes epedaphus* n. sp.

Female: body and legs light testaceous throughout; second segment of flagellum distinctly longer than second segment, antennae slightly lighter than head; eyes ovoid, flattened slightly along ventral margin, one and one-fourth times as long as wide; punctures on head very shallow, poorly defined, interspaces dull; vestiture of head moderately dense, appressed short, light yellow; pronotal punctation shallow, contiguous, becoming impunctate along latero-ventral margins; two-thirds of anterior face of mesopleura impunctate, dull; extreme posterior and posterior-lateral face of propodeum more or less impunctate; punctures on fused mesonotum and metanotum-propodeum similar to those on pronotum but becoming larger and coarser caudad with the posterior edge of each puncture raised; a very short diagonal carina on mesosternum anterior to and between middle coxae; a raised transversely flattened carina on metasternum immediately anterior to each hind coxa; mesosternum and metasternum with fine, contiguous punctures; anterior portion of first abdominal sternite glabrous, terete, slightly curved, fusing with tergite at a broadly obtuse angle; punctation on abdomen very light, almost obsolete; abdomen uniformly light testaceous, rather densely covered with long, decumbent and semi-erect shiny yellow hairs; legs very pale yellow, sparsely clothed with pale semi-erect hairs; length 5.1 mm.

Holotype.—Female, Palm Springs, California, May 2-7, 1933 (Theo. Zschokke), in collection of University of Minnesota, St. Paul, Minnesota.

Paratypes.—California, 8 females, Palm Springs, May 2-7, 1933; female, at light, May 13, 1933; 4 females, May 14, 1933 (Theo. Zschokke); female, Essex, California, April 29, 1937 (H. B. Leech) (U.M.). Arizona: 2 females, Coldwater, April 17, 1938; female, Wilton, April 23, 1935 (F. H. Parker) (U.M.); female, Tucson, Aug., 1935 (O. Bryant) (O.B.).

Distribution.—California, Arizona.

The closest relative of *epedaphus* is probably *albipes*. Each species has a distinct geographical range and, in addition, may be separated on the basis of difference in leg color. The holotype of *epedaphus* is 5.4 millimeters long and somewhat smaller than the average for the type series which ranges from 5.1 to 6.8 millimeters.

*Chyphotes elevatus* Blake

1886. *Chyphotes elevatus* Blake, Trans. Amer. Ent. Soc. 13:  
276. female.

1899. *Chyphotes elevatus* Fox, Trans. Amer. Ent. Soc. 25:  
275. female.

Holotype.—Female, Arizona (no other data), type No. 4589 in collection of American Entomological Society, Philadelphia, Pennsylvania.

Distribution.—Arizona (5), Colorado (10), Texas (1), New Mexico (1).

This species, the genotype of the genus *Chyphotes*, may readily be distinguished from related species by the infuscated femora, tibiae, and third abdominal tergite. The female species *elevatus* will probably eventually be associated with the male *belfragei*.

*Chyphotes testaceipes* Fox.

Holotype.—Female, Phoenix, Arizona (H. G. Griffith), type No. 4662, in collection of American Entomological Society, Philadelphia, Pennsylvania.

Distribution.—Arizona (3).

The inner edges of the tooth-like carinae anterior to and between the hind coxae are acutely V-shaped and the vestiture light yellow in *testaceipes*. The inner edges of the metasternal teeth are broadly V- or U-shaped, and the pubescence on the dorsal surfaces of the body is golden yellow in *auripilus*, its nearest relative.

*Chyphotes auripilus* n. sp.

Female: body and legs testaceous throughout; first segment of flagellum distinctly longer than second, entire antenna concolorous with head; compound eyes ovoid, slightly flattened ventrally, one and one-quarter times as long as wide; entire head punctate except gular region glabrous, punctures shallow but contiguous; vertex and front clothed with moderately dense, decumbent, golden yellow pubescence; clypeus and genae with sparse pale decumbent setae; propleura impunctate, sparsely pilose cephalad but with a tuft of erect setae adjacent to front coxae; pronotal punctation rather deep but margins of punctures rounded and poorly defined; dorsal portion of pronotum covered with two types of pubescence, pale sparse erect, and moderately dense appressed golden yellow vestiture; fused posterior segments of thorax punctate throughout; punctures along extreme posterior face of propodeum larger, with the

posterior edges raised and arranged in irregular transverse rows, with the raised posterior edges more or less confluent; mesosternum with a short diagonal carina anterior to and between the middle coxae; metasternum with a raised, transversely flattened carina before each hind coxa; mesosternum and metasternum coarsely, confluent punctate; anterior portion of first abdominal sternite glabrous, terete, fusing with first tergite at a ninety degree angle; punctures on second abdominal segment sub-ovate, deeper at anterior end, separated; punctation becoming much lighter on segments caudad of second; first, second, and third abdominal tergites covered pale, long, and semi-erect and short, decumbent, golden pubescence; legs testaceous, sparsely covered with pale, semi-erect hairs; length 8.8 mm.

Holotype.—Female, Riverside, California, April 12, 1934 (C. M. Dammers), in the collection of the University of Minnesota, St. Paul, Minnesota.

Paratypes.—Female, Los Angeles Co., California, July (no year) (Coquillett) (U.S.N.M.); female, California (no other data) (A.E.S.).

Distribution.—California.

The most distinguishing character of this species is the bright golden yellow pubescence on the dorsal part of the head, thorax, and first three abdominal segments. Other characters given in the key also separate it from related species.

### *Chyphotes petiolatus* Fox

1899. *Chyphotes petiolatus* Fox, Trans. Amer. Ent. Soc. 25: 277. female.

Holotype.—Female, So. (uthern) Cal. (ifornia), Cresson (no other data), in collection of American Entomological Society, Philadelphia, Pennsylvania.

Distribution.—California (11), Arizona (5), Texas (3).

This species has some nocturnal habits, having been taken at night with a flashlight and by a campfire. The characters employed in the key adequately separate it from related species.

### *Chyphotes pilosus* n. sp.

Female: head testaceous, coarsely, confluent punctate; vestiture of head moderately dense, pale yellow, decumbent and semi-erect; antennae paler testaceous than head, first segment of flagellum only slightly longer than second segment;

compound eyes ovate, flattened along ventral margin, one and one-sixth times as long as wide; thorax dark testaceous, vestiture moderately abundant, decumbent and semi-erect, light yellow; propleura sparsely punctate anteriorly with a loose tuft of erect setae adjacent to front coxae; pronotum and fused posterior segments of thorax very coarsely punctate; punctures adjacent to posterior margin of propodeum somewhat deeper, more separated than along anterior margin; a raised oblique carina just anterior to mesocoxal cavity; a transverse incisor-like carina anterior to each hind coxa; ventrum with a deep pit on midline just anterior to middle coxae; mesosternum and metasternum coarsely punctate throughout; abdomen dark testaceous, vestiture long dense, silky, pale yellow, anterior portion of first abdominal sternite very lightly punctate, with an irregular ring of erect setae around extreme anterior end; first tergite broad, densely, coarsely, punctate; first sternite with a deep ninety degree notch at junction with tergite; punctures on second tergite elongate, deeper anteriorly; punctation on second sternite coarser, denser along lateral and posterior margins; punctation on third tergite similar to second; vestiture on third, fourth, and fifth abdominal segments confined to posterior edges; punctation much reduced and present only on extreme posterior edges; anterior portion of sternites of third through sixth abdominal segments glabrous, with the extreme anterior area very faintly transversely striate; legs lighter testaceous than thorax, sparsely covered with pale setae; length 8.4 mm.

Holotype.—Female, Todos Santos, Lower California, Mexico, July 15, 1938 (Michelbacher and Ross), in collection of California Academy of Science, San Francisco, California.

Paratype.—Female, Todos Santos, Lower California, Mexico, July 15, 1938 (Michelbacher and Ross), in collection of University of Minnesota, St. Paul, Minnesota.

Distribution.—Mexico (Lower California).

Both the holotype and paratype females were taken from under the same comchip with males (not in copulo, however). These males have been identified as *jugatus*. It is not believed that this is sufficient evidence to justify associating *pilosus* and *jugatus*, especially in view of the very close relationship existing between *jugatus* and *californicus*. Eventually the female *pilosus* will probably be associated with one of the latter two species of males.

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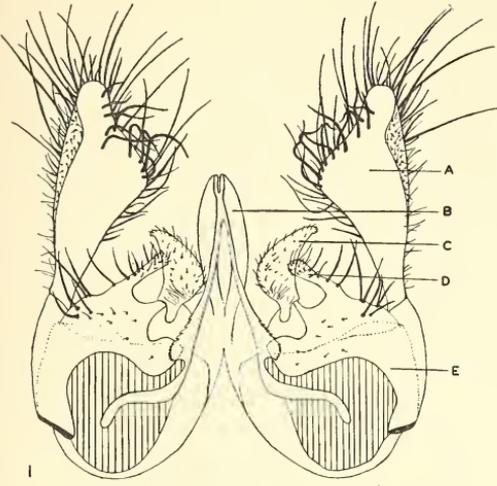
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EXPLANATION OF PLATES

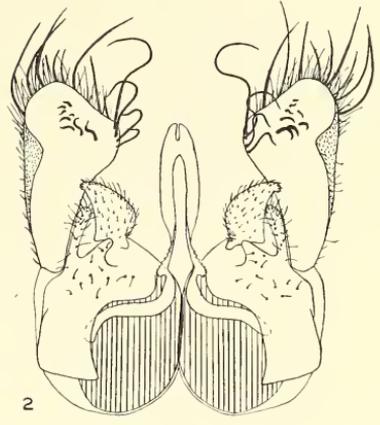
All figures of the male genitalia were drawn by the author from balsam slide mounts using a projection apparatus. Each figure represents the ventral, ental aspect of the genitalia after it has been mounted in a manner best suited to illustrate the interior structure of the organ. The cardo is not shown. All figures are drawn to the same scale and are enlarged forty-eight times. The nomenclature of the component parts of the genitalia is after Snodgrass (1941) and is given in Plate X, Figure 1.

Plate X

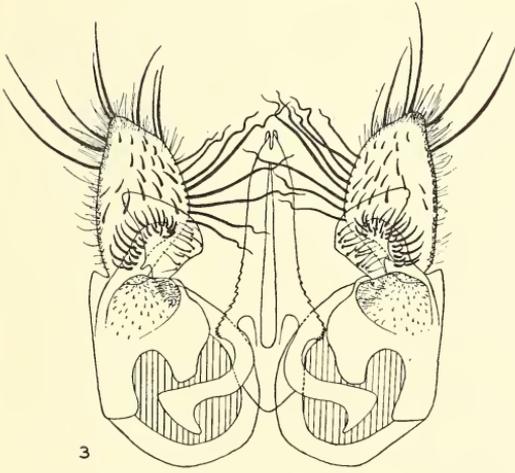
- Fig. 1. *Chyphotes subulatus* n. sp. A, paramere; B, aedeagus; C, digitus; D, cuspis; E, basiparamere.
- Fig. 2. *Chyphotes attenuatus* (Blake).
- Fig. 3. *Chyphotes nubeculus* (Cresson).
- Fig. 4. *Chyphotes pallidus* n. sp.



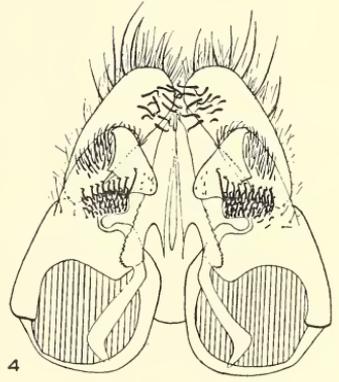
SUBULATUS



ATTENUATUS



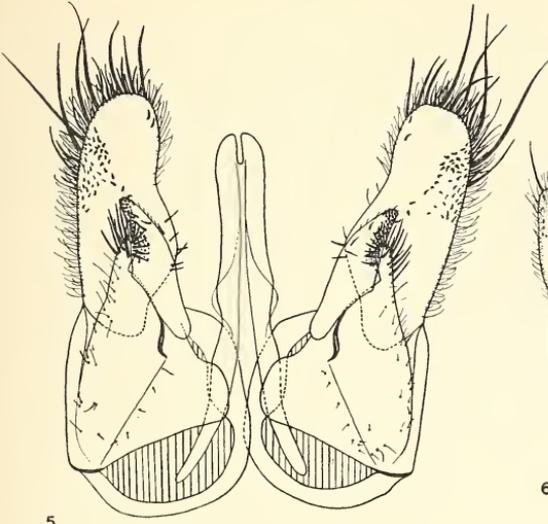
NUBECULUS



PALLIDUS

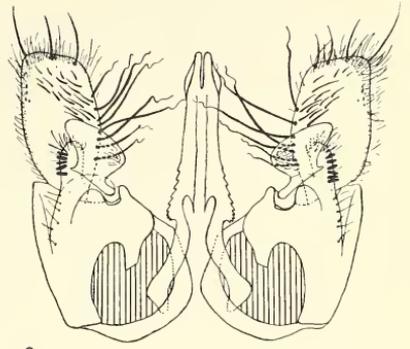
Plate XI

- Fig. 5. *Chyphotes melaniceps* (Blake).  
Fig. 6. *Chyphotes similis* Baker.  
Fig. 7. *Chyphotes heathii* Melander.  
Fig. 8. **Chyphotes bruscus** n. sp.



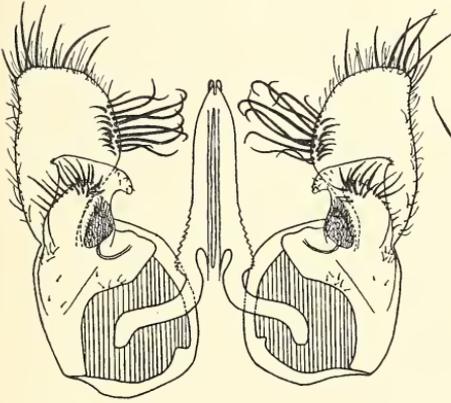
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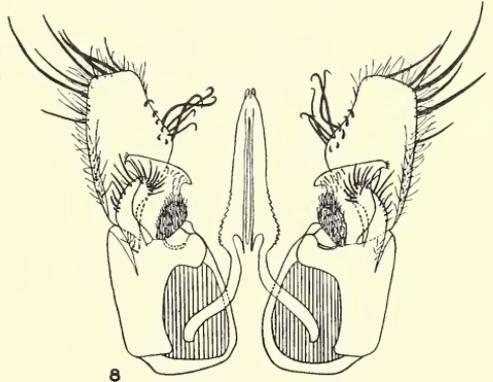
6

SIMILIS



7

HEATHII

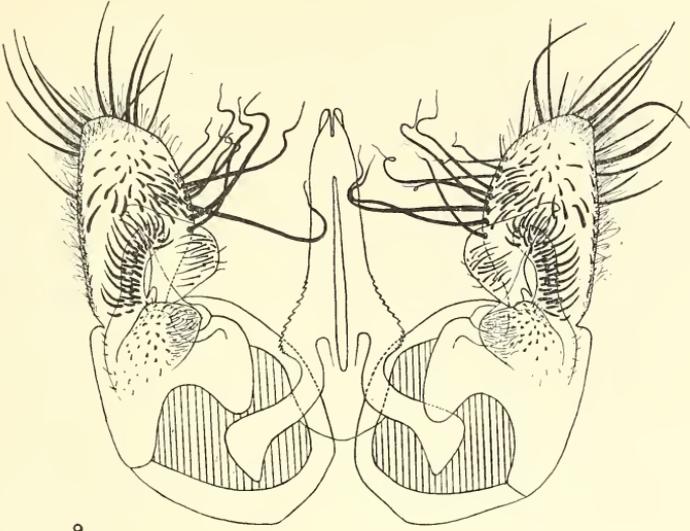


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BRUSCUS

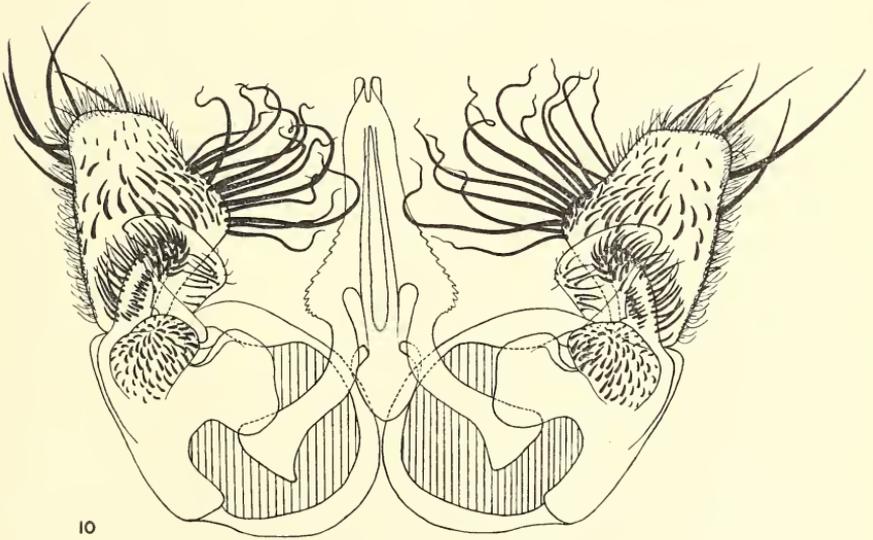
Plate XII

- Fig. 9. **Chyphotes mickeli** subsp. **mickeli** n. sp. and n. subsp.  
Fig. 10. *Chyphotes albipes* (Cresson).



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MICKELI SUBSP. MICKELI

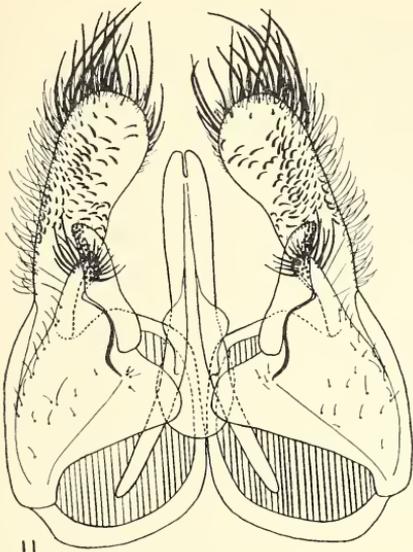


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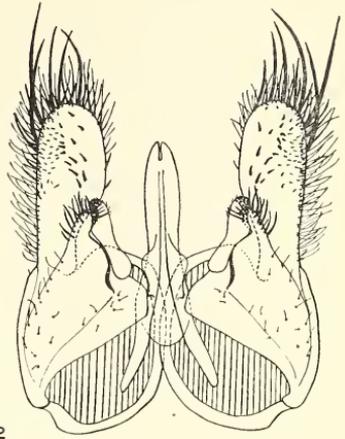
Plate XIII

- Fig. 11. *Chyphotes belfragei* (Blake).  
Fig. 12. *Chyphotes peninsularis* Fox.  
Fig. 13. *Chyphotes californicus* Baker.



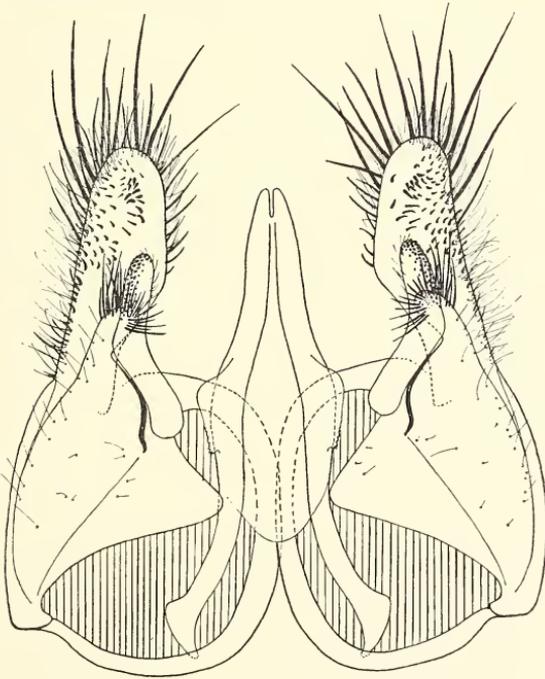
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BELFRAGEI



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PENINSULARIS



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CALIFORNICUS



## ENTOMOLOGICA AMERICANA

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Roman letters indicate valid species; bold face, new genera and forms; Italics, synonyms; \* indicates plants. (Not included in this Index, North American Species of the Families (Heteroptera) Coreidae, Alydidae, Corizidae, Neididae, Pyrrhocoridae and Thaumastotheriidae, pp. 41/122.)

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## A MONOGRAPH OF THE MELOPHAGINAE, OR KED- FLIES, OF SHEEP, GOATS, DEER AND ANTE- LOPES (DIPTERA, HIPPOBOSCIDAE)

By J. BEQUAERT<sup>1</sup>

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## PREFACE

The present monograph of the louse-flies, or keds, of sheep, goats, deer, antelopes and related Artiodactyle mammals, contains in addition to the customary taxonomy, a critical digest of what is known of the morphology, anatomy and habits of these parasites, as well as a discussion of their affinities and host relations. The pertinent information was gathered from widely scattered sources, which may be an excuse, if any were needed, for the extensive bibliographies given under some of the species. With very few exceptions, preceded by an asterisk, all references were checked with the originals. The localities which follow the references are only those based on material seen by the author himself. Throughout the work, the dates following the authors' names refer to the bibliographies introducing the taxonomic treatment of the several species.

Two preliminary papers were published, one dealing with the American species of *Lipoptena* (1937, Bull. Brooklyn Ent. Soc., XXXII, pp. 91-101), the other with the genus *Echestypus* (1940, Psyche, XLVII, pp. 85-104). All essential information contained in these has been repeated, with additions and corrections; but the collectors' names have been omitted.

Generic and specific descriptions were drawn up on a comparable basis, from actual specimens, but include only the characteristic features. They disregard color, which offers no valid specific differences in the Melophaginae, as, moreover, in most Hippoboscidae. The integument of adult keds is generally a pale dirty-yellow or brownish-yellow upon hatching; with age the ked turns darker, to varying shades of brown or nearly black, depending upon feeding and sexual maturity, possibly also to some extent upon the nature of the fur of the host or upon climatic conditions. I am convinced that these individual differences are without any real specific or subspecific significance. Further color changes occur after death and vary then with the method of preservation.

Drawings are original, except where the contrary is expressly stated. Those showing external morphology were made from specimens preserved in spirit *in toto*, without being previously treated by a chemical or mounted on slides. In my opinion, Hippoboscidae cleared in alkali and mounted in Canada balsam give a misleading picture, through distorted proportions, obliteration of superficial sutures and conspicuousness of internal sclerotized structures.

In Hippoboscidae, postimaginal growth of the internal organs of the abdomen, with concomitant stretching of the integument, makes the total length of the body dependent upon the age of the specimen.

While this measurement is of some interest as indicating the maximum size the two sexes of a species may reach, it is of little value for comparative purposes. For this reason I measure only the combined length of head and thorax (abbreviated as h.+th.), taken from the anterior margin of the frontoclypeus to the apex of the scutellum.

I am well aware of the shortcomings of this paper, some of which are due partly to limitations of material and time, partly to the present contingencies of publication. The morphology of the male terminalia especially has not been adequately treated. To do this properly will involve not only a detailed study of many specimens of the several species, but also a comparison with similar organs in the other Hippoboscidae and perhaps even in the Myiodaria. Moreover, it is doubtful whether such a study will repay the effort, for the differences shown by these structures among the Melophaginae appear to be very slight.

#### ACKNOWLEDGMENTS

As in the case of my other work on Hippoboscidae, I have depended heavily for material and information on my colleagues here and abroad, all of whom it is my pleasant duty to thank for their generosity and help: the late J. M. Aldrich, G. F. Augustson, the late E. E. Austen, R. H. Baker, T. Barbour, R. H. Beamer, W. J. Baerg, W. Beebe, S. W. Bilsing, F. C. Bishopp, R. M. Bohart, G. Chagnon, W. I. Chamberlin, J. P. Chapin, C. F. Clagg, H. Coolidge, K. W. Cooper, I. McT. Cowan, E. T. Cresson, Jr., C. H. Curran, W. T. Davis, J. De Riemaecker, R. Dow, R. R. Dreisbach, R. Du Toit, the late F. W. Edwards, E. O. Engel, G. F. Ferris, E. J. Gerberg, W. J. Gerhard, J. Ghesquière, P. Goodrum, J. C. Hare, C. M. Herman, G. H. E. Hopkins, the late W. Horn, D. E. Howell, H. B. Hungerford, F. P. Ide, T. Jaczewski, H. E. Jaques, W. L. Jellison, the late C. W. Johnson, I. La Rivers, Father Leopold, G. A. K. Marshall, R. Matheson, G. A. Mavromoustakis, J. McDunnough, A. McIntosh, R. H. Painter, H. S. Peters, C. B. Philip, E. W. Price, J. Rodhain, C. W. Sabrosky, H. Schoutedden, H. H. Schwardt, Hugh Scott, J. W. Scott, H. A. Scullen, E. Séguy, H. C. Severin, R. D. Shenefelt, J. Smart, G. J. Spencer, A. Stone, O. Theodor, E. S. Thomas, G. B. Thompson, L. H. Townsend, R. H. Van Zwaluwenburg, J. Pérez Viguera, N. Weber, Ralph Wheeler, F. X. Williams, H. Zerny, and V. Ziehen.

I have studied specimens from the following collections: Allen Hancock Foundation of the University of Southern California,

American Museum of Natural History (New York), Berlin Zoological Museum, British Museum (Natural History), California Academy of Natural Sciences (San Francisco), Canadian National Collection (Ottawa), Carnegie Museum (Pittsburgh), Congo Museum (Tervueren), Cornell University (Dept. of Entomology, Ithaca), Imperial Bureau of Entomology (London), Kansas University Entomological Museum (Lawrence), Musée d'Histoire Naturelle de Belgique (Brussels), Museum of Comparative Zoölogy (Cambridge, Mass.), New England Museum of Natural History (Boston), Ohio State Museum (Columbus), Oregon State College (Corvallis), Paris Museum of Natural History, Philadelphia Academy of Natural Sciences, Polish Zoölogical Museum (Warsaw), Stanford University Museum, U. S. Bureau of Entomology, U. S. Bureau of Animal Industry, U. S. National Museum, Vienna Museum, and the Zoölogical Institute, Halle a. S.

I am especially indebted to Professor G. F. Ferris for the loan of his valuable collection, which includes several types; to Dr. Glover M. Allen, who assisted me with advice and criticism in matters pertaining to the mammalian hosts; and to Professor Alfred S. Romer, who has discussed with me the problem of the evolution of birds and mammals in its relation to the history of the ked-flies. To Mr. E. Séguy I owe a paratype of his *Lipoptena couturieri*.

I regret that, owing to prevailing world conditions, I was unable to examine the types of most species, preserved in European museums. This drawback I believe to have overcome, however, by the study of series of specimens from different sources, available for many species. In my opinion, taxonomy should be based on extensive material, covering as much as possible of the geographical and host range of the species.

#### EXTERNAL MORPHOLOGY

The head (Figs. 1A-D and 17A-D) has the shape of a short and irregular triangular pyramid lying prone, with the base attached to the thorax and the largest plane facing upward. Seen from above, it is broader than long, elliptical in contour, often somewhat angular at the sides, particularly in *Melophagus*. The occipital margin is either almost straight or more or less arched. The frontoclypeus (*FC*) is a single sclerite; but occasionally a very superficial transverse epistomal suture marks the original limit between clypeus (epistoma) and frons. The anterior margin is continuous, slightly arched or almost straight; its ventral edge corresponds to the facialia and bears a row of setae or bristles ending in one or two vibrissae

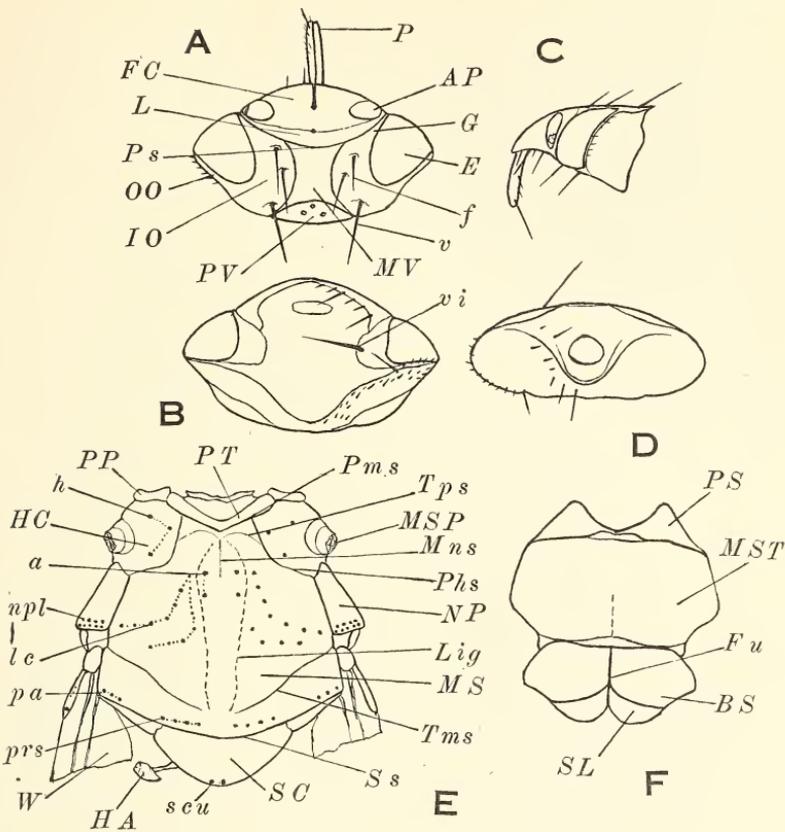


FIG. 1. A-D, *Lipoptena rusaecola* J. Bequaert, male allotype: head from above (A), below (B), the side (C) and behind (D): AP, antennal pit; E, eye; f, frontal bristles; FC, fronto-clypeus; G, gena; IO, inner orbit; L, pretilinal area; MV, mediovertex; OO, outer orbit; P, palpus; Ps, ptilinal suture; PV, postvertex; v, vertical bristle; vi, vibrissa.—E-F, *Lipoptena depressa* (Say), female: thorax from above (E) and below (F): a, aerostichals; BS, basisternum; Fu, furca; h, humerals; HA, halter; HC, humeral callosity; lc, laterocentrals; Lig, longitudinal intrascutal groove; Mns, median notal suture; MS, mesoscutum; MSP, mesothoracic spiracle; MST, mesosternum; NP, notopleuron; npl, notopleurals; pa, postalars; Phs, posthumeral suture; Pms, pro-mesonotal suture; PP, propleuron; prs, prescutellars; PS, prosternum; PT, protergum; SC, scutellum; scu, scutellars; SL, sternellum; Ss, scuto-scutellar suture; Tms, transverse mesonotal suture; Tps, transverse prescutal suture; W, basal stump of wing.

(*vi*) on the under side; dorsally, a faint median longitudinal furrow extends as far back as the theoretical limit of the clypeus, where it ends in a slight pit. This furrow represents the notch or inward curve which in most other Hippoboscidae divides the two apical arms, lobes or prongs (really the facialia) of the fronto-clypeus. Anterior to the well-marked ptilinal suture (*Ps*) there is usually a faint curved transverse line, which sets off a narrow crescent-shaped preptilinal area or lunula (*L*), sometimes provided with a median fovea. This area extends to the side, where it separates the antennal pit (*AP*) from the narrow gena (*G*). The antennal pits are small, subcircular or oval, placed far apart, and completely surrounded by a continuous rim, also anteriorly. The inner orbit (*IO*; parafrontalia) is wide, especially in *Melophagus*, and bears a variable number of frontal bristles (*f*), either toward the inner margin only or over most or part of the disk; posteriorly, close to each outer corner of the postvertex, there are one or rarely more vertical bristles (*v*). The mediovertex (*MV*; frontalia or median frontal vitta) is well developed, though rather narrow in *Melophagus*. The postvertex (*PV*; vertical triangle or ocellar plate) is large, and bears three ocelli in *Lipoptena* and *Neolipoptena* (often minute), none in *Echestypus* and *Melophagus*. The compound eyes (*E*) are smaller than in most other Hippoboscidae, elongate-oval to ribbon-shaped, extending partly over the ventral side; in some species of *Lipoptena* they are almost equally developed dorsally and ventrally; they are usually separated from the sides of the head by distinct outer orbits (*OO*) bearing a row of bristles or setae.

The antennae (Figs. 17F-G) are very small, subglobular and sunk in the pits. Although different in appearance from those of most other Hippoboscidae, they have essentially the same structure. The first segment is not only fused with the sides of the antennal pit, but also deeply merged into the head capsule, so that it is completely hidden from view. The only antennal segment visible from the outside is the second, which represents a pedicle greatly modified into a hollow cup, containing the much smaller third segment. The second segment has no dorsal prolongation (antennal appendage of other Hippoboscidae); the dorsal longitudinal furrow, present in most Hippoboscidae, is barely indicated in *Lipoptena* and seemingly absent in *Melophagus*. The third antennal segment is piriform and bears one very long and curved olfactory pit and a one-segmented arista of a peculiar shape, which protrudes through the opening of the second antennal segment. In *Melophagus* (Fig. 17G), the arista is broad at the base, rapidly narrowed and stalk-like in the middle,

and divided distally into two flattened branches, each further subdivided into a comb of bristle-like processes.

Ventrally, the median membranous region of the head is unusually developed and projects backward and downward between the two lobes of the prosternum; the latero-posterior areas, corresponding to the cheeks of the higher Myiodaria, are mostly sclerotized and deeply concave for the reception of the prosternal lobes and the fore coxae; while the latero-anterior, partly sclerotized areas correspond to the parafacialia and facialia, the one or two bristles of their inner corners being the vibrissae (*vi*). The occipital face of the head, comprising the postgenae and gulomentum, is flattened and triangular with rounded corners in outline, the subcircular occipital foramen placed dorso-medially.

The mouth parts or proboscis (Fig. 17E) are similar to those of other Hippoboscidae. The basal rostrum membrane lies inside the head capsule and bears internally the several sclerites of the tentorium, called by Jobling the fulcrum, the hyoid and the stipites. On these sclerites are inserted the muscles of the rostrum, which protract and retract the proboscis. The two maxillary palpi protrude from the rostrum beyond the anterior margin of the head. They are long in *Melophagus*, shorter in *Lipoptena* and *Neolipoptena*, and small or vestigial in *Echestypus*. The haustellum, or sucking tube of the proboscis, is very long and narrow, strongly sclerotized; at rest its needle-like distal part lies concealed in a sheath formed by the palpi, the inner sides of which are concave; its base is bulbous, slightly ovoid, and at rest is retracted within the rostrum membrane far into the head capsule. The tube of the haustellum consists of the modified labium (with a ventral portion or theca, and a dorsal portion or labial gutter), enclosing the labrum-epipharynx and the hypopharynx. These three parts enter the skin as a unit when the fly bites. The labium ends in the labella (modified labial palpi), provided at the tip with a double crown of pre-stomal teeth, which act as the cutting organs when the proboscis is inserted in the skin.<sup>2</sup>

I have found no adequate description of the structure of the thorax. In *Melophagus* the several sclerites are considerably modi-

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<sup>2</sup> I have adopted the terminology used by B. Jobling, 1926: A comparative study of the structure of the head and mouth parts in the Hippoboscidae. *Parasitology*, XVIII, pp. 319-349, Pls. XI-XV. This paper should be consulted for a more detailed account of the head and its appendages.

fied and fused, obviously as a result of the complete loss of the wings. The limits of the sclerites may, however, be traced by a comparative study of *Lipoptena*, *Neolipoptena*, and *Echestypus*.<sup>3</sup>

In the thoracic dorsum of the Melophaginae the following areas and sutures may be seen with the proper illumination on unmounted material (Fig. 1E).

1. A narrow median dorsal sclerite, immediately behind the apparent anterior margin, is the true pronotum (or protergum, *PT*). It is limited behind by a fine pro-mesonotal suture (*Pms*), much more distinct in *Lipoptena*, *Neolipoptena* and *Echestypus* than in *Melophagus*. A membranous area (covered by the occipital margin of the head) separates it from the latero-cervical sclerites. On the sides it is more or less divided from the small and narrow, dorsally placed propleuron (*PP*), on which the fore coxa articulates.

2. The remainder of the dorsum consists of the mesonotum and dorsally developed portions of the mesopleura. The scutellum (*SC*) is limited anteriorly by a deep, narrow and complete scuto-scutellar suture (*Ss*) in *Neolipoptena*, *Lipoptena* and *Echestypus*; in *Melophagus*, the scuto-scutellar suture is shallow and wide medially, and does not extend laterally to the wing rudiments.<sup>4</sup> The dorsum consists mostly of the mesoscutum (*MS*), which shows at least traces of a transverse mesonotal suture (*Tms*), placed more posteriorly than usual, bow-shaped (with anterior concavity) and more or less interrupted medially. In *Melophagus* the mesonotal suture is barely indicated on the sides by slight depressions opposite the wing rudiments. A median internal ridge runs over most of the length of the mesoscutum and is usually marked externally by a fine impressed line or median notal suture (*Mns*). In some species this is long and very distinct, in others faint or very short. Anteriorly it often connects with what appears to be a doubly arched transverse

<sup>3</sup> Massonat (1909) states of *M. ovinus* that the thorax "ne présente pas sur sa face dorsale de sillons médians et transversaux visibles, sauf celui tout à fait postérieur, d'ailleurs peu accusé, qui délimite le scutellum." On the thorax of *Lipoptena* he figures and mentions only the transverse suture of the mesonotum.

<sup>4</sup> Ferris and Cole (1922) state of *Melophagus ovinus montanus*: "scutellum apparently lacking and no scutellar setae present, while in the typical form [*M. ovinus ovinus*] the scutellum, although very small, is distinct and bears a cluster of apical setae." Their drawing (Fig. 10) shows, however, the scutellar setae, not recognized as such because the insect was examined in a prepared slide mount.

prescutal suture (*Tps*). In addition some species of *Lipoptena* show a median pair of curved impressed lines or grooves, which I shall call the longitudinal intrascutal grooves (*Lig*).

On the sides, anteriorly, the humeral callosities (*HC*) are broad and bear each a large mesothoracic spiracle (*MSP*). They are more or less divided from the mesoscutum proper by a curved post-humeral suture (*Phs*) in *Neolipoptena*, *Lipoptena* and *Echestypus*; while in *Melophagus* this suture is only faintly indicated by a depression. From the inclusion of the spiracle and the relative positions of the propleural and notopleural plates, it seems reasonable to regard the humeral callosities as formed, at least in part, by a mesopleural sclerite (mesepisternum). The metathoracic spiracles are also well developed and placed on each side above the articulation of the hind coxa. As first pointed out by Dufour (1831) for *Melophagus*, the thoracic spiracles have a different structure from those of other Hippoboscidae. They are circular, with a large ostiole partly closed by numerous hair-like scales radiating from the margin to the center.

The remainder of the side, between the humeral callosity and the wing base, seems to consist of dorsal, flattened expansions of the mesopleuron. The most conspicuous of these is the notopleuron (*NP*), very deeply divided by a suture from the mesoscutum in *Lipoptena*, *Neolipoptena* and *Echestypus*, but almost completely fused with it in *Melophagus*. It appears to be a modified mesepimeron. Two smaller sclerites intervene between the hind margin of the notopleuron and the root of the wing (*W*), and may represent modified epipleurites.

Ventrally, the prosternum (*PS*) is very narrow medially, but produced forward as a triangular lobe on each side. The mesosternum (*MST*) is long and broad, divided longitudinally by a median sternal groove or furca (*Fu*). The metasternum is a little narrower and much shorter than the mesosternum and likewise provided with a median furca; in addition it is divided by a transverse suture into a long basisternum (*BS*) and a shorter sternellum (*ST*).

*Thoracic Chaetotaxy*.—No bristles on pronotum. Mesonotum with a curved row of acrostichals (*a*) on either side of the median notal suture (number variable or none), sometimes placed on or mesad of the intrascutal grooves; a number of humerals (*h*) on the humeral callosities; a variable number (sometimes none) of laterocentrals (*lc*) in which sublateral and dorso-centrals cannot be distinguished. Sometimes a few intra-alars behind the mesonotal suture; a few postalars (*pa*) in the hind corners of the mesoscutum;

a few prescutellars (*prs*) on either side of the middle line; one or two rows of notopleurals (*npl*); and a few scutellars (*scu*) at the apex of the scutellum. In *Melophagus* the many setae of the dorsum are difficult to separate into groups. Ventrally, the lateral lobes of the prosternum, the mesosternum and the basisternum bear many, mostly short or spine-like, scattered setae.

The integument of the abdomen remains mostly or partly membranous and extensible, but there is always a dorsal basal pair of sclerotized plates (bearing the first pair of spiracles near the base at the extreme inner sides) and a single ventral basal plate, usually bilobed or crescent-shaped (elliptical in *Neolipoptena*). No other areas are sclerotized in *Melophagus ovinus*. All Melophaginae have seven pairs of abdominal spiracles, more readily seen in some species than in others. In newly hatched flies the spiracles are placed at or close to the sides of the abdomen; but, after the abdomen becomes distended by feeding or the intra-uterine growth of a larva, they usually move more dorsad. The areas carrying the several spiracles may be more or less set off, forming a series of pleurites (*PL*, Fig. 11). Pleurite I is the dorsal basal plate mentioned before. Pleurite II may become strongly sclerotized in some species, where it assumes a characteristic shape, but even in these it is usually not differentiated in newly hatched flies. In some species spiracles VI and VII migrate toward the sides of the terminal tergal plates and are sometimes even enclosed in these. The median portion of the dorsum is mostly undifferentiated as to segments, even though it may become extensively sclerotized in certain species (again some time after hatching from the pupa). In addition a variable number of true median tergal plates (*TP*, Fig. 11) may be present, their number and shape being characteristic for the several species. I number these tergal plates starting from the base, the first being the one nearest the basal pleurites I. The apical tergal plate, if present, may bear spiracle VII on or close to its sides and is often divided into a pair of sclerites. Ventrally, the abdomen usually bears no differentiated sclerotized areas behind the basal plate, except for three small sclerites at the genital and anal openings of the female, and a pair of small sclerotized lobes between which the terminalia protrude in the male. Sometimes, however, small areas around the base of one or a few setae, in the apical portion, are slightly sclerotized; or the surface may become more extensively sclerotized, regardless of segmentation.

It should be noted that the general appearance of the abdomen and the color and extent of sclerotization of its different areas are

likely to change with age in the same individual. This process is very misleading, as it produces spurious specific or sexual differences when specimens at different stages of sclerotization are compared. In all species of which I was able to compare *fed* individuals of both sexes, I have found few essential structural sexual differences, except those immediately correlated with the genital openings and their appendages. There is, however, often one median tergal plate less in the male than in the female. In newly hatched flies, the abdomen is fairly uniformly membranous and pale colored. Even the basal dorsal and ventral plates are at first soft and pale, but they soon harden and become darker. The remainder of the abdomen changes little until the insect starts feeding; it is generally short and contracted, the several individualized sclerites or plates of the dorsum being crowded together, with the edges of the plates somewhat overlapping. As a result the abdomen appears densely hairy and the individual setae seem to be very long. At this stage the sexes are often difficult to separate. Later, the membranous part of the integument stretches and the several sclerotized plates harden and move apart, thus becoming clearly set off.<sup>5</sup>

The legs are unusually short and heavy, with swollen femora and tibiae, and short, compact tarsi. They are much stouter than in most other Hippoboscidae. While the legs of bird louse-flies are adapted to scurrying about swiftly in the feathers, those of the Melophaginae are built for grasping and adhering to the skin and hairs of the fur. The tarsal claws are usually more or less asymmetrical in each pair. They are simple, the broad, plate-like basal heel not being divided into an additional tooth.

The wings are completely aborted in *Melophagus*, being reduced to a short basal knob of the costa (Fig. 18C). In all other Melophaginae they are fully developed and functional in both sexes, when the fly hatches from the puparium, but break off close beyond the base after it reaches the host. The complete wing (Fig. 5F) is relatively long, but weak. There are only three well-developed longitudinal veins and one cross-vein, in addition to the costa. The longitudinal veins are apparently the first ( $R_1$ ), third ( $R_{4+5}$ ) and fifth ( $M_{3+Cu}$ ) of other Hippoboscidae. The sixth (2d An) is sometimes partly developed in the base of the wing, and the membrane shows a number of depressed (concave) creases, some of which may be traces of other veins. The one cross-vein, placed about the middle

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<sup>5</sup> My drawings were made from specimens with distended abdomen.

of the wing, between the supposed third and fifth longitudinals, may be a fusion of the anterior basal cross-vein ( $M_3$ ), anterior cross-vein ( $r-m$ ) and a portion of the fourth longitudinal ( $M_{1+2}$ ). The second basal cell ( $M$ ) is long and broad. The costa is thickened only at the extreme base and between the tips of the first and third longitudinals. The subepaulet (or basicosta) is present, but very small and bare. The alula, squama and squamula are rudimentary or lacking. The membrane is covered with uniformly scattered, exceedingly minute microtrichia. Halteres are absent in *Melophagus*, but well-developed and of normal shape in the winged genera. At rest the wings are carried in the usual hippoboscoid fashion, lying flat on the abdomen, one above the other. (See Theodor's photograph of a newly hatched female of *Lipoptena capreoli*, 1928, p. 286, fig. 4).

The male terminalia (external genitalia; phallus of Snodgrass) are similar to those of other Hippoboscidae (Figs. 7C-E). They are simple structures, whose parts have, however, not yet been clearly homologized with those of other Diptera. The terminology I use is non-committal and adopted for descriptive purposes only. The organ is small and can be retracted completely in the body. It consists of a basal ring or common stalk (caulis), supporting a median, elongate cone-shaped aedeagus and two rod-like parameres, one on each side.

#### ANATOMY

The following account of the internal structure is a greatly condensed digest of the literature, as I have had no opportunity to dissect any of the species myself. Its main purpose is to show that the anatomy of the Melophaginae offers no fundamental departure from that of the other Hippoboscidae, which, moreover, is essentially that of the Myiodaria. The few discrepancies concern minor details, differences as are commonly observed among closely allied insects. Much information is available for *Melophagus ovinus*, which has been studied repeatedly; and some parts of the anatomy of *Lipoptena cervi* and *L. capreoli* have also been worked out.

I. *Internal Appendages of the Integument*.—These comprise the various rods, ridges and knobs of the endoskeleton, formed by folds or ingrowths of the body wall, either strengthening the exoskeleton or acting as levers and points of attachment (apodemes) for the muscles. On macerated and cleared specimens they may be seen by transparency and are readily mistaken for external sutures or structures. Those in the head are particularly important, as they con-

stitute the hyoid and tentorium, an assemblage of fixed and movable pieces acting as levers for the muscles which protrude and retract the proboscis (See Jobling, 1926, for *M. ovinus*).

II. *Muscular System*.—For *M. ovinus*, see Dufour (1845), Massonat (1909), Cuénot and Mercier (1922), and Jobling (1926); for *L. cervi*, see Massonat (1909) and Mercier (1924).—The head contains ptilinal muscles, which retract the ptilinal sac within the lunula after the fly has hatched; also antennal, proboscidal and pharyngeal or suction muscles. In the newly hatched, winged *L. cervi* the thoracic muscles are as in other winged Hippoboscidae, all being mesothoracic. Six pairs of longitudinal dorsal muscles run the whole length of the dorso-central area (dorsad of the proventriculus). Three pairs of vertical or slightly oblique sternodorsal muscles are placed laterad of the dorsals. Both sets act indirectly upon wing motion by changing the size and shape of the thorax. After the wings are shed, the sternodorsals disappear and the dorsals are weakened, while the coxal muscles are strengthened (Mercier, 1924). In *M. ovinus*, throughout life, the sternodorsals are wanting, while the dorsals are much reduced and functionless (according to Massonat; Cuénot and Mercier claim they are wanting). In both species, the thorax also contains many smaller muscles moving the neck (cervicals) and the abdomen (thoraco-abdominals) and powerful coxal muscles moving the legs as a whole. Inside the leg segments, sets of muscles move the several pieces, either flexing or extending them, or drawing them forward or backward. The abdominal muscles are relatively unimportant and are as in other Hippoboscidae. They are mostly associated with the digestive tract and the reproductive system.

III. *Digestive and Excretory Systems* (Fig. 2).—For *M. ovinus*, see Lyonet (1829 and 1832), Dufour (1845), Massonat (1909), Hoare (1923), Anigstein (1927), and Zacharias (1928); for *L. cervi*, see Massonat (1909) and Zacharias (1922); for *L. capreoli*, see Theodor (1928).—The digestive tract, similar in all three species, consists of the usual three main regions and differs from that of other Hippoboscidae only in details. Owing to its importance in the life-cycle of some of the unicellular parasites of keds, it is described somewhat at length.

1. The fore-gut (stomodeum) comprises the mouth with the salivary glands, the hyoid, the pharynx and the oesophagus. In the mouth parts, described before, the mouth proper, or buccal cavity, is the hollow tube of the haustellum. The salivary glands (*SG*) of *M. ovinus* and *L. capreoli* are a pair of slender tubes, each arising

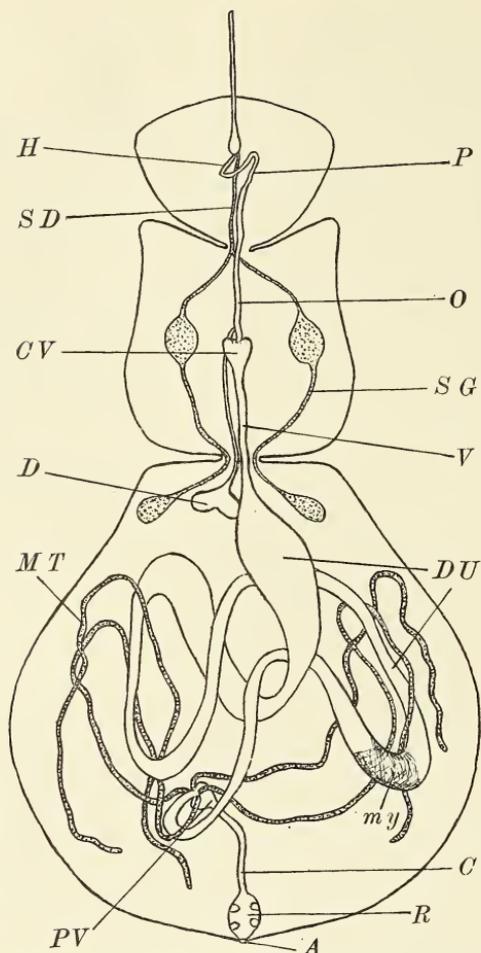


FIG. 2. *Melophagus ovinus* (Linnaeus), female: digestive and excretory systems (modified after Hoare and Anigstein): *A*, anus; *C*, colon; *CV*, cardiac valve; *D*, diverticulum; *DU*, duodenum; *H*, hyoid; *MT*, Malpighian tubule; *my*, mycetome of mid-gut; *O*, oesophagus; *P*, pharynx; *PV*, pyloric valve; *R*, rectum; *SD*, salivary duct; *SG*, salivary gland; *V*, ventriculus.

from a blind, spherical expansion (excretory gland), in the basal portion of the abdomen; they enter the thorax, where they widen into an elliptical reservoir on either side of the proventriculus and unite beneath the oesophagus to form the common salivary duct (*SD*) which enters the neck. This single duct connects at the base of the haustellum with the very fine, tubular channel which runs the

whole length of the stylet-like hypopharynx and opens close to its tip. A short distance from the hypopharynx the duct is provided with a valvular arrangement worked by a special salivary muscle, but there is no true salivary pump. As in other blood-sucking Diptera, saliva is injected through the hypopharynx in the skin of the host when the ked bites, being responsible for the various reactions of the tissues to the bite. In other Hippoboscidae, the structure of the salivary glands is the same, but the shape of the excretory glands and thoracic reservoirs may differ.<sup>6</sup> The pharynx (*P*) is the anterior soft, tubular portion of the gut, contained in the head; it is divided into two regions by an angular bend, with the apex directed forward. By means of the pharyngeal muscles, it acts as a pump drawing up the blood through the haustellum and pushing it back into the oesophagus. The pharynx connects with the hollow tube of the haustellum by means of an intervening tubular part of the buccal cavity, with sclerotized walls, the hyoid (*H*). The oesophagus (*O*) continues the pharynx as a slender tube, which passes through the neck and extends to about mid-length of the thorax. Here it opens in the mid-gut through a dilatation containing the cardiac valve (*CV*). Just before the valve a narrow tube opens on the ventral side of the oesophagus; this tube expands in the basal portion of the abdomen into a small, bilobed diverticulum (*D*), corresponding to the reservoir stomach or crop of other Diptera. The function of this vestigial crop of Hippoboscidae is not known, but it is definitely not used as a food reservoir, as blood never enters it.<sup>7</sup>

2. The mid-gut (mesenteron) comprises the proventriculus, ventriculus and duodenum. The proventriculus, abruptly wider than the oesophagus, lies in the posterior portion of the thorax. It is essentially a cardiac valve (*CV*), the interior being nearly closed by thickened folds of the wall; in the Melophaginae it seems to serve only to stop the backflow of food from the mid-gut into the fore-gut; in other Hippoboscidae, where its structure is more complex, it may also have other functions. The ventriculus (*V*) extends over the

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<sup>6</sup> According to Theodor (1928) the excretory glands of *Hippobosca* are sausage-shaped and twisted around the mid-gut. Massonat (1909) states that the salivary glands of *L. cervi* are like those of *Hippobosca*. This must be due to an oversight, as they could scarcely differ much from those of the closely allied *L. capreoli*.

<sup>7</sup> This diverticulum was overlooked by some investigators, but correctly described by Massonat for all Hippoboscidae, by Hoare for *M. ovinus*, and by Theodor for *L. capreoli*.

hind half of the thorax into the base of the abdomen; its function is digestive. The abdominal portion of the mid-gut is the duodenum (*DU*), beginning at the base of the abdomen with an abruptly widened, sausage-shaped portion, used as a blood reservoir while feeding. This is followed by a tubular portion, unusually long in Hippoboscidae (reaching 6 to 7 times the length of the body of the fly), where it shows postimaginal growth. It describes several loops and terminates in the hind-gut, in the distal region of the abdomen, just before the points of attachment of the Malpighian tubules. Its function is probably mainly of absorption, allowing passage by dialysis of digested food material through the walls of the body cavity. It should also be noted that no trace of a peritrophic membrane has been found in the mid-gut of *Melophagus* and *Lipoptena*.

3. The hind-gut (proctodeum) is relatively short. It starts with a funnel-shaped pyloric valve (*PV*) or ileum, where the Malpighian tubules open, followed by a tubular, straight colon (*C*) widened posteriorly into a rectum (*R*), the inner wall of which bears four rectal papillae or pulsating glands, projecting into its cavity. The terminal aperture of the rectum is the anus (*A*). The function of the hind-gut is excretory, its walls extracting waste products from the blood in the body cavity and dumping them by diffusion into the proctodeal cavity. The rectal glands also have a cardiac function. The four Malpighian tubules (*MT*), or main excretory organs, are very long and thin, blind at the free ends, arranged in a pair on each side, and twisted throughout the adipose tissue of the body cavity; they open close together in each pair, but without forming a true common duct.

IV. *Respiratory System*.—For *M. ovinus*, see Lyonet (1829 and 1832), Dufour (1831 and 1845), and Massonat (1909).—This is similar in all Hippoboscidae. In the female several of the main branches converge toward the uterus where they ramify intensively to form a mass of tracheae in and around the walls of that organ. This peculiarity is correlated with the intra-uterine development of the larva, whose entire respiration is carried on through the tracheal system of the mother fly. The tracheal system is in some respect simpler than that of most Myiodaria, consisting in the thorax of three longitudinal main trunks (two dorsal and one ventral) and in the abdomen of two main lateroventral trunks running the whole length. The main trunks are connected by side trunks with the several spiracles. Some of the branches extend from the thorax into the head, where they expand into small cephalic air sacs. The

thorax also contains a series of similar, but larger air sacs, which are as voluminous in the wingless *M. ovinus* as in the winged species. There are no abdominal air sacs, but the extensions of the thoracic sacs, which produce them in the Myiodaria, contribute instead to the tracheation of the walls of the uterus. There are two pairs of thoracic spiracles in all Hippoboscidae (2 mesothoracic and 2 metathoracic). Seven pairs of abdominal spiracles are readily traced in all Melophaginae and they are probably also present in most or all other Hippoboscidae.<sup>8</sup>

V. *Vascular System*.—I cannot find that this has been studied in any of the Melophaginae. In *Hippobosca*, according to Massonat (1909), the blood plasma is colorless and carries relatively few lymphocytes. The dorsal vessel or heart lies on the middle line of the abdomen immediately beneath the exoskeleton. It is a muscular tube comprising five chambers, each opening by a pair of lateral ostia, but without inner septa separating the chambers. The anterior prolongation of the heart into the thorax, or aorta, is much narrower, simple and without lateral ostia. The heart is contained in a pericardial cavity (dorsal sinus) separated from the body cavity below by the pericardial or dorsal diaphragm; on either side it is joined by the branches of five pairs of wing-like muscles and many tracheal ramifications. The remaining space of the pericardial sinus is filled with peculiar pericardial cells, whose nature and function has been much disputed. They have been regarded successively as nervous cells, as merely supporting or connective elements, or as storage cells; at present they are generally believed to play an important rôle in excretion.

VI. *Adipose System*.—For *M. ovinus* and *L. cervi*, see Massonat (1909); also Berlese (1899) for *M. ovinus*.—In all Hippoboscidae there are masses of fat cells in the head, thorax and abdomen. In *M. ovinus* and in deãlated specimens of *L. cervi* adipose tissue replaces most of the longitudinal dorsal muscles.

<sup>8</sup> Dufour (1845) believed that *Hippobosca* and *Ornithomyia* lacked the metathoracic spiracles of *Melophagus* and that *Hippobosca* had only 5 pairs of abdominal spiracles instead of the 7 pairs he and Lyonet had recognized in *Melophagus*; he even attempted a physiological explanation of this difference. Massonat (1909) correctly described two pairs of thoracic spiracles for all Hippoboscidae, but he gave the number of abdominal spiracles as five pairs for all members of the family. In all Melophaginae seven pairs may be traced, although some of them can only be found with difficulty in certain species.

VII. *Nervous System*.—For *M. ovinus*, see Dufour (1845) and Massonat (1909); for *L. cervi*, see Massonat (1909).—This is the same in all Hippoboscidae and agrees with that of the Myiodaria. The central nervous system comprises: (1) a large cephalic ganglion, perforated by the oesophagus, and sending off nerves to the different structures and sense organs of the head; and (2) a voluminous thoraco-abdominal ganglion, placed in the anterior region of the thorax, close to the mesosternum, and connected anteriorly with the cephalic ganglion by the cephalo-thoracic cord; it sends out nerves to the various inner and outer parts of thorax and abdomen. In addition, a splanchnic system, consisting of a proventricular ganglion connected with the cephalic ganglion, innervates the viscera.

The sense organs comprise: (1) those of sight: compound eyes, present in all Melophaginae, though much smaller than in most other Hippoboscidae; and ocelli, present in *Neolipoptena* and *Lipoptena*, absent in *Echestypus* and *Melophagus*, which show no pits or foveae representing vestigial ocelli. (2) Those of smell, or olfactory pores, located on the antennae and legs; in *Lipoptena* also on the base of the costa and on the halteres (see McIndoo, 1918). (3) Those of taste, primarily located on the palpi, which are well-developed in some species, small or vestigial in others. (4) Those of touch, consisting of many tactile hairs on various parts of the body. There appear to be no organs of hearing nor any organs producing sound or scent; the flight of the winged species is noiseless. The inner structure of the sense organs is the same in Melophaginae as in the other Hippoboscidae.

VIII. *Reproductive System*.—For *M. ovinus*, see v. Siebold (1837), Dufour (1845 and 1851), Leuckart (1858), Pratt (1899), Berlese (1899), Massonat (1909), Roubaud (1909), Patton and Cragg (1913), and Hardenberg (1927 and 1929); for *L. cervi*, see Hardenberg (1927 and 1929).

A. *Internal Male Genital Organs* (Fig. 3A).<sup>9</sup>—The pair of testes (*T*) are simple, slender tubes of considerable length (4 to 5 times the length of the body of the ked when uncoiled), each closely convoluted into an oval tangle, from which the somewhat club-

<sup>9</sup> The terminology here adopted is that of Snodgrass (1935, Principles of Insect Morphology, pp. 567–573). There is much disagreement among authors as to the names to be applied to the different parts. C. H. T. Townsend calls the vasa deferentia, vasa efferentia and the ductus ejaculatorius, vas deferens.

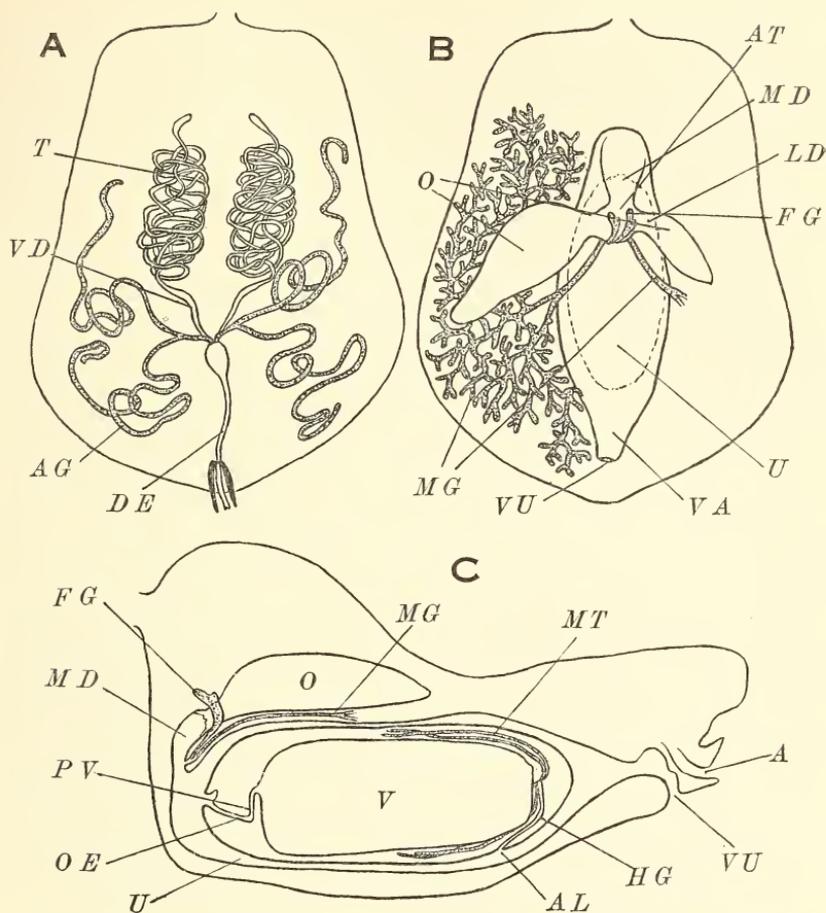


FIG. 3. *Melophagus ovinus* (Linnaeus), reproductive system (modified after Pratt, Roubaud and others): A, male organs: *AG*, accessory glands; *DE*, ductus ejaculatorius; *T*, testes; *VD*, vas deferens.—B, female organs from above: *AT*, atrium; *FG*, forward pair of glands; *LD*, lateral oviduct; *MD*, median oviduct; *MG*, milk-glands (drawn on one side only); *O*, ovary; *U*, uterus; *VA*, vagina; *VU*, vulva.—C, longitudinal section of abdomen and larva developing in uterus; *A*, anus of adult; *AL*, anus of larva; *FG*, forward gland; *HG*, hind-gut of larva; *MD*, median oviduct; *MG*, duct of milk-gland; *MT*, Malpighian tubule of larva; *O*, ovary; *OE*, oesophagus of larva; *PV*, proventriculus of larva; *U*, uterus; *V*, ventriculus of larva; *VU*, vulva.

shaped blind end protrudes. Each tube appears to be a single sperm tube, in which the male germ cells develop into spermatozoa. It continues posteriorly as a very short, slightly swollen vas deferens (*VD*), which opens directly (without intervening vesicula seminalis) into the single median ductus ejaculatorius (*DE*). This is moderately long, slightly swollen at its origin and connected by the gonopore with the endophallic chamber of the aedeagus. There are two pairs of unusually long vehicular or accessory glands (*AG*), each pair ending by a common duct in the corresponding vas deferens at the point where the latter enters the ductus ejaculatorius. In *M. ovinus*, as in other Hippoboscidae, the accessory glands serve as storage reservoirs for the sperm, there being no true seminal vesicles.<sup>10</sup> The male organs of these flies are remarkable for the unusual development of the testes and of the accessory glands. A possible explanation of these peculiarities will be discussed in the section dealing with the development.

B. *Internal Female Genital Organs* (Fig. 3B).—These were first described correctly for *M. ovinus* by Leuckart (1858). The pair of ovaries (*O*) are ovoid bodies, strikingly dissimilar in size, because they alternate in furnishing a mature ovum, a characteristic feature of all Hippoboscidae and of other pupiparous Diptera. Each ovary is incased in a peritoneal sheath of unusual thickness, forming an elastic sac within which lie only two ovarioles, each enclosed in its tunica propria and with a germarium and two successive follicles. In each ovary the two ovarioles function alternately, so that it contains only one developing ovum at a time. Each ovary narrows into a very short lateral oviduct (*LD*) which combines with its fellow to form a rather spacious but short common or median oviduct (*MD*). The junction of the lateral oviducts is a somewhat dilated atrium (*AT*; preuterus), which functions as a reservoir for the sperm, there being no functional spermathecae or receptacula seminis of the form usual in Diptera. The median oviduct joins the genital chamber or uterus (*U*) somewhat behind the latter's antero-ventral end. In the newly hatched ked, the

<sup>10</sup> As a result, Dufour misinterpreted them as seminal vesicles. Moreover, he did not merely imply by the name that they serve as containers of the seminal fluid, for he states (1845, p. 75): "Ces organes, destinés à tenir en réserve la liqueur fécondante, devaient être en rapport de capacité avec ceux qui sont chargés de préparer et de leur transmettre cette liqueur, et il en est effectivement ainsi."

uterus is a broad, depressed tube, about half as long as the abdomen; but when it contains a growing larva, it stretches considerably and occupies half or more of the cavity of the abdomen, which itself expands greatly. At the anterior end of the uterus, its dorsal wall receives two pairs of glands through a single opening. The hind pair are two large, extensively branched, tubular structures, evidently modified accessory (or fecundatory) glands. They have a nursing function, secreting a milk-like fluid on which the growing larva feeds, and may therefore be called milk-glands (*MG*). The forward pair of glands (*FG*) are short, thick and simple tubes, the origin and function of which are disputed; but most likely they are modified spermathecae.<sup>11</sup> In *Hippobosca*, this forward pair are long and branched and seem to be also true milk-glands; but they have apparently lost this function in *M. ovinus* and *L. cervi*. The uterus narrows posteriorly into a short vagina (*VA*) which opens externally through a slit-like vulva (*VU*), at the postero-ventral end of the abdomen, basad of the anus. The two terminal lips of the vulva form small, finely hairy sclerotized plates, one anterior (or ventral), the other posterior (or dorsal), which I call the genital plates. According to Hardenberg, the female genital organs of *L. cervi* scarcely differ from those of *M. ovinus*.<sup>12</sup>

Although presenting some unusual features, the several parts of the female organs of Hippoboscidae are readily homologized with those of the Myiodaria. The latter group exhibits many different types, that of the Glossinidae and other viviparous genera often closely approximating conditions found in Hippoboscidae. (See the discussion by C. H. T. Townsend, 1934, Manual of Myiology, pt. 1, pp. 144-153.) No particular phylogenetic importance should therefore be attached to these peculiarities.

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<sup>11</sup> According to Townsend, the number of spermathecae varies in the higher Myiodaria from one to three, very rarely more. *Stomoxys* and *Glossina* have two, much in the same position as the forward pair of glands of Hippoboscidae.

<sup>12</sup> Hardenberg's account contains some misleading statements and should be perused with caution. He writes, for instance (1929, p. 521): "The Pupipara have 2 ovaries, the Muscidae, however, several, which in any case points to a difference between the two groups." In the higher Myiodaria there is one pair of ovaries (except in freak specimens), but in each ovary, the number of ovarioles varies greatly.

## DEVELOPMENT AND EARLY STAGES

The development of *M. ovinus* has been studied in detail by Dufour (1845 and 1851), Leuckart (1854 and 1858), Pratt (1893, 1897 and 1900), Berlese (1899), Stange (1907), and Hardenberg (1927 and 1929). For the remainder of the Melophaginae, only the embryology of *L. cervi* has been partly worked out by Hardenberg (1927 and 1929) and there are some brief notes on the larva of this species by Em. Blanchard (1846); while Buxton (1924) described the larva of *L. capreoli*.

The ontogeny of Melophaginae follows the general pattern of all Hippoboscidae and other so-called pupiparous Diptera.<sup>13</sup> The single fully-formed ovum, produced by one of the ovarioles in one of the ovaries, moves into the atrium, where it is impregnated, and develops in the uterus into a maggot. The several larval instars remain in the uterus. Not until the larva is full-grown and ready to pupate, is it voided by the mother. Once outside, it neither moves nor takes food, but its integument hardens into a puparium within which is formed the true pupa, as in all Muscoidea. Eventually the adult escapes through a circular opening at the cephalic end of the puparium, a preformed cap being pushed off by the ptilinum of the fly. Unless otherwise specified, the following descriptions refer to *M. ovinus*.

The egg, as it enters the atrium, is elongate cylindrical, tapering at the poles, blunter posteriorly, about 1.2 mm. long and 0.3 mm. wide. It is enclosed in a membranous two-layered chorion, pierced at the cephalic end by a funnel-shaped micropyle, which is soon filled with a dense mass of spermatozoa. The early processes, leading to maturation and fertilization of the egg, have not been observed. The blastoderm formation and the succeeding stages leading to the embryo, with the imaginal disks, were studied by Leuckart (1858), Pratt (1897 and 1900), and Lassmann (1936).

*Larva.*—The first larval instar, newly hatched from the egg, is shaped like a flattened cylinder with slightly pointed ends. It

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<sup>13</sup> I fail to see any serious objection to the use of the term "pupiparous" for Diptera voiding fully developed larvae, which, if they are not "pupae" strictly speaking, are nevertheless potential puparia. To call such flies merely "larviparous" is misleading, since this term applies equally well to the many other species of Diptera voiding larvae in early stages of development, which feed and grow outside the body of the female. There seems to be no advantage in changing the term "pupiparous" to "nymphiparous."

shows weak traces of superficial segmentation (12 segments, according to Leuckart), as well as 8 pairs of rudimentary lateral spiracles, and is not unlike the usual maggot of the Muscoidea. Posteriorly there is an anal opening; anteriorly, a small nipple-like projection, bearing the mouth between two minute lateral papillae; but there is no trace of a cephaloskeleton at this or at any later larval stage. In the course of intra-uterine development there appear to be two moults in all, between the three successive larval instars. After the first moult, the maggot-like shape disappears and the larva becomes a plump ellipsoid.

The third larval instar is, at the time of parturition, 3.5 to 3.7 mm. long, 1.9 mm. wide and 1.6 mm. thick, slightly flattened at both ends. The mouth, at the anterior end, is directed cephalad in the female's body and faces the atrium of the uterus. The posterior end, with the anus and respiratory openings, faces the vulva. The larva lies free, without connection with the mother's tissues; but between its own body and the inner wall of the uterus may be found the exuviae of the earlier larval instars. The only external traces of segmentation are two curved rows, one on each side both dorsally and ventrally, of 7 shallow depressions, which mark the points of attachment of the dorso-ventral respiratory muscles, running on either side of the digestive tract. These are the only cutaneous muscles developed in the larva. Anteriorly the outer wall shows the first indications of the seams or weakened lines, typical of all Diptera Cyclorrhapha, along which the puparium will break open when the adult hatches (see the description of the puparium). According to Pratt, the first and second larval instars show no traces of these seams, which appear only after the second larval moult. The digestive tract occupies most of the inner cavity of the body (Fig. 3C). The mouth is followed by a short, irregular cavity, representing the invaginated true cephalic segment (cephalic pouch), moved by a set of muscles in rhythmic contractions, so that it acts as a sucking pump to take up the liquid food. There are no salivary glands. The cephalic pouch continues in the tubular, horizontal oesophagus, which bends upward abruptly into a tubular vertical proventriculus, itself opening in the very large, balloon-shaped ventriculus, completely closed behind. The hind-gut is a short, narrow tube, blind anteriorly, where it receives four Malpighian tubules (2 ventral and 2 dorsal), and ending in a ventrally placed anus. A tubular heart extends nearly the whole length of the body, dorsad of the mid-gut. Abundant adipose tissue is present in the general cavity and first indications of the sexual organs may be traced. The

nervous system is similar to that of muscoid maggots, but the several ganglia are less concentrated in a central mass.<sup>14</sup> The larva also possesses a number of imaginal disks from which the adult organs will be built up during pupation.

The respiratory system presents several unusual features. There are two main longitudinal, dorsal tracheal trunks, with three transverse connectives and many side branches ramifying throughout the body. Of the eight pairs of rudimentary lateral spiracles of the first stage larva, the six hind pairs are completely lost, but the two anterior pairs (presumably mesothoracic and metathoracic) persist as microscopic, functionless apertures of the cuticula. The main tracheal trunks do not open anteriorly and posteriorly, as in most Muscoidea, but only in the pair of posterior respiratory plates. In all pupiparous Diptera, these plates or "polypneustic lobes" of Newstead (1918) are really the modified anal stigmal plates of the Muscoidea. Each of these lobes is furnished with a deep cup-shaped pit, near the bottom of which and occupying a sub-central position is the stigmal opening which communicates directly with one of the main tracheal trunks; near the rim or periphery of the pit are two large stigmata: one toward the venter, the other toward the dorsum; in addition there is also a very minute pore-like stigma; and outside the pit an outer-lateral stigma rendered most conspicuous by its large and strongly sclerotized peritreme. All the stigmata, with the possible exception of the very minute one, are connected by a thick-walled air sac or trunk, which latter can be easily traced through the integument. Buxton (1924) describes and figures on each spiracular plate of the larva of *L. capreoli* three curved lines of spiracular pores, those of each line opening in a tracheal branch, the three tracheal branches uniting in a spherical chamber from which starts the rather thick-walled main tracheal trunk. Ferris and Cole (1922) figure a somewhat similar arrangement of spiracular pores for the larva of *L. mazamae*. As Buxton suggests, the three groups of spiracular pits are no doubt derived from the three slits which occur in the anal stigmal plates of the maggots of many Muscoidea. The more aberrant arrangement of *M. ovinus* is a further specialization of the same general type.

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<sup>14</sup> Rádl (1905, Biol. Centralbl., XXV, p. 4) claims to have found chordotonal sense organs in "larvae of Pupipara living as parasites in other insects." He must have made a confusion, presumably with tachinid larvae, as none of the Pupipara have larvae parasitizing other insects.

The nature of the food of the larva still needs to be considered. From the position of the larva in the uterus and the rhythmic movements of its cephalic pump, it should take up any material, either liquid or in suspension, that fills the common median oviduct. Leuckart and Pratt, followed by most authors, thought that this material was essentially, if not solely, the secretion from the milk-glands of the female. Berlese (1899), on the other hand, claimed that the larva feeds on the abundant sperm and secretion from the accessory glands of the male, both being injected in the uterus at the frequent matings. He also stated that the secretion from the so-called milk-glands of the female has no nutritive function, but serves only to cover the newly laid larva with the sticky substance that glues the puparium to the fleece. It seems probable that both views are too extreme and that the larval food includes sperm and secretion from the accessory glands as well as secretion from the milk-glands. This would explain the unusual development of the male internal organs. Zacharias (1928), however, found a few spermatozoa in the lumen of the rudimentary spermathecae of the female, so that some of the superfluous sperm might perhaps be resorbed in these organs. The viscose substance which surrounds the larva when voided is most probably a secretion of the milk-glands, as Berlese believed, since no other glands are known that might produce it. That these milk-glands have, in addition, a nutritive function is shown by their development in the other Hippoboscidae, which do not glue the puparium but deposit clean larvae.

*Puparium.*—The full-grown, newly voided larva is completely motionless, there being no muscles of progression. Prematurely laid larvae do not develop further nor transform into puparia.<sup>15</sup> Normally, however, the integument gradually turns chestnut-brown, while it hardens and becomes almost brittle. At the anterior end the papilla with the closed buccal slit is barely visible; while posteriorly the two “polypneustic lobes” protrude somewhat more. Dorsally and ventrally the two rows of 7 depressions of the larva are visible, each row placed in a slight longitudinal groove. The seams of the cap, through which the adult will escape, are difficult to see. The circular seam runs transversely around the body at about the anterior sixth (in Muscoidea it is placed in the apparent maggot segment five). The semicircular seam forms a vertical bow

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<sup>15</sup> Root (1921) has recorded the case of a larva of *M. ovinus* transforming into a puparium inside the mother's uterus, later developing into an adult ked.

slightly dorsad of the buccal papilla and connected on the sides with the circular seam. When about to hatch, the adult pushes the blood by contraction of abdomen and thorax into the reversible ptilinal pouch. This exerts increasing pressure on the inner wall of the cap, which finally ruptures at the semicircular seam, into two valves which break off at the circular seam.

A fourth larval instar, or prepupa, is formed within the hardened puparium, and later produces the true pupa. Gäbler (1935) found on the newly formed inner pupa of *Lipoptena cervi* a pair of anterior functional spiracles (thoracic spiracular horns). These are, however, functionless in the pupa of *M. ovinus*, where, according to de Meijere (1902), they are present only as two minute rudiments, placed rather far back of the head; they scarcely project and seem to consist only of a scar, without buttons or pits.

#### HOST RELATIONS

Unquestionably the extreme specialization of the Melophaginae is correlated with the host specificity, which is more pronounced in this group than usual among the Hippoboscidae. In this connection, it is of particular interest that some of these flies are known to act as biological vectors of certain blood parasites of their hosts.

The present discussion will consider only the normal hosts, which I propose calling the *breeding hosts*, as they furnish, not only permanent shelter in the fur, but also a supply of suitable blood enabling the continuous reproduction of the parasite. When the breeding hosts disappear from a district, their parasites do the same. The present-day breeding hosts are not necessarily the primitive hosts, as a parasite may well become permanently adapted to a new host onto which it strayed at first accidentally. The determination of the primitive hosts is a difficult problem, notwithstanding its interest for a study of geographical distribution and evolution. As a rule, when an ectoparasite strays onto an abnormal host, it is unable to live there permanently and to reproduce its kind, temporary hosts being therefore relatively unimportant. Stray hosts will be mentioned in the body of the paper under the several species.<sup>16</sup>

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<sup>16</sup> In matters of classification and nomenclature of the hosts, I follow, in the main, R. Lydekker's Catalogue of the Ungulate Mammals in the British Museum (London, 1913-1916; 5 vols.), and, for the African species, Glover M. Allen's Checklist of African Mammals (1939, Bull. Mus. Comp. Zoöl., LXXXIII).

All Melophaginae are normal and obligate, permanent but freely-moving, blood-sucking ectoparasites of hoofed mammals of the order Artiodactyla, being restricted to the three families Bovidae, Cervidae and Tragulidae. The majority of the species occur, moreover, on the suborder Pecora or true ruminants (Bovidae and Cervidae), which "form at the present time an extremely homogeneous group, one of the best-defined and most closely united of any of the Mammalia." (W. H. Flower and R. Lydekker, 1891, *An Introduction to the Study of Mammals Living and Extinct*, p. 307.) The Tragulidae are so closely allied to them, that some students include them in the Pecora; but others place them in a distinct suborder Tragulina.

Bovidae.—This family is found, in a wild state, throughout the World with the exception of South America and Australia; but certain domesticated species are now cosmopolitan. Although over 150 Recent species (with many subspecies) are known, arranged in 52 genera, Melophaginae have been recorded thus far from only 27 species, belonging to 17 genera.<sup>17</sup> These louse-flies seem to avoid most of the large and very large members of the family, belonging to the subfamilies Ovibovinae, Bovinae (cattle, bison, buffalo), Alcelaphinae, Madoquinae, Oreotraginae, Pantholopinae, Saiginae and Oryginae. Some of these, it may be mentioned, harbor other louse-flies of the subfamily Hippoboscinae.

Subfamily Caprinae.—This contains the goats and sheep and is restricted, in a wild state, to Europe, Asia, North Africa and western North America. Three of the five genera have no known louse-flies: *Pseudois* (bharal), *Ammotragus* (arui or aoudad), and *Hemitragus* (tahr). The six species of wild sheep (*Ovis*) have never been properly investigated for ectoparasites in nature, although two of them are reported to harbor *Melophagus ovinus*: the Marco Polo sheep, *Ovis ammon poli* Blyth, of the Pamirs; and the Alaskan mountain sheep, *Ovis dalli* Allen (the type host of *Melophagus ovinus montanus*, which appears to be identical with typical *M. ovinus*). It is somewhat open to question, however, whether the native American sheep did not acquire their keds from domestic sheep, after the discovery of America.

The usual breeding host of the sheep-ked, *Melophagus ovinus*, is nowadays the domestic sheep, spread by man to most parts of the

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<sup>17</sup> These numbers intend only to show the proportion of species of Bovidae known as hosts. There is no agreement among mammalogists as to the number of genera and species to be recognized.

World. Although treated as a distinct species, *Ovis aries* Linnaeus, it is not known in a wild state and its ancestry is obscure. It is generally supposed that the many domesticated breeds have a mixed origin, although derived mainly from the wild mouflon, *Ovis musimon* Schreber,<sup>18</sup> formerly widely distributed in southern Europe (now living in Sardinia and Corsica only), and from the argali, *Ovis ammon* (Linnaeus), of Central Asia. The wild red sheep of Cyprus and Asia Minor, *Ovis orientalis* Brandt and Ratzeburg, may also have contributed to the original stock.<sup>19</sup> It is perhaps significant in this connection, that *Melophagus ovinus* is reported from Marco Polo sheep, which is generally regarded as a race only of the argali.

Lydekker recognizes nine species of wild goats (*Capra*), now living in the mountains of the Mediterranean countries, Asia Minor, Arabia, Nubia and Central Asia. Probably most of these harbor *Lipoptena*, although these flies have only been reported thus far from the Nubian ibex, *Capra nubiana* F. Cuvier, and the wild ancestor of the domestic goat of Asia Minor and Arabia, *Capra hircus aegagrus* Erxleben. At present *Lipoptena capreoli* is a common parasite of domestic goat, *Capra hircus* Linnaeus, in the Near East. The closely related *Lipoptena chalcomelaena* occurs on the several races of *Capra nubiana*. Speiser (1905) reports it also from *Capra hircus aegagrus*, after specimens obtained by Kotschy in Asia Minor, but there is a possibility that these parasites were *L. capreoli*. The sheep- ked, *Melophagus ovinus*, frequently passes to domestic goats, where these animals mingle with sheep, although it is not yet known whether it is able to breed permanently or remain alive for long on this type of host. There is also one record of *M. ovinus* from a wild goat in the Caucasus (? *Capra caucasica*). Like those of sheep, the several domestic breeds of goats are apparently polyphyletic.<sup>20</sup> The ancestral stock of most breeds was probably the wild goat or pasang, *Capra hircus aegagrus* Erxleben, of Arabia, Asia Minor and Greece. A few breeds may have been derived from the markhor, *Capra fal-*

<sup>18</sup> Kruseman (1937, Entom. Bericht. Nederl. Ent. Ver., IX, p. 331) mentions specimens of *Lipoptena* at the Amsterdam Museum, labelled as taken from mouflon. He refers them to *L. cervi*, but notes that they were very small. This identification is questionable.

<sup>19</sup> See C. Keller, 1902, Die Abstammung der ältesten Haustiere, (Zürich), pp. 176-183; and R. Lydekker, 1912, The Sheep and its Cousins, (London).

<sup>20</sup> See C. Keller, *Op. cit.*, pp. 205-209.

*coneri* (Wagner), of Central Asia, or even from the tahr, *Hemitragus jemlahicus* (H. Smith), of the southern Himalaya.

Subfamily Rupicaprinae.—These have much the same distribution as the Caprinae, with which some authors unite them. No louse-flies are known as yet from three of the five genera: *Nemorhaedus* (goral), *Budorcas* (takin), and *Oreamnos* (wild white goat of North America). *Rupicapra rupicapra* (Linnaeus), the chamois or gemse of the mountains of Europe and Asia Minor and the Caucasus, has a fur much like that of sheep, with a thick under coat of short wool beneath the longer hair. This peculiarity may account for the occurrence on this animal of a distinct species of *Melophagus* (*M. rupicaprinus*), in addition to a peculiar *Lipoptena* (*L. couturieri*).

*Capricornis* contains the two species of serows of the Oriental Region. No flies are as yet known from the larger species, *C. sumatrensis* (Bechstein), of India, Indo-China, southern China and Sumatra. *Lipoptena japonica* is described in this paper from the dwarf serow, *C. crispus* (Temminck), of Japan and Formosa, and it is worthy of notice that this fly is very closely allied to *L. couturieri* of the European chamois.

Subfamily Neotraginae.—The small or medium-sized African antelopes of this group belong to five genera. *Ourebia* (oribi) has 3 species, one of which, *Ourebia ourebi* (Zimmermann), is one of the normal hosts of *Echestypus sepiaceus*. *Raphicerus* (steinbok; including *Nototragus*, the grijsbok) has 3 species, one, *Raphicerus campestris* (Thunberg), being the normal host of *Echestypus binoculus* in South Africa. *Nesotragus* (suni or dwarf antelopes) has 2 species, one, *Nesotragus moschatus* von Dueben, of East Africa, being one of the hosts of *Lipoptena hopkinsi*. The other genera have no known ked-flies: *Hylarnus* (Bates' dwarf antelope) and *Neotragus* (royal antelope), both restricted to the West African forest region.

Subfamily Cephalophinae.—This comprises the small African antelopes known as duikers, *Cephalophus* (with 17 species) and *Sylvicapra* (with 1 species). *Cephalophus rufilatus* Gray and *Cephalophus caerulus* (Ham. Smith) are the normal hosts of *Echestypus sepiaceus*; and *Cephalophus nigrifrons* Gray and *Cephalophus caerulus*, those of *Lipoptena hopkinsi*. *Sylvicapra grimmia* (Linnaeus) is one of the normal hosts of *Echestypus paradoxus*.

Subfamily Antilopinae (or Gazellinae).—The small African springbok, *Antidorcas marsupialis* (Zimmermann), is one of the two known hosts of *Echestypus binoculus*. *Gazella* comprises the

true gazelles, with 11 species in western, southern and central Asia, and 11 species in North and East Africa. On one of these, *Gazella gutturosa* (Pallas), of Mongolia, Pallas obtained his "*Hippobosca antilopes*," which appears to be a species of *Lipoptena* not recognized since. *Echestypus sepiaceus* has been taken in East Africa on *Gazella tilonura* (Heuglin) and *Gazella rufifrons* Gray; possibly also on Grant's gazelle, *Gazella granti* Brooke, in Kenya. The other genera of this group have as yet no known Melophaginae: *Antilope* (heran), of India; and *Litocranius* (gerenuk), of northeastern Africa.

Subfamily Aepycerotinae.—Some authors combine this subfamily with the Antilopinae. It consists of only one antelope, *Aepyceros melampus*, (Lichtenstein), the impalla of South and East Africa, one of the recorded hosts of *Echestypus paradoxus* (perhaps an accidental host only).

Subfamily Reduncinae.—This comprises large or medium-sized antelopes of the 6 genera *Adenota* (kob), *Ammodorcas* (dibatag), *Kobus* (waterbuck), *Onotragus* (lechwe), *Pelea* (Vaal rhebok) and *Redunca* (reedbuck). *Echestypus paradoxus* has been reported by Bedford from *Redunca arundinum* (Boddaert), but this occurrence must have been accidental; and the same may apply to the single specimen of *E. paradoxus* supposedly taken off *Kobus ellipsiprymnus* (Ogilby) in Zululand. If any of these large and common antelopes were regular breeding hosts of Melophaginae, it would seem that more records would be available.

Subfamily Tragelaphinae.—Large or medium-sized antelopes of Africa and southern Asia. Of the seven genera, four have no known louse-flies: *Boöcercus* (bongo), *Limnotragus* (sitatunga), *Boselaphus* (nilgau), and *Tetracerus* (four-horned antelope). Of the two African species of *Strepsiceros*, or kudus, *S. strepsiceros* (Pallas) is a normal host of *Echestypus paradoxus*, more rarely of *E. sepiaceus*; while *Strepsiceros imberbis* Blyth harbors only *E. paradoxus*. Allen recognizes three species (and many races) of *Tragelaphus*, all of Africa, two of which are hosts of louse-flies. *Tragelaphus scriptus* (Pallas), the bushbuck, harbors commonly *Echestypus paradoxus*, more rarely *E. sepiaceus*. *Tragelaphus angasii* Gray, the nyala, is the host of *E. paradoxus*. There is a single, perhaps accidental, record of *E. paradoxus* off *Taurotragus oryx* (Pallas), the eland.

Cervidae.—According to Lydekker, this family extends in the Old World from the neighborhood of the Arctic Circle southward to the Mediterranean islands, extreme northwestern Africa, India, the

Malay Archipelago and the Philippines. In the New World, it covers most of the mainland of North and South America. Two subfamilies are recognized.

Subfamily Moschinae.—This comprises only the musk-deer, *Moschus moschiferus* Linnaeus, of central and eastern Asia. Over a century ago, Pallas described a "*Hippobosca moschi*" from this host. Unfortunately this parasite is at present unrecognized, although it was obviously a *Lipoptena*.

Subfamily Cervinae.—There are probably about 40 Recent species, placed in 14 genera, of which the following eight have not yet yielded keds: *Elaphurus* (of China), *Elaphodus* (of China), *Blastocerus* (of South America), *Hippocamelus* (of the South American Andes and Patagonia), *Pudu* (of the South American Andes), *Rangifer* (reindeer and caribou of northern Eurasia and North America), *Hydropotes* (of China), and *Dama* (of southern Europe, Asia Minor and Persia).<sup>21</sup> No doubt some of these will eventually be found to harbor species of *Lipoptena*.

*Muntiacus* (or *Cervulus*) comprises six species of barking deer (muntjacs or kijangs), extending from India to China, Formosa, Sumatra, Java and Borneo (not in the Philippines). The most widely distributed species, *M. muntjak* (Zimmermann), occurs over much of this area and is the normal host of *Lipoptena pauciseta* and *L. efovea*.

*Cervus* includes the subgenera *Axis*, *Hylaphus*, *Rusa*, *Rucervus* and *Sika*, which are sometimes given generic rank. In the Old World its range is about that of the family, but in America it does not reach south of Mexico. The following five species are known to have louse-flies. *Cervus* (*Axis*) *axis* Erxleben, the chital of Peninsular India and Ceylon, harbors *Lipoptena efovea*. *Cervus* (*Rusa*) *unicolor* Bechstein, the sambar of the Oriental Region, is the host of *Lipoptena rusaecola* in the Philippines. One of the races of the sika deer, *Cervus* (*Sika*) *nippon* Temminck, is reported as the host of *Lipoptena cervi* in the Far-East. *Cervus* (*Cervus*) *elaphus* Linnaeus, the red deer of Europe and Asia Minor, harbors normally *Lipoptena cervi*, and this parasite is also known from the Far-Eastern race, *Cervus elaphus xanthopygus* Milne-Edwards.

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<sup>21</sup> *Dama dama* (Linnaeus), the fallow deer, was listed by Linnaeus as one of the hosts of his "*Pediculus cervi*," but I am unable to find a reliable or definite record of the capture of a *Lipoptena* on this host. Linnaeus apparently never saw a specimen of deer-ked. Later authors merely copied his statement.

Specimens of *Lipoptena depressa* have been taken on the North American wapiti (often miscalled elk), *Cervus (C.) canadensis* Schreber.

*Odocoileus* (or *Cariacus*) includes most of the New World deer, extending from Alaska to Peru, Bolivia and Northern Brazil. Lydekker recognized three species, but these have now been reduced to two, each with several races. Those of the white-tailed deer, *Odocoileus virginianus* (Boddaert), occur over most of the range of the genus and are the normal hosts of the two indigenous American species of *Lipoptena* (*L. depressa* and *L. mazamae*) and of *Neolipoptena ferrisi*. Those of the mule-deer, *Odocoileus hemionus* (Rafinesque) of western North America, are normal hosts also of *Lipoptena depressa* and *Neolipoptena ferrisi*. In addition, the introduced *Lipoptena cervi*, of Europe, has become established on the indigenous white-tailed deer, *O. virginianus borealis* Miller, of the northeastern United States.

*Mazama* (or *Coassus*) comprises, according to Lydekker, eleven species of brockets, ranging throughout Central and tropical South America. Probably all of these are likely to harbor *Lipoptena mazamae*, although there are at present records only from *Mazama tema* Rafinesque (Syn.: *M. sartorii* de Saussure), *Mazama americana* (Erxleben) (Syn.: *M. rufa* Illiger), and *Mazama simplicicornis* (Illiger) (Syn.: *M. nemorivaga* Cuvier).

*Capreolus*, with one species, *Capreolus capreolus* (Linnaeus), the roe or roebuck of Europe, occurs in several races throughout Europe and Asia north of the Himalaya. It is the most common breeding host of *Lipoptena cervi*.

Lydekker recognizes only one species of *Alces*, *A. alces* (Linnaeus), including the true elk of Europe and the moose of North America; but he divides it into five races. The European, typical race is one of the breeding hosts of *Lipoptena cervi*. No Melophaginae have as yet been found on the American moose.

Tragulidae.—This is an isolated and apparently ancient branch of ruminants, with few living representatives, placed in 2 genera. No louse-flies are known as yet from the water-chevrotain, *Dorcatherium aquaticum* (Ogilby), of equatorial Africa. *Tragulus* comprises the chevrotains or mouse-deer of southeastern Asia and the Malay Archipelago, with 4 species, one of which, *Tragulus kanchil* (Raffles), is a breeding host of *Lipoptena gracilis*.

Although narrower on the whole than that of most louse-flies of birds, the host specificity of the Melophaginae is of the type characteristic for Hippoboscidae. Very few species are known from one

host only and most of these cases may be due to insufficient collecting. As a rule, each parasite lives normally on two or a few closely related hosts, members either of the same genus or of the same family. No fly is known to parasitize representatives of more than one family. It should be noted also, that all louse-flies recorded as normal parasites from any of the Caprinae, Rupicaprinae, Cephalophinae, Neotraginae, Antilopinae, Cervidae, and Tragulidae belong to the Melophaginae. They occur, therefore, mostly on small or medium-sized Pecora, except for the few records from eland, oribi, impalla, waterbuck, kudu, wapiti and elk.<sup>22</sup>

Of the two species of *Melophagus*, one is a fairly specific parasite of sheep (*Ovis*), although occasionally found on goats (*Capra*); while the other is restricted to chamois (*Rupicapra*). The genus is, therefore, a peculiar parasite of Caprinae and Rupicaprinae. *Echestypus* occurs only on African antelopes belonging to six subfamilies and twelve genera (*Gazella*, *Antidorcas*, *Ourebia*, *Raphicerus*, *Strepsiceros*, *Taurotragus*, *Aepyceros*, *Tragelaphus*, *Redunca*, *Kobus*, *Cephalophus* and *Sylvicapra*); but none of the three species is restricted to a single host. *Neolipoptena* occurs only on two North American deer of the genus *Odocoileus*. The 13 recognized species of *Lipoptena* have together a much wider range of breeding hosts, including representatives of 6 subfamilies of Bovidae, as well as of Cervidae and Tragulidae. Seven of the species are known at present from a single host only; of one the host is unknown; and the remaining five have two or more breeding hosts. It is to be hoped that these considerations will discourage future workers from describing new species merely because the specimens were obtained from a host not previously known to harbor Melophaginae.

#### BREEDING HOSTS OF MELOPHAGINAE

##### Order ARTIODACTYLA

##### Suborder Pecora

##### Family BOVIDAE

##### Subfamily CAPRINAE

*Ovis aries* Linnaeus, domestic sheep: *Melophagus ovinus*.

*Ovis ammon poli* Blyth: *Melophagus ovinus* (?).

*Ovis dalli* Allen: *Melophagus ovinus* (?).

*Capra hircus* Linnaeus, domestic goat: *Lipoptena capreoli*.

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<sup>22</sup> Possibly some of these larger ruminants are only accidental or at most temporary hosts.

*Capra hircus aegagrus* Erxleben: *Lipoptena chalcomelaena* (?).  
*Capra nubiana* F. Cuvier: *Lipoptena chalcomelaena*.

Subfamily RUPICAPRINAE

*Rupicapra rupicapra* (Linnaeus): *Melophagus rupicaprinus*; *Lipoptena couturieri*.  
*Capricornis crispus* (Temminck): *Lipoptena japonica*.

Subfamily CEPHALOPHINAE

*Cephalophus rufilatus* Gray: *Echestypus sepiaceus*.  
*Cephalophus caeruleus* (Ham. Smith): *Lipoptena hopkinsi*; *Echestypus sepiaceus*.  
*Cephalophus nigrifrons* Gray: *Lipoptena hopkinsi*.  
*Sylvicapra grimmia* (Linnaeus): *Echestypus paradoxus*.

Subfamily ANTILOPINAE

*Antidorcas marsupialis* (Zimmermann): *Echestypus binoculus*.  
*Gazella gutturosa* Pallas: *Lipoptena antilopes*.  
*Gazella tilonura* (Heuglin): *Echestypus sepiaceus*.  
*Gazella rufifrons* Gray: *Echestypus sepiaceus*.  
*Gazella granti* Brooke: *Echestypus* (? *sepiaceus*).

Subfamily NEOTRAGINAE

*Ourebia ourebi* (Zimmermann): *Echestypus sepiaceus*.  
*Raphicerus campestris* (Thunberg): *Echestypus binoculus*.  
*Nesotragus moschatus* von Dueben: *Lipoptena hopkinsi*.

Subfamily AEPYCEROTINAE

*Aepyceros melampus* (Lichtenstein): *Echestypus paradoxus* (accidental?).

Subfamily REDUNCINAE

*Redunca arundinum* (Boddaert): *Echestypus paradoxus* (accidental?).  
*Kobus ellipsiprymnus* (Ogilby): *Echestypus paradoxus* (accidental?).

Subfamily TRAGELAPHINAE

*Strepsiceros strepsiceros* (Pallas): *Echestypus paradoxus*; *E. sepiaceus*.  
*Strepsiceros imberbis* Blyth: *Echestypus paradoxus*.

*Tragelaphus scriptus* (Pallas): *Lipoptena hopkinsi*; *Echestypus paradoxus*; *E. sepiaceus*.

*Tragelaphus angasi* Gray: *Echestypus paradoxus*.

*Taurotragus oryx* (Pallas): *Echestypus paradoxus* (accidental?).

#### Family CERVIDAE

##### Subfamily MOSCHINAE

*Moschus moschiferus* Linnaeus: *Lipoptena moschi*.

##### Subfamily CERVINAE

*Muntiacus muntjak* (Zimmermann): *Lipoptena pauciseta*; *L. efovea*.

*Cervus (Cervus) elaphus* Linnaeus: *Lipoptena cervi*.

*C. elaphus xanthopygus* Milne-Edwards: *Lipoptena cervi*.

*Cervus (Cervus) canadensis* Schreber: *Lipoptena depressa*.

*Cervus (Axis) axis* Erxleben: *Lipoptena efovea*.

*Cervus (Rusa) unicolor* Bechstein: *Lipoptena rusaccola*.

*Cervus (Sika) nippon* Temminck: *Lipoptena cervi*.

*Odocoileus virginianus* (Boddaert): *Neolipoptena ferrisi*; *Lipoptena depressa*; *L. mazamae*; *L. cervi* (introduced).

*Odocoileus hemionus* (Rafinesque): *Neolipoptena ferrisi*; *Lipoptena depressa*.

*Mazama tema* Rafinesque: *Lipoptena mazamae*.

*Mazama americana* (Erxleben): *Lipoptena mazamae*.

*Mazama simplicicornis* (Illiger): *Lipoptena mazamae*.

*Capreolus capreolus* (Linnaeus): *Lipoptena cervi*.

*Alces alces* (Linnaeus): *Lipoptena cervi*.

#### Suborder Tragulina

##### Family TRAGULIDAE

*Tragulus kanchil* (Raffles): *Lipoptena gracilis*.

#### GEOGRAPHICAL DISTRIBUTION

The Melophaginae are nowadays nearly cosmopolitan, but their occurrence in Australia, Tasmania, New Zealand and Hawaii is due solely to the importation by man of *Melophagus ovinus* with domestic sheep.<sup>23</sup>

*Melophagus* (with 2 species) was, I believe, originally restricted in a wild state to the Palearctic Region, its occurrence elsewhere

<sup>23</sup> Melophaginae are unknown in the Antilles, Madagascar, New Guinea and most of the Pacific islands (except Hawaii).

being due to importation by man. The few records of *M. ovinus* from North American wild bighorn sheep are somewhat open to question and may be due to the species having strayed from imported domestic sheep after the discovery of the New World. *Neolipoptena* (with 1 species) is strictly North American. *Lipoptena* (with 13 species) is nearly world-wide, lacking only in Madagascar, the Australian Region, New Guinea and the Pacific islands. *Echestypus* (with 3 species) is strictly Ethiopian.

The distribution over the several continents is as follows:

Europe: *Melophagus ovinus*, *M. rupicaprinus*; *Lipoptena cervi*; *L. couturieri*; *L. capreoli*.

Asia: *Melophagus ovinus*; *Lipoptena cervi*; *L. chalcomelaena*; *L. capreoli*; *L. japonica*; *L. pauciseta*; *L. efovea*; *L. gracilis*; *L. grahami*.

Malay Archipelago: *Lipoptena pauciseta*; *L. rusaecola*.

Africa: *Melophagus ovinus* (introduced); *Lipoptena cervi*; *L. chalcomelaena*; *L. hopkinsi*; *Echestypus paradoxus*; *E. sepiaceus*; *E. binoculus*.

Australia, New Zealand and Hawaii: *Melophagus ovinus* (introduced).

North America: *Melophagus ovinus* (probably introduced); *Neolipoptena ferrisi*; *Lipoptena cervi* (introduced); *L. depressa*; *L. mazamae*.

South America: *Melophagus ovinus* (introduced); *Lipoptena mazamae*.

#### SUBFAMILY CHARACTERS, AFFINITIES AND EVOLUTION

The subfamily was first established by Speiser (1908, Zeitschr. Wiss. Insektenbiol., IV, p. 445), who called it Lipopteninae. I prefer the name Melophaginae, proposed by Bezzi (1916, Natura, Riv. Sci. Nat., VII, p. 177), because it is derived from the oldest genus included.

The following combination of characters separates the Melophaginae from all other Hippoboscidae. Occipital margin straight or slightly arched, closely fitted in the slightly concave humeral margin of the prothorax. Antennal pits far apart, completely surrounded by a continuous rim, containing the minute, subglobular antennae, which lack a dorsal prolongation, the second segment without or with a trace only of dorsal longitudinal furrow. Frontoclypeus forming a single sclerite, with undivided, truncate anterior margin. Ptilinal suture separated from the postvertex by a well-developed mediovertex. Compound eyes relatively small, extend-

ing over the dorsal and ventral surfaces of the head. Pronotum developed dorsally as a narrow transverse sclerite. Humeral angles rounded off, slightly produced. Two pairs of thoracic spiracles. Postalar pleural process (pleurotergite of postscutellum) rudimentary in *Melophagus*, present as a low, simple swelling in the other genera (just above the metathoracic spiracle). Scutellum much smaller than usual. Base of abdomen dorsally with a distinct sclerotized plate, narrowly divided medially into two sclerites (pleurites I); ventrally with a single strongly sclerotized plate. Seven pairs of abdominal spiracles. Legs unusually short and heavy. Claws more or less asymmetrical, simple though apparently bidentate, without supplementary tooth between the sharp apex and the strong, flattened "heel" of the base. Wings completely aborted in *Melophagus*; fully developed but weak in newly hatched adults of the other genera, where they break off near the base, leaving permanent stumps. Costa thickened at extreme base and over apical half, very thin in the intervening stretch; only three longitudinal veins and one cross-vein present; alula, squama and squamula rudimentary. Halteres well developed in the winged genera, wanting in *Melophagus*.

The Melophaginae are an isolated group of Hippoboscidae and in many respects the most highly evolved in the family.<sup>24</sup> They comprise the only louse-flies having lost both wings and halteres permanently (*Melophagus*). Their extreme specialization is also shown by the structure of the head (in which the two apical arms of the fronto-clypeus are fused and a complete rim encircles the antennal pits), the abdomen (with the peculiar dorsal and ventral basal sclerites) and the wings (when present, with much reduced venation and rudimentary alula).

These considerations and others to be developed later, strongly suggest that the adaptation of the ancestors of the Melophaginae to mammalian hosts is of long standing. In the Recent fauna the Hippoboscidae peculiarly adapted to mammals belong to the four subfamilies Hippoboscinae, Alloboscinae, Ortholfersinae and Melophaginae. These four groups show no closer relationship to one

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<sup>24</sup> Williston (1908, Manual of North American Diptera, 3d Ed., p. 62) stated that "*Nycteribia* and *Melophagus* are perhaps the most highly specialized of all insects, that is, they have traveled further from the starting point." Some of the Streblidae (*Asco-dipteron*) have, however, progressed much farther, though in a different direction.

another than to the remaining two subfamilies (Ornithomyiinae and Ornithoicinae) which live only on birds. The adaptation to mammalian hosts apparently proceeded along four independent lines of descent. To judge from their extreme specialization, the Melophaginae may be the oldest of the four and presumably developed shortly after the Class Mammalia became differentiated as such, or at least shortly after the mammals acquired a hairy coat offering a suitable permanent shelter for the flies.

Nowadays the study of the affinities of a biological group is that of its evolution in time and space. It should be an attempt to discover its ancestral stock and its further differentiation and dispersal. Unfortunately, as is frequently the case in Insects, no facts are available bearing directly on this problem for the Hippoboscidae as a whole or for any of the subfamilies. No fossils are known that might be referred to the family or to its possible ancestors. The oldest near relatives known are typical Myiodaria from the Eocene of North America. As these were already differentiated into acalyprate and calyptrate types and as the Hippoboscidae seem to have branched off from the pre-Myiodarian stem before these two types separated, the common ancestors must have been older, presumably of Cretaceous age. Unfortunately, the Cretaceous period is as yet nearly a blank, so far as our knowledge of Insects is concerned. The Diptera of the next earlier period, the Jurassic, are somewhat better known, but no Myiodaria or pre-Myiodarian types have been found among them. The hypothetical dating to the Cretaceous of the ancestral Hippoboscidae will be referred to later.

In the absence of a fossil record, speculation as to the evolution of the louse-flies must rely entirely on circumstantial evidence, based in part on the comparative morphology, anatomy and ontogeny of the Diptera, and in part on the direct or inferred knowledge of the evolution of the vertebrate hosts. An adequate discussion of these topics would call for an exhaustive consideration of all Hippoboscidae, which is obviously beyond the scope of this paper. I shall merely state my present position in a few postulates.

1. The Hippoboscidae are a monophyletic group, its recognizable subdivisions (subfamilies) having been derived from one common root, although some of them no doubt branched off earlier than others. All agree in the essential anatomical and morphological features, while the differences appear to be secondary specializations. In particular, no single character of primary importance sets off all members of any of the subfamilies from all other Hippo-

boscidae, these subgroups being characterized by combinations of characters. Thus, in Melophaginae, only the peculiar venation of the winged forms is not duplicated elsewhere, and this is of relatively little importance, since it can be derived readily from some other hippoboscoid venational type and is seemingly correlated with the habit of dropping the wings shortly after hatching.

Bezzi (1916, *Natura*, Riv. Sci. Nat., VII, p. 157) suggested a polyphyletic origin for the Hippoboscidae, particularly for the forms with reduced or rudimentary wings, to which the following quotation refers: "*Allobosca* must be a very old form, like the Australian *Ortholfersia* of kangaroos, which has, moreover, retained the wings; it is not possible at present to advance a hypothesis concerning its origin. The other three genera found on mammals [*Melophagus*, *Echestypus*, and *Lipoptena*] were probably derived from the higher Myiodaria related to *Calliphora*, a group containing many cuticolous forms. The genera living on birds [*Craeterina*, *Stenopteryx*, *Myiophthiria* and *Brachypteromyia*] originated probably from nidicolous acalyptrate lower Myiodaria, perhaps Dryomyzidae, a family containing *Neottiophilum*. It seems to me that the case of *Carnus* illustrates very well the transition from a winged nidicolous acalyptrate to an apterous ectoparasite of a bird." In an earlier paper Bezzi (1911, *Arch. de Parasitologie*, XV, pp. 117 and 119) stated that the Hippoboscinae were closely allied to the Glossinidae.<sup>25</sup> Although these suggestions are no doubt worthy of serious consideration, I doubt whether the general conclusion is warranted by the facts. All Hippoboscidae, whether

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<sup>25</sup> The many similarities in structure and habits between Hippoboscinae and Glossinidae were first discussed by Roubaud (1909, *Rapport Mission Etude Maladie du Sommeil*, pp. 381-504), who regarded them as due to convergence. Zavattari (1928, *Atti Soc. Ital. Sci. Nat.*, LXVII, pp. 37-70) elaborated on them and concluded that they support Bezzi's contention of a close relationship between the two groups. In my opinion, the similarities do not point to a true kinship, closer than that existing between the several other groups of Myiodaria. They are due partly to the retention by both Hippoboscidae and Glossinidae of certain archaic characters of the primitive pre-Myiodarian stock (see C. H. T. Townsend, 1935, *Manual of Myiology*, pt. 2, p. 117), and partly to convergence of adaptive specializations. It should be noted that nothing in the head structure of Glossinidae even suggests the peculiar condition characteristic of all Hippoboscidae.

of birds or of mammals, show an unmistakable kinship and it is most improbable that this could have been acquired by mere convergence in four or five distinct stocks, independent of some common ancestral root.

2. The Hippoboscidae are an ancient and highly specialized offshoot from the ancestral stock of the Myiodaria and show no special kinship to the other groups generally included in the Pupipara.<sup>26</sup> They do not appear to tie up satisfactorily with either of the major subdivisions of Recent Myiodaria (Holometopa and Schizometopa), although they are obviously closer to the Schizometopa. For this reason, it seems wisest to follow C. H. T. Townsend's course (1935, *Manual of Myiology*, pt. 2, pp. 81 and 100-101), at least to the extent of ranking the Hippoboscidae as a subsection of the Diptera Schizophora, more or less on a par with the subsection Myiodaria. The one distinctive feature shared by all Hippoboscidae is the shape and structure of the head. This is flattened dorso-ventrally and horizontal, with one plate-like fronto-clypeus broadly dividing the antennae, which have a peculiar structure and are pushed forward and inserted in pits close to the oral margin. The reduction of squama and squamula is apparently a secondary development, determined by the gradual waning of the power of flight; for even the fully winged louse-flies are very poor fliers as compared with most calyptrate Myiodaria. The reduction of these organs follows, moreover, that of the wings. There is scarcely a trace of them in the apterous or subapterous forms and even in the winged Melophaginae; whereas they are well-developed in all genera of Ornithomyiinae with fully developed wings and large alula (particularly in *Ornithoctona*), as well as in *Hippobosca*, though their form is somewhat aberrant; they become rudimentary in the winged genera of bird-flies without or with reduced alula.

C. H. T. Townsend (1935, *op. cit.*, p. 81) at first included in the subsection "Pupipara" (which he calls "Nymphipara"), within the superfamily Hippoboscidea, the two families Hippoboscidae and Streblidae. In later "Addenda and Corrigenda" (1935, pt. 2, p. 292; 1938, pt. 6, pp. 243-244; 1938, pt. 7, p. 429), he added the

<sup>26</sup> Contrary to prevailing opinion, I am inclined to regard the Streblidae and Nycteribiidae as very closely related and derived from one ancient branch of pre-Myiodaria, probably of more recent derivation than the Hippoboscidae and entirely independent from them. The Nycteribiidae I should regard as perhaps no more than an extreme specialization of the Streblidae.

Nycteribiidae and Braulidae. The subsection he characterized as follows: "Head of fly more or less closely united with thorax, not freely movable; neck vestigial or much reduced." This scarcely fits *Hippobosca* and even less *Ornithoica* among the Hippoboscidae (nor several of the Streblid genera and all the Nycteribiidae). Moreover, these peculiarities do not seem to be of fundamental importance, but merely the result of the extreme flattening of head and thorax in most Hippoboscidae.

3. Very probably the earliest Hippoboscidae were parasites of birds and the subfamilies now mainly or wholly parasitic on mammals were derived from bird-flies. Owing to the lack of a fossil record this is a pure hypothesis. It may be noted, in the first place, that in the Recent fauna the bird louse-flies far outrank those of mammals in point of numbers and in variety. Thirteen (or 65 per cent) of the 20 generally recognized genera and 96 (or 78 per cent) of the 123 recognizable species occur on birds. The bird louse-flies make up the two subfamilies Ornithomyiinae (12 genera with 91 species) and Ornithoicinae (1 genus with 4 species). Those of mammals are distributed among four subfamilies: Hippoboscinae (1 genus with 7 species and one additional species on the ostrich), Alloboscinae (1 genus with 1 species), Ortholfersinae (1 genus with 4 species) and Melophaginae (4 genera with 19 species). As all Recent Hippoboscidae are highly specialized, it is difficult to trace primitive characters among them. Nevertheless the forms which are clearly the most generalized are found nowadays on birds only and those farthest evolved, on mammals. *Ornithoica* is perhaps the most generalized genus of the entire family, as shown particularly by the movable head, the narrow fronto-clypeus, the relatively simple and protruding antennae, the structure of the thorax (with straight anterior margin, broad and blunt humeri, laterally placed mesothoracic spiracles, narrow and simple prosternum), the presence of the alula, the complete venation of the wing, and the simple tarsal claws. Some of the winged genera of Ornithomyiinae are also decidedly less specialized than any of the louse-flies of mammals. I am fully aware, however, that neither of these arguments is very convincing. There are known cases of archaic groups surviving in the Recent fauna only as a few species, while some relatively recent offshoots became very prolific. It might indeed be claimed that louse-flies became more numerous on birds merely because the dense cover of feathers was a more favorable environment than the coarser fur of hairs of the mammals on which they had originally acquired the ectoparasitic habit. Plausibly enough, the extreme

specialization of most Recent louse-flies of mammals might also be claimed to predicate a long previous evolution on the same type of host.

I believe, however, that a brief consideration of the early geologic history of birds and mammals throws some light on the problem and makes it highly probable that the primitive Hippoboscidae were avian parasites. The family originated presumably in the Cretaceous period from some free-living, blood-sucking fly of pre-Myiodarian stock, which acquired the habit of remaining on the host after feeding.<sup>27</sup> The incentive to this was not so much, in my opinion, the acquisition by birds and mammals of a constant and relatively high body and blood temperature, but rather the need for protection against enemies (particularly against the host) while feeding. It should be kept in mind that the ancestral Hippoboscidae were relatively primitive flies, without any of the structural and physiological specializations and adaptations of the Recent species. The dense cover of finely divided, soft, overlapping feathers of birds no doubt offers a much better protection than the simple, relatively loose hairs of most mammals. Both mammals and birds, it is well known, originated independently from terrestrial reptilian stocks. Geologically speaking, mammals are the older group, first traces of them appearing in rocks of late Triassic age, while the oldest-known birds are of Jurassic age. Birds are known in the Cretaceous by a number of dissimilar types, in many essential features similar to modern forms, so that the differentiation of the group must have been far under way at that period. Moreover, it is quite certain that the Jurassic and Cretaceous birds were as fully feathered as the Recent species, providing a cover quite adequate to the development of permanent ectoparasitic habits. Meanwhile, the primitive mammals persisted, but, according to the fossil record, in a few types all of small size (averaging that of rats and mice). What

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<sup>27</sup> Blood-sucking Diptera are no doubt much older, the habit having been acquired by feeding upon the early cold-blooded land Vertebrates, which were dominant throughout the Mesozoic. Even nowadays mosquitoes bite frogs freely, some midges and sand-flies feed on lizards, tabanids attack crocodiles and turtles, while tsetse flies often bite crocodiles. The passage from temporary to permanent ectoparasitism by adult Diptera is illustrated in the Recent fauna by some of the black-flies or Simuliidae that hide in the feathers of birds and by *Carnus hemipterus*, although the latter is not definitely known to be a blood-sucker.

their fur was like, if they had any, we do not know; but it is significant that no Recent Hippoboscidae live on small mammals (specifically on Insectivora and Rodentia). The scarcity and small size of the Mesozoic mammals make them extremely improbable hosts of the ancestral Hippoboscidae, particularly as a fairly large variety of satisfactory bird hosts was available at that time.<sup>28</sup> Mammals, of course, blossomed out in the next or Cenozoic Era, when they became the dominant group; but there is every reason to believe that the true Hippoboscidae had acquired all their distinctive structural and physiological features before the close of the Mesozoic.

4. The Recent Melophaginae developed from avian winged louse-flies that passed onto primitive Artiodactyla, with which order of mammals the group remained closely associated ever since. As they are nowadays restricted to the two suborders Pecora and Tragulina, it seems reasonable to assume that the early Melophaginae became adapted to these particular groups soon after their emergence and in the regions where their differentiation occurred. Henceforth the evolution and dispersal of the keds followed the vicissitudes of the Pecora and Tragulina.

The geologic history of the Artiodactyla is fairly well known, at any rate much better than that of most groups of Insects.<sup>29</sup> The earliest members of the order definitely recognized are of Lower Eocene age; but as these occur both in Europe and North America and have no known allies in the Paleocene faunas of those regions, they must have been invaders from elsewhere. The original stock of the order was probably derived from archaic mammals during the Cretaceous, either in Central Asia or more probably (according to Pilgrim) in Central Africa. At any rate, the order flourished and became world-wide during the Eocene, Oligocene and Miocene, when the Recent families became differentiated. Both sub-orders which concern us (Pecora and Tragulina) had a common ancestor in the Upper Eocene. The Tragulina presumably originated in Central Asia. They spread to Europe and most of the Old World, but never were very prolific and have survived to-day only in two genera in the Oriental and Ethiopian regions. The original birthplace of the Pecora appears to have been also Central Asia, probably during

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<sup>28</sup> The data on the evolution of birds and mammals were taken from A. S. Romer, 1933, *Vertebrate Paleontology* (see particularly pp. 209-213 and 257-261).

<sup>29</sup> See G. E. Pilgrim. 1941. The dispersal of the Artiodactyla. *Biolog. Reviews Cambridge Phil. Soc.*, XVI, pp. 134-163.

the Miocene. They became a flourishing group, eventually spreading to all parts of the world except Australia. Primitive Cervidae are found in the Middle Miocene of Central Asia and Europe, where they were very numerous during the Pliocene and Pleistocene, migrating to America, India and probably most of Africa; but they do not appear to have survived in Central Africa after the Pliocene. The Bovidae may be traced as far back as the Lower Miocene and seem to have had a double developmental center. One series (Aegodontia), including the subfamilies Caprinae, Rupicaprinae, Neotraginae, Antilopinae and Aepycerotinae, originated in Central Asia; while the other (Boodontia), comprising the Tragelaphinae, Reduncinae and Cephalophinae, seems to have developed during the Pliocene in a region between India and Africa.

To judge from the relative numbers of known Extinct and Recent genera and species, the Artiodactyla were evidently a flourishing order during late Tertiary times and are nowadays on the wane. This natural process of decline, which eventually must lead to their extinction, is now being hastened greatly by Man; if indeed Man might not be regarded as a natural adverse factor in the struggle for survival, for few living things have a worse enemy. The several considerations developed in this section seem to warrant the conclusion that the history of the Melophaginae is irrevocably tied up with that of the Artiodactyla. No doubt they too were once more abundant than nowadays and probably reached their zenith during the Oligocene and Pliocene, only a few remnants having survived. Like their hosts, they are a group with a great past, but with little future, a fate shared by all over-specialized organisms. All signs point to their rapid disappearance with their wild hosts within the next century. A very few species may be able to survive on domesticated sheep and goats, although even these might conceivably be exterminated by more powerful insecticides or other means of control. To future naturalists ked-flies would then be known only by the incomplete published accounts, such as I have attempted to bring together in this paper.

#### NAMES PROPOSED IN MELOPHAGINAE

*alcis* (*Lipoptena*) Schnabl.—*Lipoptena cervi*.

*antilopes* (*Hippobosca*) Pallas.—? *Lipoptena*, unrecognized.

[*aptera* (*Hippobosca*) Linnaeus.—*Melophagus ovinus*. Pre-Linnaean.]

*binoculus* (*Echestypus*) Speiser.—*Echestypus*, valid.

*bolivianus* (*Melophagus ovinus*) Bau.—*Melophagus ovinus*.

- [*capensis* (*Ornithobia*) Walker.—Not Melophaginae. See below.]  
*capreoli* (*Pediculus*) “Frisch” v. Olfers.—*Lipoptena cervi*.  
*capreoli* (*Lipoptena*) Rondani.—*Lipoptena*, valid.  
*caprina* (*Lipoptena*) Austen.—*Lipoptena capreoli*.  
*cervi* (*Pediculus*) Linnaeus.—*Lipoptena*, valid.  
*cervi* (*Hippobosca*) Olivier.—*Lipoptena cervi*.  
*cervina* (*Hippobosca*) Nitzsch.—*Lipoptena cervi*.  
*chalconelaena* (*Lipoptena*) Speiser.—*Lipoptena*, valid.  
*conifera* (*Lipoptena*) Speiser.—*Lipoptena mazamae*.  
*couturierii* (*Lipoptena*) Séguy.—*Lipoptena*, valid.  
*depressus* (*Melophagus*) Say.—*Lipoptena*, valid.  
 [ *dubia* (*Lipoptena*) Rudow.—Streblidae.]  
*efovea* (*Lipoptena*) Speiser.—*Lipoptena*, valid.  
*fera* (*Melophagus ovinus* var.) Speiser.—*Melophagus ovinus*.  
*ferrisi* (*Lipoptena*) J. Bequaert.—*Neolipoptena*, valid.  
*gracilis* (*Lipoptena*) Speiser.—*Lipoptena*, valid.  
*grahami* (*Lipoptena*) J. Bequaert.—*Lipoptena*, valid.  
*hirta* (*Lipoptena*) “Loew” Speiser.—*Lipoptena chalconelaena*.  
*hirtella* (*Melophaga*) v. Olfers.—*Melophagus ovinus*.  
*hopkinsi* (*Lipoptena*) J. Bequaert.—*Lipoptena*, valid.  
*ibicis* (*Lipoptera*) Theobald.—*Lipoptena chalconelaena*.  
*japonica* (*Lipoptena*) J. Bequaert.—*Lipoptena*, valid.  
*mazamae* (*Lipoptena*) Rondani.—*Lipoptena*, valid.  
*mexicana* (*Lipoptena depressa* var.) Townsend.—*Lipoptena mazamae*.  
*montanus* (*Melophagus ovinus*) Ferris and Cole.—*Melophagus ovinus*.  
*moschi* (*Hippobosca*) Pallas.—? *Lipoptena*, unrecognized.  
*nigrirostris* (*Ornithomyia*) v. Roser.—*Lipoptena cervi*.  
*obscura* (*Lipoptena cervi* var.) “Rörig” Lühe.—*Lipoptena cervi*.  
*ovilla* (*Hippobosca*) Pallas.—*Melophagus ovinus*.  
*ovina* (*Hippobosca*) Linnaeus.—*Melophagus*, valid.  
*ovis* (*Melophagus*) Harris.—*Melophagus ovinus*.  
*pallida* (*Ornithobia*) Meigen.—*Lipoptena cervi*.  
*pallipes* (*Haemobora*) Curtis.—*Lipoptena cervi*.  
*paradoxa* (*Lipoptena*) Newstead.—*Echestypus*, valid.  
*parvipalpis* (*Echestypus*) Speiser.—*Echestypus paradoxus*.  
*pauciseta* (*Lipoptena*) Edwards.—*Lipoptena*, valid.  
 [ *phyllostomatis* (*Lipoptena*) Rudow.—Streblidae.]  
*pteroi* (*Lipoptena*) Denny.—? *Lipoptena*, unrecognized.  
 [ *reduvius* (*Pediculus*) Moufet.—*Melophagus ovinus*. Pre-Linnaean.]

- rupicaprinus* (*Melophagus*) Rondani.—*Melophagus*, valid.  
*rusaecola* (*Lipoptena*) J. Bequaert.—*Lipoptena*, valid.  
*sepiacea* (*Lipoptena*) Speiser.—*Echestypus*, valid.  
*subulata* (*Lipoptena*) Coquillett.—*Lipoptena cervi*.  
*surinamensis* (*Lipoptena*) Bau.—*Lipoptena mazamae*.  
 [ *tolisina* (*Lipoptena*) "Speiser" Muir, MS.—Not *Melophaginae*;  
 see below.]  
*traguli* (*Lipoptena*) Ferris and Cole.—*Lipoptena gracilis*.  
*trifasciata* (*Melophaga*) v. Olfers.—*Lipoptena cervi*.  
*vulgaris* (*Melophagus*) M'Murtrie.—*Melophagus ovinus*.

*Ornithobia capensis* Walker, 1849, List Dipt. Brit. Mus., IV, p. 1142 (no sex; Natal).—"Picea, capite fulvo antice flavo, verticis vitta ferruginea, pedibus fulvis, alis limpidis. Body pitchy, smooth, shining: head tawny, yellow in front, having on the crown a large dull ferruginous obconical mark, which is slightly concave at the base and truncated at the tip: eyes pitchy; the facets rather large: borders of the chest and spines of the shoulders ferruginous: abdomen dull, clothed with short black hairs: legs tawny, beset with a few bristles; claws black; foot-cushions yellow: wings colorless; veins dark tawny. Length of the body 1 line [= 2.2 mm.]; of the wings 4 lines [= spread of the wings, 8.8 mm.]" This insect, the type of which should be at the British Museum, is as yet unrecognized. From the description it seems to have been not one of the *Melophaginae*, but rather a species of *Ornithoica* or *Ornitheza*, from a bird. Speiser (1908) and Bezzi (1908) transferred it to *Lipoptena* merely because Walker had placed it in *Ornithobia*, a generic name now regarded as a synonym of *Lipoptena*.

*Lipoptena tolisina* "Speiser, MS" was quoted by Muir (1912, Bull. Mus. Comp. Zoöl., LIV, No. 11, pp. 351 and 352) as the name of a parasite which he took on bats (*Miniopterus schreibersi* and *Nyctinomus* sp.) in Amboina. Speiser never described the species, which was really one of the Nycteribiidae, as shown by Muir's labelled specimen. The name was evidently an error of transcription for *Listropoda tolisina* (See H. Scott, 1914, Ann. Mag. Nat. Hist., (8) XIV, p. 230).

KEY TO GENERA AND SUBGENERA

1. Wingless at all stages, the rudiments only of the wings present as minute knobs. No halteres. No ocelli. Basal sternite of abdomen crescent-shaped ..... *Melophagus*. 2.
- Wings well developed in newly-hatched adults, later breaking off close to the base, leaving veined stumps. Halteres present ..... 3.

2. Palpi as long as height of head. No median tergal plates near tip of abdomen ..... *Melophagus*, proper.  
Palpi at most as long as fronto-clypeus. Median tergal plates present near tip of abdomen ..... Subgenus **Dorcadophagus**.
3. No ocelli. Palpi rudimentary or very short. Basal sternite of abdomen crescent-shaped. Median tergal plates large and distributed over most of dorsum ..... *Echestypus*.  
Ocelli present. Palpi well developed, though sometimes short. 4.
4. Basal sternite of abdomen elliptical, with broadly rounded hind margin. Dorsum of abdomen with the median plates very small and placed near the tip ..... **Neolipoptena**.  
Basal sternite of abdomen crescent-shaped ..... *Lipoptena*. 5.
5. Mid tibia with one spur. Median tergal plates small, crowded near the tip of the abdomen ..... Subgenus **Lipoptenella**.  
Mid tibia with two spurs. Median tergal plates distributed over most of the dorsum ..... *Lipoptena*, proper.

#### **Neolipoptena**, new genus

Head broad, transversely elliptical; its slightly convex hind margin inserted in the shallowly concave anterior slope of the prothorax; ventrally, the projecting hind margin rests between the two lobes of the prosternum. Antennae very slightly protruding from the antennal pits. Eyes large, extending over both dorsal and ventral sides of head, of many, minute ommatidia. Ocelli present. Fronto-clypeus, mediovertex, postvertex and inner orbits as in *Lipoptena*. Palpi well developed, shorter than head. Thorax as in *Lipoptena*, but mesothoracic spiracles placed dorsally, far from the side margins of the humeral callosities. Wing as in *Lipoptenella*; third longitudinal vein and costa ending together rather far from tip of wing in a knob-like swelling. Legs as in *Lipoptena*; claws strongly asymmetrical, one claw of each pair being not only longer, but also thicker and with a much broader "heel" than the other; mid tibia with a single true apical spur, but with an additional spine-like seta on each side; fore coxa dorsally with a strong retrograde spur. Abdomen dorsally with a pair of basal sclerites (pleurites I), separated medially; in the female, two median tergal plates, each divided in a pair of sclerites, near the tip of the abdomen and associated with spiracles VI and VII, hence corresponding to the fourth and fifth tergal plates of *Lipoptena cervi*; in the male, only the anterior pair of median sclerites is present, associated with spiracles VI;

ventrally, the basal sclerite is elliptical, with evenly rounded, entire hind margin.

Monotypic for *Lipoptena ferrisi* J. Bequaert, 1935.

The peculiar shape of the fore coxa and of the basal abdominal sternite set off this parasite sharply from all other known Melophaginae. In the reduction of the median tergal plates and the venation of the wing it approaches the subgenus *Lipoptenella*.

1. *Neolipoptena ferrisi* (J. Bequaert). Figs. 4A-F.

*Lipoptena subulata* Ferris and Cole, 1922, Parasitology, XIV, p. 187, figs. 2C and 4 (♀♂; Humboldt Co. and Mendocino Co., off *O. h. columbianus*; Mt. Wilson; all in California). Essig, 1926, Insects Western North America, p. 619. Cole, 1927, Proc. California Ac. Sci., (4) XVII, p. 453 (♂ terminalia). Dixon, 1934, California Fish and Game, XX, p. 279. Not of Coquillett, 1907.

*Lipoptena ferrisi* J. Bequaert, 1935, Bull. Brooklyn Ent. Soc., XXX, p. 170 (new name for *Lipoptena subulata* Ferris and Cole, 1922); 1937, *op. cit.*, XXXII, p. 92 (♀♂). G. J. Spencer, 1938, Proc. Ent. Soc. Brit. Columbia, XXXIV, p. 42 (Pemberton Meadows, British Columbia; Vancouver Id.); 1939, *op. cit.*, XXXV, p. 17 (off *O. h. columbianus*, North end and Campbell River, Vancouver Id.; Pemberton Meadows; off *O. hemionus*, Kamloops; all in British Columbia).

*Female*.—Head much lengthened behind the eyes, which are relatively short; mediovertex short, about as long as fronto-clypeus or postvertex, slightly wider than long; clypeus separated from frons by a superficial prestomal suture, with a fine median longitudinal groove ending in a pit; preptilinal area distinct, without fovea; inner orbit nearly as wide as the eye, with 15 to 20 frontal bristles in anterior two-thirds, some extending behind the eye; one vertical bristle; postvertex long and broad, almost semi-circular; ocelli small, but distinct, in an equilateral triangle near the center of the postvertex. Palpi nearly as long as fronto-clypeus. Pro-mesonotal suture very deep; pronotum distinctly divided from propleura. Mesothorax: no transverse prescutal suture; no longitudinal intrascutal grooves; median notal suture very weak, except anteriorly; transverse mesonotal suture very deep, extending to near the scutellum; posthumeral sutures well marked, except at inner corners; mesothoracic spiracle small, placed dorsally, an extension of the notopleuron apparently separating the

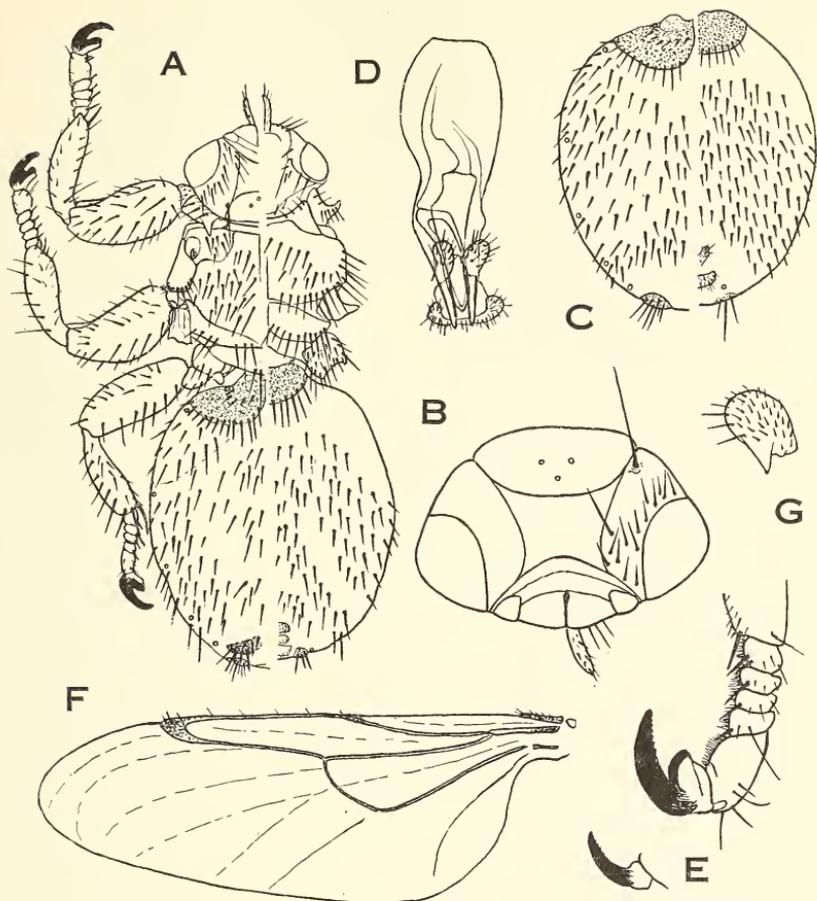


FIG. 4. *Neolipoptena ferrisi* (J. Bequaert): A, female, Mt. Palomar, California, from above (left) and below (right).—B, head of female.—C, abdomen of male, same locality, from above (left) and below (right).—D, male terminalia.—E, tarsus and claws (inner and outer) of fore leg.—F, wing.—G, fore coxa from above.

humeral callosity from the side of the thorax; 6 or 7 acrostichals; laterad of them 16 to 25 setae, in which prealars and laterocentrals cannot be distinguished; 3 or 4 postalars and 3 prescutellars, often forming one continuous row; 7 to 10 heavy, short notopleurals, mostly in one row; 6 or 7 humerals; usually 4 (rarely 3, 5 or 6) scutellars, in 2 pairs and of about equal length; ventrally, mesosternum with relatively few setae, most

of them placed in a curved anterior and a preapical row; basisternum with only an apical row of setae. Abdomen: basal dorsal pleurites shorter and more transverse than in most species of *Lipoptena*, with a comb-like apical row of heavy setae, the disk bare except for a transverse curved row of minute setae; remainder of dorsum mostly membranous, with relatively few, irregularly scattered setae; the only trace of segmentation is a weak oblique depression which, together with a curved row of long setae and the position of spiracles II and III, outlines pleurite II. The two pairs of apical tergal sclerites small, rather far apart in each pair, each with 3 to 5 long setae. Basal ventral sclerite with an apical row of 12 to 16 rather long bristles; no setae on the disk; remainder of venter with a moderate number of irregularly scattered setae. Abdominal spiracles unusually small, perhaps functionless. Legs more thickset than usual, very setulose; femora much swollen; apical spur of fore tibia heavy. Longer claw of each pair very thick and rather blunt; the shorter one much more slender and sharper. Wing with the knob-like swelling at junction of costa and third longitudinal vein darkened.

*Male*.—Similar to female in structure and chaetotaxy. Tip of abdomen with only one pair of median tergal sclerites corresponding to the first pair of the female. Terminalia much smaller than in most *Lipoptena*; aedeagus a simple flattened cone, pointed at apex; parameres slender, straight rods, with pointed tips.

Length (h. + th.): ♀, 1.8 to 2.2 mm.; ♂, 1.5 to 2 mm.

SPECIMENS EXAMINED.—BRITISH COLUMBIA: Victoria; Savary Id.; Kamloops, off *O. h. hemionus*; Pemberton Meadows (R. Anderson); Bobby Burns Mt., Okanagan (J. Grant).—OREGON: High Ridge Lookout Sta., 1 mile NW of Gasquet, Siskiyou National Forest, off *O. v. leucurus*; Prineville, Crook Co., off *O. h. hemionus*; Brownsville, Linn Co., off *O. h. columbianus*; Green Mt., between Ashland and Klamath Falls, off *O. h. columbianus*; Klamath, Klamath Co.; Canyon Creek, Grant Co., off *O. h. hemionus*; Alsea, Benton Co.; Summit Prairie, off *O. h. hemionus* (all sent by Oregon Agr. Coll.); Cascadia, Linn Co.; Adel, Lake Co., off *O. h. hemionus*; Riddle, Douglas Co.; Tiller, Douglas Co.; Enterprise, Wallawa Co., off *O. h. hemionus*; Dayville, Grant Co.; Big Valley, Lake Co., off *O. h. hemionus*; Keno, Klamath Co., off *O. h. columbianus*; Malheur National Forest, Harney Co., off *O. h. hemionus*; Curry Co.—WYOMING: Shell Creek Area, Big Horn Mts., off *O. h. hemionus*

(J. W. Scott).—MONTANA: Ravalli Co., off *O. h. hemionus*; Lincoln Co.; Thompson River, Sanders Co., bred from pupae off *O. v. leucurus*; Missoula Co., off *O. h. hemionus* (H. Welch).—CALIFORNIA: Mt. Lowe, Los Angeles Co.; Toro Peak, Sa. Rosa Mts., 8,000 ft., Riverside Co., off *O. h. hemionus*; San Gabriel Mts., Switzers Camp, Los Angeles Co.; Humboldt Co., off *O. h. columbianus*; Mendocino Co., off *O. h. columbianus*; Madera Co., off *O. v. leucurus*; San Jacinto Mts., Riverside Co.; Strawberry, Tuolumne Co., off *O. h. hemionus*; Lemon Cove, Tulare Co.; Tehama Co., supposedly off *Lophortyx californica*; Beckwith, Plumas Co., off *O. h. hemionus*; Westwood, Lassen Co., off *O. h. columbianus*; Mt. Pinos, Sa. Barbara Co.; Sulphur Springs, Lake Co.; Minnelusa, San Bernardino Co.; San Bernardino, San Bernardino Co.; Shaver Lake, off *O. h. hemionus*; Fresno Co., off *O. h. columbianus*; Logan Creek, Riverside Co. or San Bernardino Co.; Carson Creek, Marin Co.; Yosemite Valley, Mariposa Co., off *O. h. hemionus*; Claremont, Los Angeles Co. (R. H. Beamer).

*Distribution.*—Restricted to western North America, where it is known thus far from British Columbia, Oregon, Wyoming, California and Montana. It will no doubt be found also in the State of Washington, Alberta, Idaho and Nevada.

*Host Relations.*—*N. ferrisi* is a common parasite of deer in the Pacific Coast and western Rocky Mountain area. It is most abundant on the two races of *Odocoileus hemionus* (Rafinesque), the mule deer, *O. h. hemionus*, and the black-tailed or coast deer, *O. h. columbianus* (Richardson). There are also a few records from the western race of white-tailed deer, *Odocoileus virginianus leucurus* (Douglas). These three deer are somewhat segregated ecologically, *O. h. columbianus* preferring the Coast Belt, *O. h. hemionus* the so-called "Dry Belt," and *O. virginianus leucurus* the more eastern Mountain Belt. Intergrades are known between *O. h. columbianus* and *O. h. hemionus*. All three deer may also be infested with *Lipoptena depressa*, both parasites sometimes occurring together on the same individual host. In British Columbia, G. J. Spencer (1939) found both *N. ferrisi* and *L. depressa* in the Coast Belt on *O. h. columbianus*, but the latter was much more frequent; in the Dry Belt only *N. ferrisi* occurred on *O. h. hemionus*. He suggests that this distribution of the parasites "may be either a host relationship or a climatic one—probably the latter."

Mr. W. L. Jellison found puparia of *N. ferrisi* loose in the heavy winter haircoat of an adult male *O. v. leucurus*, killed February 13, 1934, in Montana. As he remembers it, the puparia were not at-

tached in any way to the fur. They hatched into winged adults by April 14.

The single winged male taken from California valley quail, *Lophortyx californica* (Shaw), in Tehama Co., California, may have strayed by accident onto this bird, soon after hatching, if, indeed, the labelling be trustworthy.

*Original Description.*—We may perhaps regard as such the brief description given by Ferris and Cole (1922) of their supposed *L. subulata*, on which I based *N. ferrisi*: “Head beset dorsally with numerous stout setae along the orbits and ventrally with numerous slender setae. Thorax dorsally with a row of short, stout, but sharply pointed prealar setae and with numerous small setae on the mesonotum; with a group of three post-alars and three pre-scutellars on each side and with four scutellars. Ventrally there are two rows of moderately large setae across the mesosternum and a single row across the metasternum. Wings as in *L. depressa*. Legs quite stout; anterior tibiae with a strong, inner apical seta; tarsi with one claw much smaller than the other. Abdomen dorsally without the pair of diverging lines seen in *depressa*, but with a pair of basal plates which bear a row of slender setae along the posterior margin. Remainder of the dorsum membranous and with quite numerous setae except for a pair of small, pre-apical chitinized plates which bear three or four long setae. Basal sternite rounded posteriorly, not emarginate as in *depressa*, and quite small, bearing a row of small setae. Remainder of the venter with numerous setae, those in the submarginal regions larger than the others. *Male.*—In general appearance closely resembling the female. External genitalia merely a pair of small protuberances bearing small setae. The internal genitalia in the two males available are not in condition to figure but appear to resemble those of *L. traguli*.” I have seen the holotype (♀) and allotype (♂), from Mendocino Co., California, now in the collections of Stanford University Museum.

#### Genus *Lipoptena* Nitzsch

*Hippobosca* subgenus *Lipoptena* Nitzsch, 1818, in Germar's Mag. d.

Entom., III, p. 310 (monotypic for *Hippobosca cervina* Nitzsch, 1818 = *Pediculus cervi* Linnaeus, 1758).

*Lipotevna* “Nitzsch” Latreille, 1829, in Cuvier, Le Règne Animal, 2d Ed., V, p. 544 (misspelling of *Lipoptena*).

*Lipotena* “Nitzsch” Latreille, 1829, *op. cit.*, V, p. 544 (misspelling of *Lipoptena*).

- Leptotena* Macquart, 1835, Hist. Nat. Ins. Dipt., II, p. 644 (misspelling of *Lipoptena*, with *Pediculus cervi* Linnaeus, 1758, as type).
- Lipolepha* "Nitzsch" Voigt, 1839, in Cuvier's Das Thierreich, V, p. 674 (misspelling of *Lipoptena*).
- Lipoptera* Macquart, 1843, Mém. Soc. Sci. Lille, (1842), p. 437; 1843, Dipt. Exot., II, pt. 3, p. 280 (emendation of "Leptotena Nitzsch" = *Lipoptena*). v. Siebold, 1845, Stettin. Ent. Zeitg., VI, p. 277, footnote (emendation of *Lipoptena*).
- Leptotaena* Emile Blanchard, 1840, Hist. Nat. Ins., III, p. 631 (emendation of *Leptotena*).
- Leptonema* d'Orbigny, 1846, Dict. Univ. Hist. Nat., VII, p. 315 (misspelling of *Lipoptena*).
- Leptoptena* Walker, 1849, List Dipt. Brit. Mus., IV, p. 1148 (misspelling of *Lipoptena*).
- Leptotaenia* "Blanchard, 1847," Scudder, 1882, Nomenclator Zoologicus, I, p. 186 (misspelling of *Leptotaena* Blanchard = *Lipoptena*).
- Lioptera* E. C. Reed, 1904, Rev. Chilena Hist. Nat., VIII, p. 149 (misspelling of *Lipoptena*).
- Liptotena* Ern. Olivier, 1905, Rev. Scientif. Bourbonnais, XVIII, p. 79 (misspelling of *Lipoptena*).
- Lipoptema* Kruseman, 1937, Entom. Bericht. Nederl. Ent. Ver., IX, p. 331 (misspelling of *Lipoptena*).
- Ornithobia* Meigen, 1830, Syst. Beschr. Europ. Zweifl. Ins., VI, p. 229 (monotypic for *Ornithobia pallida* Meigen, 1830 = *Pediculus cervi* Linnaeus, 1758).
- Haemobora* Curtis, 1824, British Entomology, VIII, Pl. XIV (with letterpress; monotypic for *Haemobora pallipes* Curtis, 1824 = *Pediculus cervi* Linnaeus, 1758).
- Hoemobora* "Curtis" Bigot, 1885, Ann. Soc. Ent. France, (6) V, p. 229 (misspelling of *Haemobora*).
- Haemabora* "Curtis" Coquillett, 1910, Proc. U. S. Nat. Mus., XXXVII, p. 549 (misspelling of *Haemobora*).
- Alcephagus* Gimmerthal, 1845, Stettin, Ent. Zeitg., VI, p. 152; 1845, Bull. Soc. Imp. Nat. Moscou, XVIII, pt. 4, p. 328 (substitute for *Ornithobia* Meigen; monotypic for *Ornithobia pallida* Meigen, 1830 = *Pediculus cervi* Linnaeus, 1758).
- Alaphagus* "Gimmerthal" Walker, 1849, List Dipt. Brit. Mus., IV, p. 1141 (misspelling of *Alcephagus*).
- Alcophagus* "Verrall" Scudder, 1882, Nomenclator Zoologicus, I, p. 12 (emendation of *Alcephagus*).

Head broad, transversely elliptical; its slightly convex oc-

cipital margin fitting in the shallowly concave anterior slope of the pronotum. Antennae short, subglobular, without dorsal prolongation, flattened in the antennal pits, which are completely surrounded by a continuous rim. Eyes large, oval, extending over both dorsal and ventral sides of head, of many, minute ommatidia. Ocelli present. Fronto-clypeus with truncate anterior margin; not lobed, but divided by a narrow, suture-like, median longitudinal furrow; postvertex at most twice as long as mediovertex (usually less); mediovertex at least as wide as inner orbit. Palpi well developed, of variable length, but always shorter than head. Thorax: dorsally, pronotum well developed, though short, separated by a distinct suture from mesonotum; median notal suture at least partly present; intrascutal grooves present or wanting; transverse mesonotal suture interrupted medially; humeral callosities more or less defined; humeral angles hardly projecting, rounded off; mesothoracic spiracles placed dorso-laterally; scutellum large, flat. Wings well developed in all freshly hatched individuals; in both sexes they break off a short distance from the base, after the fly reaches the host; the break occurs some distance beyond the apex of the short, thickened, basal portion of the costa, which is not or hardly developed beyond that point; only three longitudinal veins developed (apparently the first, third and fifth); sixth vein sometimes rudimentary and other veins indicated by depressed (concave) lines; no closed anal cell; alula rudimentary or absent. Halteres present, with a long, slender stalk. Claws either nearly symmetrical or more or less asymmetrical in each pair; in the latter case, anterior or left claw (if the tarsi are looked at from above) very robust, finely denticulate along inner curve in apical two-thirds, with a broad leaf-like heel at base; posterior or right claw much shorter, slender, smooth along inner curve and with narrow basal heel. Fore coxa dorsally without retrograde spur, but obliquely swollen throughout. Abdomen dorsally with a pair of basal pleurites (I); succeeding pleurites variable; female with two to five median tergal plates of variable size and shape according to the species; male with one to four such plates; ventrally, basal sclerotized sternite crescent-shaped.

*Classification.*—The species here retained in *Lipoptena* are rather closely related, differing only, as a rule, in minor details of chaetotaxy and arrangement or shape of the sclerites. Nevertheless, two fairly distinct groups may be recognized, to which I give tentatively subgeneric rank.

1. Subgenus *Lipoptena*, proper.—Type: *Pediculus cervi* Linnaeus, 1758 (as restricted by Panzer, 1798). Dorsal pleurites II of abdomen as a rule moderately elongate, though larger than the others, usually trapezoidal or broadly triangular, often not or weakly sclerotized. Female usually with five (rarely four) and male with four (rarely three) median tergal plates distributed over most of the dorsum of the abdomen, the apical plate often divided into a pair of sclerites. Mid tibia with two distinct apical spurs. Wing, where known (*L. rusaeicola*, *L. cervi* and *L. capreoli*), with the apical portion of the costa and the third longitudinal vein ending together simply (without swelling), a short distance from the tip. The following species are also included: *L. couturieri* Séguy, 1935; *L. japonica* J. Bequaert, 1942; *L. capreoli* Rondani, 1878; *L. pauciseta* Edwards, 1919; *L. hopkinsi* J. Bequaert, 1942; *L. grahami* J. Bequaert, 1942; *L. chalcomelaena* Speiser, 1904; *L. efovea* Speiser, 1905; *L. rusaeicola* J. Bequaert, 1942; and probably also the unrecognized *L. antilopes* (Pallas, 1777). *L. rusaeicola* is the only species of this group approaching *Lipoptenella* in the shape of pleurites II, but otherwise it is very closely related to *L. pauciseta*.

2. Subgenus **Lipoptenella**, new.—Type: *Melophagus depressus* Say, 1823. Dorsal pleurites II of abdomen usually strongly sclerotized and regularly elongate triangular, with the inner sides strongly converging to the median basal notch between pleurites I. Female with two to four, male with one to three median tergal plates, crowded together near the apex of the abdomen. Mid tibia with one apical spur. Wing, where known (*L. depressa* and *L. mazamae*), with apical portion of costa and third longitudinal vein ending together in a prominent knob-like swelling rather far from the tip. The following species are also included: *L. mazamae* Rondani, 1878; *L. gracilis* Speiser, 1903; and the unrecognized *L. moschi* (Pallas, 1777).

## KEY TO SPECIES OF LIPOPTENA

1. Mid tibia with one apical spur. Median tergal plates small, crowded near the tip of the abdomen. Dorsal pleurites II very elongate triangular, with the inner margins converging to the base ..... 2.
- Mid tibia with two apical spurs. Median tergal plates distributed over most of the dorsum. Dorsal pleurites II usually short triangular or trapezoidal, very rarely somewhat elongate triangular. Spur of fore tibia stout ..... 4.
2. Oriental species. Mediovertex more than twice the length of

- the postvertex; inner orbit much narrower than the eye. Usually no acrostichals (rarely 1 small); usually 2 pairs of scutellars. Apical spur of fore tibia stout. (Wing unknown) ..... *L. gracilis*.  
 American species. Mediovertex scarcely or not longer than postvertex; inner orbit almost as wide as the eye. Always a row of 2 to 4 acrostichals on each side; usually one pair of scutellars. Wing with the junction of costa and third longitudinal vein swollen, knob-like ..... 3.
3. Inner orbit with 3 to 7 setae. Disk of mesonotum with a transverse group of setae connecting the acrostichals with the notopleurals. Apical spur of fore tibia very thin, hair-like ..... *L. depressa*.  
 Inner orbit with 1 or 2 setae. Disk of mesonotum mostly bare, the acrostichals separated by a bare area from the few setae placed near the notopleurals. Apical spur of fore tibia stout ..... *L. mazamae*.
4. Sides of disk of mesonotum with many setae (6 or more) between the long row of 7 to 12 acrostichals and the notopleurals ..... 5.  
 Sides of mesonotum with very few setae (2 to 5) between the row of 2 to 5 acrostichals and the notopleurals ..... 10.
5. Body and legs very hairy; discal setae of mesonotum forming one continuous patch with the acrostichals; several intra-alars on the disk behind the mesonotal suture; 4 or 5 pairs of scutellars. Inner orbit with 6 or 7 long setae and many smaller ones; postvertex very large, about as long as mediovertex. Median tergal plates of female all very large. (Wing unknown) ..... *L. couturieri*.  
 Body less hairy; rarely with intra-alars on the disk behind the mesonotal suture (except in *L. japonica*, which has postvertex much shorter than mediovertex); 3 or 4 pairs of scutellars ..... 6.
6. Mesonotum very hairy; intra-alars present on the disk behind the mesonotal suture; 4 pairs of scutellars. Inner orbit with 3 or 4 long setae and several smaller ones; postvertex much shorter than mediovertex. First median tergal plate of female small. (Wing unknown) ..... *L. japonica*.  
 Mesonotum moderately hairy; usually no (very rarely 1 or 2 small) intra-alars on the disk behind the mesonotal suture; usually 3 pairs of scutellars ..... 7.
7. Postvertex much shorter than mediovertex; inner orbit much

narrower than the eye, with 4 or 5 long setae and a few smaller ones. Palpi as long as fronto-clypeus. Second to fourth median tergal plates of female large; first small. Wing with the junction of costa and third longitudinal vein simple, without knob-like swelling ..... *L. cervi*.

Postvertex nearly as long as or longer than mediovertex; inner orbit about as wide as the eye, with 2 to 8 setae. Palpi shorter than fronto-clypeus ..... 8.

- 8. Sides of mesonotum (laterad of row of acrostichals) fairly uniformly covered with 15 to 25 setae and without admedian bare area. Inner orbit with 4 to 8 long setae. First to third median tergal plates of female small. (Wing unknown) ..... *L. chalomelaena*.

Sides of mesonotum (laterad of row of acrostichals) with 8 to 15 setae, arranged so as to leave a distinct admedian bare area. Inner orbit with 2 to 6 long setae ..... 9.

- 9. First to third median tergal plates small, those of female less than three times as wide as long; abdominal spiracles VI not enclosed in the fourth tergal plate. Wing with the junction of costa and third longitudinal vein simple, without knob-like swelling ..... *L. capreoli*.

First to third median tergal plates large, those of female at least three times as wide as long; abdominal spiracles VI enclosed in the fourth tergal plate. (Wing unknown)

*L. grahami*.

- 10. African species. Inner orbit narrower than the eye, usually without setae. Mesonotum with 2 acrostichals in each row. (Wing unknown) ..... *L. hopkinsi*.

Oriental species. Inner orbit usually with 2 setae, rarely more. Mesonotum with 3 to 5 acrostichals in each row ..... 11.

- 11. Inner orbit less than half as wide as the eye. Mesonotum with 5 or 6 acrostichals in each row and a transverse row of 4 or 5 latero-centrals; 3 or 4 pairs of scutellars. (Wing unknown) ..... *L. efovea*.

Inner orbit about half as wide as the eye or wider. Mesonotum with 3 acrostichals in each row and 2 or 3 latero-centrals close to the notopleurals ..... 12.

- 12. Dorsal pleurites II elongate triangular. First median tergal plate poorly or not differentiated, its setae connected by an oblique row of bristles with those at the sides of the dorsal area; second to fourth median tergal plates rather

narrow and long. Wing with the junction of costa and third longitudinal vein simple, without knob-like swelling.

*L. rusaecola.*

Dorsal pleurites II short triangular. First median tergal plate distinct, its setae broadly separated from the lateral patches of bristles of the dorsal area; second to fourth median tergal plates broad and short. (Wing unknown)

*L. pauciseta.*

Subgenus *Lipoptena*, proper

1. *Lipoptena cervi* (Linnaeus). Figs. 5A-G.

["Reh-Laus" Frisch, 1736, Beschreibung von Allerley Insecten in Teutschland, XII, p. 15, 2d Plate, Tab. V (Germany; off "Rehbock," *Capreolus capreolus*)].

*Pediculus cervi* Linnaeus, 1758, Syst. Nat., 10th Ed., I, p. 611 (in part; no sex; "in *Cervo elapho, dama, capreolo*"; no locality given, but from Europe); 1761, Fauna Suecica, 2d Ed., p. 476; 1767, Syst. Nat., 12th Ed., I, pt. 2, p. 1017. Houttuyn, 1769, Natuurl. Historie, I, pt. 13, p. 72. Fabricius, 1775, Syst. Entom., p. 805. P. L. S. Müller, 1775, Vollständiges Natursystem, V, pt. 2, p. 1031. O. F. Müller, 1776, Zool. Danicae Prodr., p. 184. Fabricius, 1781, Species Ins., II, p. 477; 1787, Mantissa Insect., II, p. 368. Gmelin, 1790, in Linnaeus, Syst. Nat., 13th Ed., I, pt. 5, p. 2916. Goeze, 1793, Europäische Fauna, Naturg. Europ. Thiere, III, p. 37. Fabricius, 1794, Ent. Syst., IV, p. 418. Panzer, 1798, Fauna Ins. Germaniae, pt. 51, Pl. XV (Germany). Fabricius, 1805, Syst. Antliat., p. 341.

*Hippobosca cervi* Olivier, 1792, Encyclop. Méthod., Insectes, VII, pt. 1, p. 92 (as a new species; no sex; off "cerf," *Cervus elaphus*; Europe).

*Melophagus cervi* Meigen, 1830, Syst. Beschreib. Europ. Zweifl. Ins., VI, p. 237. Scholtz, 1848, Zeitschr. Entom., Breslau, 4. Quartal, No. 8, p. 7 (Germany). Gurlt, 1857, Arch. f. Naturgesch., XXIII, pt. 1, p. 279; 1878, *op. cit.*, XLIV, pt. 1, p. 166.

*Leptotena cervi* Macquart, 1835, Hist. Nat. Ins. Dipt., II, p. 645, Pl. XXIV, fig. 14. Gimmerthal, 1847, Bull. Soc. Nat. Moscou, XX, pt. 3, p. 208 (Curland or Latvia). Zetterstedt, 1848, Diptera Scandinaviae, VII, p. 2913 (southern Scandinavia); 1849, *op. cit.*, VIII, p. 3366; 1852, *op. cit.*, XI, p. 4340; 1860, *op. cit.*, XIV, p. 6481. F. Rossi, 1848,

Syst. Verz. Zweifl. Ins. Oesterreich, p. 86 (Austria: Prater near Vienna; Hütteldorf; district between Traun and Inn rivers, near Gütenbrunn). Hagen, 1849, Neue Preussische Provinzialbl., XLII, p. 235 (Prussia). van der Wulp and Snellen van Vollenhoven, 1856, in Herklots, Bouwstoffen Fauna Nederland, II, p. 117 (Gelderland and 't Loo, Netherland). Disconzi, 1865, Entom. Vicentina, p. 228 (Vicenza Prov., Italy). F. B. White, 1877, Scottish Natural., IV, p. 185 (Glen Tilt, Scotland; off *Cervus elaphus*). Mégnin, 1880, Parasites Maladies Parasitaires, p. 31; 1899, C. R. Soc. Biol. Paris, LI, p. 231 (off horse); 1906, Insectes Buveurs de Sang, p. 66.

*Leptotaena cervi* Em. Blanchard, 1840, Hist. Nat. Ins., III, p. 631; 1846, Extr. Proc.-Verb. Séances Soc. Philom. Paris, p. 7; 1846, L'Institut, XIV, p. 31; 1846, Froriep's Neue Notizen, XXXVII, p. 277; 1868, Moeurs Métamorphoses Insectes, p. 657, fig. P. J. Van Beneden, 1876, Schmarotzer des Thierreichs, p. 182, fig. 39. P. M. Duncan, 1882, Transformations of Insects, p. 406, fig.

*Lipoptena cervi* C. v. Siebold, 1845, Stettin. Ent. Zeitg., VI, p. 277 (near Königsberg, Germany; off *Alces alces*). Scholtz, 1850, Zeitschr. Entom., Breslau, 4. Quartal, No. 15, p. 27. Gerstfeldt, 1853, Ueber die Mundtheile der Saugenden Insecten, Dorpat, p. 41. Schiner, 1864, Cat. Syst. Dipt. Europae, p. 114; 1864, Fauna Austriaca, Die Fliegen, II, p. 648 (♀♂; Austria). Puls (and Ruthe), 1864, Berlin. Ent. Zeitschr., VIII, Suppl., p. 14 (near Berlin, Germany). Costa, 1864, Ann. Mus. Zool. Univ. Napoli, II, p. 98 (Parma, Italy). Nowicki, 1873, Beitr. Kenntn. Dipt. Galiziens, p. 34 (near Krakow, Galicia). Raddatz, 1873, Arch. Ver. Fr. Naturg. Mecklenburg, XXVII, p. 126 (Schwienkullen and Oberhagen, Mecklenburg). Stein, 1877, Deutsch. Ent. Zeitschr., XXI, p. 297 (Wiessenbach on the Attersee, Germany; off *Cervus elaphus*). Bertkau, 1878, Verh. Naturh. Ver. Preuss. Rheinlande, XXXV, Sitzungsber., p. 178 (Lenep, Rheinland; off *Capreolus capreolus*). Rondani, 1879, Bull. Soc. Ent. Italiana, XI, p. 14 (Italy; off *Cervus elaphus*). Taschenberg, 1880, Praktische Insekten-Kunde, IV, Zweiflügler, p. 171. Mik, 1882, Wien. Ent. Zeitg., I, p. 64. Girard, 1885, Traité Élémentaire d'Entomologie, III, p. 1069. Bigot, 1885, Ann. Soc. Ent. France, (6) V, p. 229. Leunis, 1886,

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<sup>30</sup> In all editions of this book the legends of figs. 437 and 438 are unfortunately transposed. Fig. 437 shows the male of *L. cervi*; fig. 438, the female of *Ornithomyia*.

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*Lipoptera cervi* Kawall, 1847, Correspondenzbl. Naturf. Ver. Riga, II, p. 12 (♀♂; Kurland). H. Schaum (and H. Loew), 1849, Stettin. Ent. Zeitg., X, pp. 294-298 (♀♂; Altenburg, Germany; off *Capreolus capreolus*; Germany, off *Cervus elaphus*). C. v. Siebold, 1850, Stettin. Ent. Zeitg., XI, p. 407 (♀♂; near Königsberg, Germany; off *Alces alces*); \*1850, Verh. Schles. Forst-Ver., Breslau, p. 369; 1851, 28. Jahresber. Schlesisch. Ges. Vaterl. Kultur, (1850), p. 83. Schiner and Egger, 1853, Verh. Zool. Bot. Ver. Wien, III, p. 14. Schiner, 1853, *op. cit.*, III, p. 153 (Austria; off *Capreolus capreolus*). Bachmann, 1858, Oster-Programm Realschule Insterburg, p. 18 (West Prussia). Ritzema Bos, 1891, Tierische Schädlinge u. Nützlinge, p. 653, fig. 383a. Ormerod, 1897, 20th Rept. Observations Injurious Insects, pp. 60-68, figs. (♀♂; Strathconan Forest, Muir of Ord, Ross-shire, Scotland; off *Capreolus capreolus*); 1898, 21st Rept. Observations Injurious Insects, pp. 34-39, figs. (♀♂, puparium); 1904, in R. Wallace, Eleanor Ormerod, pp. 140 and 259-261, figs. 23-24 (♀♂, puparium). G. B. Walsh, 1924, Ent. Mo. Mag., LX, p. 143.

*Leptonema cervi* d'Orbigny, 1846, Dict. Univ. Hist. Nat., VII, p. 315.

*Leptoptena cervi* Walker, 1849, List Dipt. Brit. Mus., IV, p. 1148.

*Lioptera cervi* E. C. Reed, 1904, Rev. Chilena Hist. Nat., VIII, p. 149.

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(To be continued in number 2)

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## A MONOGRAPH OF THE MELOPHAGINAE, OR KED- FLIES, OF SHEEP, GOATS, DEER AND ANTE- LOPES (DIPTERA, HIPPOBOSCIDAE)

BY J. BEQUAERT

(Continued from number 1)

*Lipoptema cervi* Kruseman, 1937, Entom. Ber. Nederl. Ent. Ver., IX, pp. 331-332 (winged specimens; Rossitten, East Prussia).

*Melophaga trifasciata* v. Olfers, 1816, De Vegetativis et Animatis Corporibus in Corp. Anim. Rep., I, p. 99 (no sex; off deer; Europe; with description and reference to "Frisch, Ins., XII, 9, tab. II. 5").

*Pediculus capreoli* "Frisch" v. Olfers, 1816, De Vegetativis et Animatis Corporibus in Corp. Anim. Rep., I, p. 99 (as a synonym of *Melophaga trifasciata*; Frisch used no Latin names).

*Hippobosca* (*Lipoptena*) *cervina* Nitzsch, 1818, Germar's Mag. d. Entom., III, p. 311 (substitute name for "*cervi*" Linnaeus). Fallén, 1826, Diptera Sueciae Descripta, Suppl. 2, p. 11 (♀; ?♂; Sweden: Baldringe, off *Cervus elaphus*; Högestad). Giebel, 1861, Zeitschr. Ges. Naturw., XVIII, p. 292; 1866, *op. cit.*, XXVIII, p. 355.

*Lipoptena cervina* Gervais and Van Beneden, 1859, Zoologie Médicale, I, p. 391.

*Haemobora pallipes* Curtis, 1824, British Entomology, VIII, Pl. XIV (with letterpress; ♂; off man; New Forest, En-

- gland). Walker, 1853, *Insecta Britannica*, Dipt., II, p. 288, Pl. XX, fig. 4. A. White, 1854, *List Spec. Brit. Anim. Brit. Mus.*, XV, p. 41.
- Ornithobia pallida* Meigen, 1830, *Syst. Besch. Europ. Zweifl. Ins.*, VI, p. 230, Pl. LXIII, figs. 21-24 (no sex; no host; Germany). Macquart, 1835, *Hist. Nat. Ins. Dipt.*, II, p. 639, Pl. XXIV, fig. 9. Em. Blanchard, 1840, *Hist. Nat. Ins.*, III, p. 631. Rossi, 1848, *Syst. Verz. Zweifl. Ins. Oesterreich*, p. 85 (Austria: Kahlenberg and Danauauen near Vienna). Zetterstedt, 1848, *Diptera Scandinaviae*, VII, p. 2900 (? ♂; Sweden: Högestad, Scania; Oefvedskloster, Scania; Denmark; Dalmatia). Walker, 1849, *List Dipt. Brit. Mus.*, IV, p. 1141; 1853, *Insecta Britannica*, Dipt., II, p. 286, Pl. XX, fig. 2. A. White, 1854, *List Spec. Brit. Anim. Brit. Mus.*, XV, p. 41.
- Alcephagus pallidus* Gimmerthal, 1845, *Bull. Soc. Nat. Moscou*, XVIII, pt. 4, p. 328 (Curland; off *Alces alces*); 1845, *Stettin. Ent. Zeitg.*, VI, p. 152.
- Ornithomyia nigrirostris* \*v. Roser, 1840, *Correspondenzbl. Landwirthsch. Ver. Württemberg*, I, pt. 1, p. 64.
- Lipoptena alcis* Schnabl, 1881, *Phys. Denkshr. Warschau*, p. 34 (♀; region of Pinsk, Lithuania; off *Alces alces*). Bezzi, 1916, *Natura, Riv. Sc. Nat.*, VII, p. 178. Séguy, 1938, in M. A. J. Couturier, *Le Chamois*, p. 428.
- Lipoptena cervi* var. *alcis* Schnabl, 1882, *Deutsch. Ent. Zeitschr.*, XXVI, p. 13 (♀). Speiser, 1900, *Illustr. Zeitschr. Entom.*, V, p. 278 (off *Alces alces* brought in at Königsberg; Wehlau, Prussia, off *Capreolus capreolus*). Bezzi, 1905, *Kat. Paläarkt. Dipt.*, IV, p. 283. Lühe, 1906, *Schrift. Phys.-Oekon. Ges. Königsberg*, XLVI, (1905), *Sitzungsber.*, p. 180 (East Prussia; off *Alces alces*). Bau, 1929, *Zoolog. Anz.*, LXXXV, p. 11 (Zoological Garden at Dresden; off *Alces alces*). Heinemann, 1937, *Zeitschr. Parasitenk.*, IX, p. 561 (Kur. Nehrung, Germany; off *Alces alces*).
- Lipoptena cervi* var. *obscura* "Rörig" Lühe, 1906, *Schrift. Phys.-Oekon. Ges. Königsberg*, XLVI, (1905), *Sitzungsber.*, p. 180 (as a synonym of *L. cervi* var. *alcis*); 1913, *Naturw. Wochenschr.*, XXVIII, p. 63.
- Lipoptena subulata* Coquillett, 1907, *Ent. News*, XVIII, p. 290 (♀ ♂; off deer; Woodstock, New Hampshire). Bezzi, 1916, *Natura, Riv. Sc. Nat.*, VII, p. 178. C. W. Johnson, 1925,

- Occas. Pap. Boston Soc. Nat. Hist., VII, No. 15, p. 293 (Corbin Park, New Hampshire, off "American elk," *Cervus canadensis*, and deer; Naushon Id., Massachusetts).  
["Hirschlausfliege" H. Landois, 1900, 28. Jahresber. Zool. Sect. Westfäl. Prov.-Ver. Wiss., p. 34 (Hiltrup, Westfalia; off *Capreolus capreolus*)].  
["Lipoptène du Cerf" Roubaud, 1919, Ann. Inst. Pasteur, Paris, XXXIII, p. 532 (intracellular symbionts)].  
["Leptotène du Cerf" P. J. Van Beneden, 1875, Commensaux Parasites Règne Animal, p. 159, fig. 39 (also in English Edition, 1876, p. 177, fig. 39)].

The following references were based on misidentifications:

*Lipoptena cervi* C. W. Howard, 1912, Bull. Ent. Res., III, p. 218 (Nyasa District, Portuguese East Africa). Specimens at the U. S. National Museum, collected by C. W. Howard in Portuguese East Africa, off *Sylvicapra grimmia*, are *Echestypus paradoxus*.

*Lipoptena cervi* C. Dover, 1921, Rec. Indian Mus., XXII, p. 396 (Barkuda Id. in Chilka Lake, India; named by Brunetti). From the text one might be led to believe that the specimen came from a chital, *Cervus axis*. Dr. B. Prashad recently wrote me that it is labelled as taken on man. Possibly *Lipoptena fovea*.

*Lipoptena cervi* E. A. Lewis, 1931, Ann. Rept. Dept. Agric. Colony Prot. Kenya for 1930, p. 162 (South Masai Reserve, Kenya; off Grant's Gazelle). Certainly *Echestypus*, probably *E. sepiaceus*.

*Lipoptena cervi* Calzada, 1939, Bol. Mens. Dir. Ganadería, Uruguay, XXIII, pp. 466-469, figs. 1-3 (♀ ♂; Sierras of the Depts. of Rocha and Maldonado, Uruguay; off *Mazama* sp.). The figures show clearly that this was *Lipoptena mazamae*.

*Female*.—Head moderately lengthened behind the eyes, which are relatively short and broad; mediovertex long and nearly square, about as long as fronto-clypeus, much longer than postvertex; clypeus completely fused with frons, its extent only indicated by the very fine median longitudinal furrow; pretilinal area distinct, with or without fovea; inner orbit much narrower than the eye, with 4 or 5 frontal bristles, two of them longer; one long vertical bristle; postvertex very short and wide, flattened semi-elliptical; ocelli small, but distinct, in a slightly flattened triangle. Palpi slightly longer than fronto-clypeus. Promesonotal suture very deep, except on the sides; suture between pronotum and propleuron weak. Mesothorax: median notal suture distinct over nearly entire length; no transverse prescutal suture; well-marked longitudinal intrascutal

grooves; mesonotal suture weak, but extending to near the scutellum; posthumeral suture weak; mesothoracic spiracle large, at latero-posterior edge of humeral callosity; 6 to 9 acrostichals, in a curved row between the median notal suture and the intrascutal groove; laterad of them 15 to 18 latero-

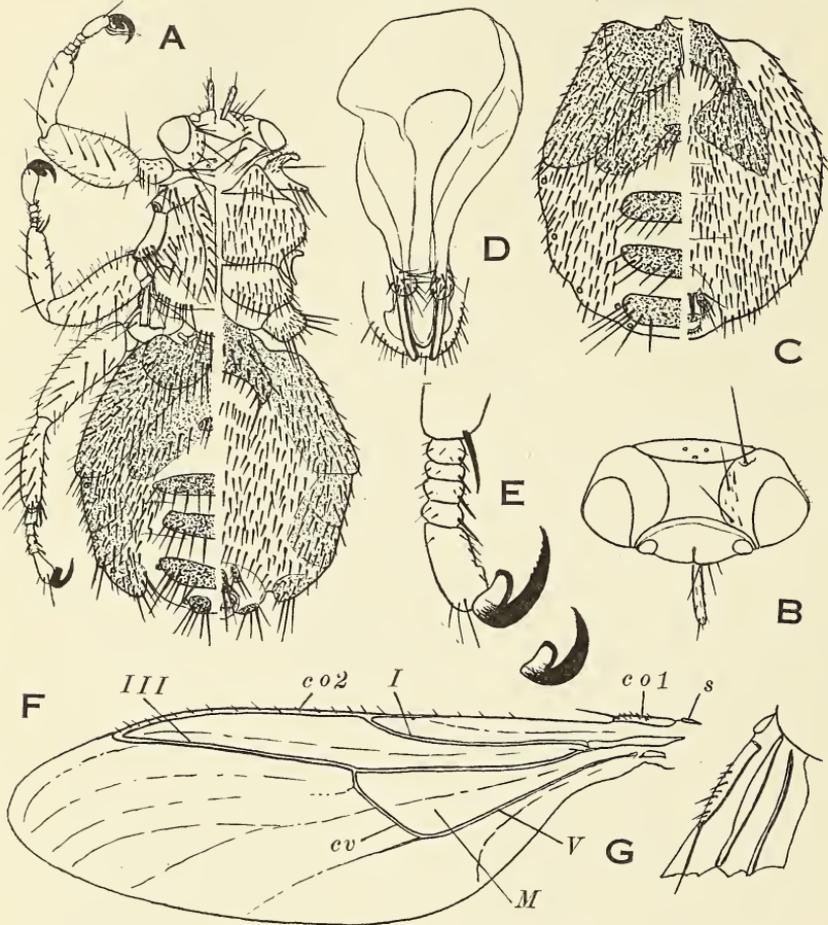


FIG. 5. *Lipoptena cervi* (Linnaeus): A, female, Woodstock, New Hampshire (paratype of *L. subulata* Coquillett), from above (left) and below (right).—B, head of male, Recey-sur-Ource, France.—C, abdomen of male, same locality, from above (left) and below (right).—D, male terminalia.—E, tarsus and claws (inner and outer) of fore leg.—F, wing: I, first, III, third, and V, fifth longitudinal veins; *Co1* and *Co2*, basal and apical portions of costa; *cv*, crossvein; *M*, first basal cell; *s*, subpaulet.—G, basal stump of wing.

centrals, none or very few extending beyond the mesonotal suture; 6 to 8 humerals; 4 postalars and 4 or 5 prescutellars, the two groups only slightly divided; two rows each of 3 or 4 notopleurals, the hind row heavier and longer; 6 to 8 scutellars, in 3 or 4 pairs, the median pair longer; ventrally, lobes of prosternum with 8 to 10 heavy setae; mesosternum and basisternum mostly covered with many short, thick setae and a few longer ones. Abdomen: basal dorsal pleurites (I) large, but often rather indistinctly divided from pleurites II, with an apical row of long bristles and many smaller setae over the disk; pleurites II to V more or less set off and sclerotized (according to age), third and fourth usually fused; all with many scattered setae; five median tergal plates: first very small and with few setae, often indistinct from the more or less sclerotized surrounding, bifurcate area of the tergum; second and third large, transverse, about the same size, with a regular transverse row of 12 to 15 long setae; fourth as large as second, divided by a median depression, each of the raised halves with a group of 6 or 7 long setae; fifth consisting of a pair of sclerites, each with 4 to 6 long setae; integument between the median plates and separating them from the pleurites mostly membranous and extensible, but the anterior portion between pleurites I becomes strongly sclerotized, forming a bifurcate sclerite bearing fairly numerous setae posteriorly; membranous portion with setae on the sides only near the pleurites. Basal ventral sclerite deeply emarginate, with fairly numerous heavy setae all over, one very long bristle at each hind corner; ventral portion of pleurites more or less sclerotized and uniformly covered with many setae; remainder of venter membranous and uniformly setulose; anal area mostly bare, medially before the finely hairy, small anal and genital sclerites, with three small sclerotized plates, two of them forming an anterior pair (each with three strong setae), the third placed on the middle line (with 5 or 6 strong setae). Abdominal spiracles small, but distinct; spiracles VI and VII not enclosed in the fourth and fifth median plates. Legs heavy and strongly setose; apical spur of fore tibia thick; mid tibia with two apical spurs, one of them much stronger; claws slender, slightly asymmetrical in each pair. Wing: costa and third longitudinal vein ending together a short distance from the tip, without knob-like swelling.

*Male*.—Similar to the female in structure and chaetotaxy. Usually only pleurites II sclerotized dorsally, and in older speci-

mens also a ventral plate on each side behind the crescent-shaped basal sclerite; only four median tergal plates, corresponding to the first to fourth of the female: first small, as in female; second to fourth somewhat larger than in female; median area between dorsal pleurites II often as strongly sclerotized as in female. Terminalia: aedeagus a simple cone, broadly rounded at apex; parameres nearly straight rods, uniformly thick in apical portion, with blunt tips.

Length (h. + th.): ♀, 2 to 2.5 mm.; ♂, 2 to 2.3 mm.

SPECIMENS EXAMINED.—ENGLAND: Nottingham, Wollaton Park, off *Cervus elaphus*; Great Park, Windsor, Berks.—SCOTLAND: Perthshire, 2000 ft., off *Cervus elaphus*; Balmacaan, Glen Urquhart, Inverness, off *Cervus elaphus*; Guisachan, Inverness (J. J. King).—DENMARK: Horseus, Jutland; Lindum, Jutland; Ruderhegn and Dyrehaven near Copenhagen.—ESTHONIA: Reval, off *Alces alces*.—POLAND: Zyrardów, off *Alces alces*; Iwacewieze, off *Alces alces*; Chojnów pow. Grójecki; Puszcza, Bialowieska (all sent by the Zoölogical Museum, Warsaw).—GERMANY: Rossitten, Kurischer Nehrung, off *Alces alces*; East Prussia, off *Alces alces*; Hunsrück, Rheinland, off *Capreolus capreolus*.—BELGIUM: Mirwart, off *Capreolus capreolus*.—FRANCE: Parcé, Dept. Sarthe; Recey-sur-Ource, Dept. Côte d'Or, off *Capreolus capreolus*; Fougère, Dept. Maine-et-Loire, off *Capreolus capreolus*.—AUSTRIA: Villach, Carniolia; Kaltenlust Geb., Lower Austria; Aggsbach, Lower Austria; Hainfeld, Lower Austria; Mödling; Stein am Danau; Manhartsberg, Lower Austria; Nasswald, Lower Austria; Forchtenau, Burgenland.—HUNGARY.—ALBANIA: Ungrej.—SIBERIA: Baikal University Station; Amur region.—NORTH AMERICA: NEW HAMPSHIRE: Woodstock, Grafton Co., off deer (types of *L. subulata*); Corbin Park near Newport, Sullivan Co., off *Odocoileus virginianus borealis*.—MASSACHUSETTS: Naushon Id., Dukes Co., off *O. virginianus borealis*.—PENNSYLVANIA: Pike Co., off *O. virginianus*; Clinton Co., off *O. virginianus*; New Florence, West Moreland Co., off *O. virginianus*, February 1907 (F. S. Webster); Elk Co., off *O. virginianus*, December, 1915.—NEW YORK: Indian Lake, Hamilton Co., off *O. virginianus borealis* (E. J. Gerberg).

*Distribution.*—There are at present definite and reliable records of *L. cervi* in the Old World from Scotland, England, southern Sweden, Denmark, the Netherlands, Belgium, France, Germany, Esthonia, Curland (Latvia), Lithuania, Poland, Czecho-Slovakia, Austria, Carniolia, Switzerland, Hungary, Dalmatia, Albania, Bulgaria, Italy, Spain, Algeria, northern China (Kansu) and eastern

Siberia. In all probability it occurs over most of the Palearctic Region. It was, in my opinion, introduced by man with European deer in the northeastern United States where it is now established on the native deer in New Hampshire, Massachusetts, New York, Pennsylvania, and probably elsewhere.

Walker's (1849) records from Northern Bengal and Egypt, I regard as erroneous. Likewise C. Dover's record from Barkuda Island in Chilka Lake, India (1921), based on Brunetti's identification, was no doubt an error. Austen (1906) writes: "In February, 1901, a specimen of *L. cervi* was taken by Mr. P. S. Stammwitz, near Johannesburg, Transvaal, under circumstances pointing to the possibility that it had been introduced into South Africa with remounts during the South African War." This statement obviously refers to the specimen Austen recorded in 1903 as taken at Modderfontein Factory, 14 miles South of Johannesburg, on a man who had been carrying a *Cephalophus* on a horse. I believe, with Speiser (1908), that this fly was really a species of *Echestypus* and a true parasite of the *Cephalophus*. The supposed *L. cervi* recorded by C. W. Howard (1912) as "sent in from the Nyasa District" of Portuguese East Africa, were definitely *Echestypus*.

*Host Relations.*—*L. cervi* is at present known to occur normally and to breed in nature on the following hosts, in the Old World: the red deer, *Cervus elaphus* Linnaeus, and its races (including the Far-Eastern race *xanthopygus* Milne-Edwards); the roe, *Capreolus capreolus* (Linnaeus), and its races; the true elk, *Alces alces* (Linnaeus); and the sika deer, *Cervus nippon* Temminck. The fallow deer, *Dama dama* (Linnaeus), is also listed as a host by most authors, but I have been unable to find a single authentic record of a *Lipoptena* having been taken on this animal. It should be noted that the fallow deer occurs in the wild state in Asia Minor only, a closely allied species, *Dama mesopotamica* (Brooke), being found in Persia. Fallow deer have been introduced within historic times in Western and Central Europe, where they have become feral in certain areas.

In my opinion, *L. cervi* was originally introduced into North America by man, with European deer; but it has now become established on the northeastern race of Virginia deer, *Odocoileus virginianus* (Boddaert), and has been reported even from the wapiti, *Cervus canadensis* Schreber. It was first reported from New Hampshire in 1907, when Coquillett described it as a new species (*L. subulata*). As it was taken the same year (1907) in Pennsylvania, it must have been introduced from Europe some years earlier.

I have seen several specimens, agreeing in all characters with

*L. cervi*, which were labeled as taken off nilgau, *Boselaphus tragocamelus* (Pallas), recently imported from Europe into an American zoological park. No doubt they had strayed onto this accidental host from deer kept with them. A female at Stanford University Museum, labeled "off *Rupicapra rupicapra*, Europe, Bau," is definitely *L. cervi*, not *L. couturieri*. If trustworthy, this record would show that *L. cervi* strays occasionally onto chamois, where these animals mingle with roe deer, as they are well known to do in certain districts.

In nature, *L. cervi* has been taken on the following accidental hosts: domestic horse; domestic cattle; European badger, *Meles meles* (Linnaeus); and man.<sup>31</sup> It is not known, however, whether or not the deer keds bite or suck blood and are able to survive for any length of time on all these stray hosts. The supposed normal occurrence on wild birds in nature will be discussed in connection with the life-history. Scholtz (1848) first noted that *L. cervi* will occasionally bite man. Under experimental conditions, Brumpt (1913) and Hase (1939) fed deer-keds in captivity on man, domestic dog, horse, house-mouse, mole and monkey, as well as on domestic fowl and domestic pigeon. On man they engorge in from 15 to 25 minutes. Hase experimented with 21 newly hatched, winged flies, caught in the open. Some of these he fed 6 to 8 times on human blood, but most of them died inside a week; only one lived 8 days in captivity. Both Brumpt and Hase noted that the bite itself is hardly felt by man and leaves no trace at first. One to three days later, however, a hard, pruriginous welt appears at the spot, often with a small vesicle in the center. The itching is intense and may last 14 to 20 days.

*Life-History*.—Adult, deãlated keds of both sexes occur on deer and elk throughout the year, having been actually seen on these animals in fall, winter and spring. Reproduction is probably re-

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<sup>31</sup> R. Blanchard (1890) also includes the European wild boar among the hosts, but I have been unable to find on what evidence. His fig. 723 does not represent the tarsus of *L. cervi*, which does not have three-toothed claws. He also credits Van Beneden by error as having recorded *L. cervi* biting man in a hospital at Louvain. Van Beneden (1875, *Commensaux Parasites Règne Animal*, p. 114) called the flies he observed, *Ornithomyia hirundinis* (= *Stenopteryx hirundinis*). In an earlier account of the same observation (1859, *Zoologie Médicale*, I, p. 391), Gervais and Van Beneden called them *Ornithomyia pallida* (= *Crataerina pallida*).

tarded in winter and greatly speeded up in summer, as swarms of newly hatched winged flies often appear in the fall, from September until early December. According to J. P. E. Stein (1877), Hartmann in Germany found many mated keds on deer throughout winter, the male sitting on top of the female. If a pair were kept in a vial, the female might sometimes void a larva, this being invariably followed by a new mating, lasting for about half a day. Even after mating the male often stays on the female. The full-grown larva is deposited while the female remains on the host. A few puparia are commonly found in the fur of the host; but, as they are smooth and not attached nor glued to the hair, most of them must eventually drop off. Of 11 puparia collected by Hartmann in winter and kept away from deer, none hatched until early next August, when three produced winged flies after having been exposed to direct sunlight. It is sometimes stated that the puparia occur in nature in crevices of trees or on the ground, but, so far as I could discover, none have ever been retrieved in nature.

Darling (1937) made some interesting observations on the relations between deer-keds and red deer in Ross-shire, Scotland. They are well worth reproducing in full: "The deer-ked, *Lipoptena cervi*, is a parasite interesting in itself. Unlike the sheep-ked, *Melophagus ovinus*, the deer-ked is winged in the early imaginal state and there appears to be one generation only each year, whereas the sheep-ked may produce several. My observations on its life-history are as follows: it appears as a winged imago in September, a reddish flat chitinous creature which it is difficult to push off the skin. Its flight is weak and it seems to tumble on to a host rather than alight. Autumn wallowing on the part of the stags has started by the 10th or 12th of September, and the winged deer-keds are most commonly found near the wallows and the peat hags where the hinds rub. By the middle of October winged keds have disappeared, though I found one in 1934 as late as December 5th. It is evident that the keds spend but little time on the wing before mating and finding a host. The deer do not appear to react strongly to the onset of these insects. As soon as the keds are in the deer's coat they lose their wings and begin blood-sucking. Their abdomen increases in size and their whole body darkens in colour. They remain on the deer throughout the winter. On stags shot in October and hinds in December and January, and on occasional beasts found newly dead in March, I have found hundreds and even thousands of these parasites. Their debilitating effect on the host must be great. During the winter I have never found puparia of the ked among the hair,

but they are present after the end of March. Now the deer wallow at the end of April and during May, when they begin to shed their winter coats. Much of the hair is shed at the wallows and rubbing places, and it would appear that the puparia of the deer-*ked* lie on the ground near such places until they emerge in September, and this would account for their being particularly numerous at the wallows. If my observations are correct, the diapause which seems to occur in the life-history of this species alone of the British Hippoboscidae presents an interesting problem for solution by the entomologist."

The winged individuals are very active, flying onto any animal or man within reach, which no doubt accounts for most of the records of stray hosts. I am inclined to believe that only those that reach deer or elk survive long enough to mate and produce offspring. Hase (1930) suggests that the newly hatched flies might perhaps hibernate regularly on the European badger (*Meles meles*) or at any rate in the burrows of these animals; but he himself did not find them there and he seems to have been rather unduly impressed by Massonat's record of a single female *L. cervi* found on this host.

Shortly after the flies reach a normal or definitive host, the wings break off along an irregular, jagged line, a short distance beyond the base, thus leaving a permanent stub.<sup>32</sup> In the complete wing, the thick and setulose basal portion of the costa is very short and ends abruptly, with a long seta just before the tip; beyond this point the fore margin is scarcely thickened over some distance. The wing breaks off not at the very tip of the thickened costa, but slightly beyond (see Kemner, 1932, fig. 3). How the wings are actually shed has not yet been observed. Probably they are lost unintentionally; they either are torn by rubbing against the fur of the host or are removed by the cleaning motions of the hind legs, which, as Hase (1939) describes, are frequently brushed over the back of the fly.<sup>33</sup> L. Mercier (1924) has shown that the shedding of the wings is followed by interesting postimaginal changes in the histology of the thoracic muscles. The longitudinal dorsal muscles are mostly resorbed into a mass of adipose tissue, while the sternodorsal muscles

<sup>32</sup> Wing stubs are present in de-labeled specimens of both sexes. It seems rather incorrect to call them "abortive wings," since they are merely the basal remnants of complete wings.

<sup>33</sup> *Lipoptena*, having only a sucking proboscis, could not use the mouth-parts to bite off its own wings or those of other individuals, as was claimed by W. W. Froggatt (1900).

disappear completely, the tissue material thus made available strengthening the muscles that move the legs.

The winged and deälated conditions of the same individual are so different in size, shape and color that they were originally placed in distinct genera (*Ornithobia* and *Haemobora* for the winged state). Even after the connection between the two was recognized, the belief remained widespread that the winged keds live in winter and spring on birds (particularly gallinaceous game birds) and migrate in the summer to deer, where they shed the wings.<sup>34</sup> There is, however, no evidence whatsoever that such is the case. Austen (1906) notes that winged individuals of both sexes have been caught flying round a dead roe and that the females all shed their wings in dying; also that wingless males and females are found together in the hair. This is confirmed by Massonat (1909) who found deälated specimens of both sexes equally abundant on roe during the winter in France. H. P. Jones (1932) also saw both winged and wingless keds on red deer in England, in the autumn, showing that newly hatched flies will settle on deer at once, if they have the opportunity to do so. The occasional occurrence of stray winged keds on birds is not by itself a proof that *L. cervi* is a normal parasite of birds. There appears to be no strictly reliable record of *L. cervi* having actually been taken off a bird in nature. Leunis (1886) lists the European grouse (*Bonasa umbellus* Linnaeus) as one of the hosts, while Schuurmans-Stekhoven (1928) includes among them "Finken: *Passer domesticus*, *Fringilla* sp." But in neither case is it clear that these statements were based on personal observations. Records by hunters are not always reliable, as some of the common bird louse-flies may readily be mistaken for winged deer-keds and vice-versa. Moreover, where *Lipoptena* is common, winged indi-

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<sup>34</sup> Packard (1869, Guide to the Study of Insects, p. 417) writes that *Lipoptena* "is remarkable for living in its wingless state on the deer, but when the wings are developed it is found on the grouse (*Tetrao*)." C. V. Riley (1893, Proc. Ent. Soc. Washington, II, pt. 4, p. 414) says that *L. cervi* is "peculiar in that in the earlier state the flies have wings and live on birds, while later they seek quadrupeds and have no further use for their wings which are shed." Similar statements are made by R. Blanchard (1890), Riedel (1895), Rudow (1896), Massonat (1909) and others. Even Bezzi (1916) writes that the male may be found on birds, while the female gets established on deer. None of these writers, however, offers evidence in support of this view.

viduals may alight on the hunter in the autumn, as he picks up his quarry, giving the impression that they came off the bird, whereas they were only flying about freely.

*Parasites.*—It is probable that *L. cervi* and the other species of *Lipoptena* harbor as great a variety of internal parasites as the sheep-keed, but thus far they have been little investigated.

The presence of intracellular microorganisms (bacteroids) was first mentioned by Roubaud (1919) and later confirmed by Zacharias (1928). According to the latter, they infect normally some of the epithelial cells of the mid-gut. They are apparently of two types and similar to those of *M. ovinus*, where I shall discuss them more fully. As in the sheep-keed, they are transferred by the milk-glands from the female fly to the developing larva (not to the egg itself) and later through the puparium to the adult.

*L. cervi* apparently also carries *Rickettsia*-like organisms in the hind region of the mid-gut, although nothing very definite is known about them (Zacharias, 1928).

No flagellates that might be developmental stages of blood trypanosomes have as yet been reported from *L. cervi*. But, in view of their common occurrence in *L. capreoli* and *M. ovinus*, they may be expected in the deer-keed. In this connection, attention may be called to the presence of a trypanosome in the blood of European roe, reported some years ago by P. Knuth (1909, *Zeitschr. Infektionskrankh. Paras. Krankh. Haustiere*, VI, pp. 357–362, Pls. X–XII).

Although deer-keeds sometimes occur in unbelievable numbers (Darling, 1937), there is no reliable information on the effect they may have on the health of the host.<sup>35</sup> Ströse (1916) blames *L. cervi* for a peculiar skin affection or eczema of red deer in certain districts of Germany, consisting of hairless patches with thickened spots, but offers no real evidence.

*Historical Note.*—The European deer-keed was unknown, or at any rate not discriminated from ticks and lice also found on deer, until the middle of the eighteenth century. Frisch (1736) first gave a description and a clearly recognizable figure, based on specimens

<sup>35</sup> A. Eysell's (1924) statement that Tulare fever or tularemia (*Bacterium* or *Pasteurella tularensis*) is carried by a "Hirschfliege (*Lipoptena cervi* L.?)," in Utah, is based on a misunderstanding of the vernacular name "deer-fly" which is used in North America for the tabanids of the genus *Chrysops*, not for deer-keeds. The error is repeated by T. A. Maass (1937, *Tabulae Biologicae*, XIII, p. 162).

taken in Germany off roe ("Rehbock," *Capreolus capreolus*). Panzer's (1798) figure was original and also based on an actual specimen. Olivier (1792) described the deer-keed more fully, believing it to be a new species, and he first definitely recorded it from red deer ("Cerf," *Cervus elaphus*). Meanwhile Linnaeus (1758) had proposed the name "*Pediculus cervi*," which he based not on a description of his own, but on references to Frisch's figure of the "Reh-lauss" (a true *Lipoptena*) and to Redi's two figures of Pl. XXIII in the "Experimenta circa Generationem Insectorum" (1671). Redi's upper figure of this plate represents a sucking louse (Anoplura) and his lower figure a biting louse (Mallophaga). It would seem that Linnaeus never saw a specimen of any of these deer parasites; hence his inability to distinguish between them and his failure to recognize the affinity of Frisch's deer-keed with the sheep-keed and the louse-fly of the horse.<sup>36</sup> Panzer (1798), who knew that the deer-keed is related to *Hippobosca*,<sup>37</sup> apparently first restricted Linnaeus' specific name "*cervi*" to this fly. This has been the general custom ever since and, if correct, makes the name unavailable for either the sucking louse or the biting louse of deer. If this conclusion were proved untenable, the correct specific name of the deer-keed would remain "*cervi*," but would have to be credited to Olivier (1792), who described this insect as a new species in the genus *Hippobosca*, where this specific name had not been used before. Olivier, moreover, also recognized its correct affinities.

The earliest mention of the association of *L. cervi* with the European elk is apparently by J. G. Büttner (1838, Oken's Isis, p. 361), who noted that hippoboscids, known by the hunters as "Elendsfliege," often fly onto people who wander through a forest stocked with elk (no scientific name is used for the fly). v. Siebold (1845) found puparia of *L. cervi* in the fur of elk and recognized that the deälated stage of the elk-keed was identical with the deer-keeds of roe and red deer. He refused to admit, however, that the winged *Ornithobia pallida* was the same insect, although he suggested that the wings of *L. cervi* were more fully developed in newly hatched keeds. The true state of affairs, first suspected by Fallén (1826),

<sup>36</sup> Massonat (1909, p. 13) states that Linnaeus placed *L. cervi* in the same genus as the sheep-keed and called it "*Melophagus cervi* L." I can find no evidence for this in Linnaeus' writings. Meigen (1830) was the first to use the combination "*Melophagus cervi*."

<sup>37</sup> "*Pediculus cervi* ad genus *Hippoboscae* adlegendus, qui haec tenus perperam pediculorum genus auxit."

was definitely cleared up by H. Schaum and H. Loew (1849), after Kawall and Gimmerthal (1845) had recognized that the winged *Ornithobia pallida* occurred on eland and not on birds. Schaum and Loew showed conclusively that both *Haemobora pallipes* Curtis (1824) and *Ornithobia pallida* Meigen (1830) were the newly hatched, winged state of *L. cervi*.

*Original Descriptions and Synonymy.*—As pointed out before, Linnaeus gave no formal description and he probably never saw a specimen. Hence there was no "type" of his *Pediculus cervi*.

Of *Hippobosca cervi* Olivier the type is lost. The description is as follows (translated): "Hippobosca aptera, fusco ferrugineoque varia, abdomine plicato. A little smaller than the foregoing [*Melophagus ovinus*]. Head and thorax mixed brown and pale ferruginous. Abdomen broad, depressed, provided with folds, blackish, with ferruginous margins. Legs pale ferruginous. Hind part of thorax with only rudiments of wings."

Original description of *Melophaga trifasciata* v. Olfers: "Abdomine brunneo piloso, superne area orbiculari nuda fasciis tribus transversalibus brunneis pilosis notata, femoribus tenuioribus, rudimento alarum.—Caput rotundiusculum, oculi majores globosi laterales. Pedes pilis sparsis hinc inde obsiti. Alae minutissimae truncatae, nervis tribus validis, primo seta aucto, instructae, halteres niveae capitulo complanato. Processus sternalis ut in praec. [*Melophagus ovinus*]." The description was based on a specimen in Hoffmannsegg's collection, which may yet be in existence.

*Hippobosca cervina* Nitzsch was apparently intended as a substitute name for "*cervi*." It is defined not by a description, but by a reference to Frisch's figure of 1736.

*Haemobora pallipes* Curtis was based on the figures of a winged male and the following specific description: "Shining, pale and dull greenish-yellow, clouded with brown, with strong hairs scattered over the body and legs; eyes and claws black; thorax beneath punctured and covered with short strong erect hairs; wings nearly transparent, nervures yellow, the costa slightly ciliated." The structural characters were, however, contained in the generic diagnosis, the genus *Haemobora* being monotypic: "Antennae inserted close to the anterior angles of the clypeus, globular, hairy and sunk into the head. Labrum horny, elongated, hollow, slightly arcuated, inclosing the tongue. Tongue nearly as long as the labrum, slender. Lip horny, arched, hollow, inclosing the labrum and tongue. Maxillae ? rigid, obtuse, ciliated with strong hairs united at their internal edges, bent downwards, inclosing the proboscis, and extending be-

yond the head like a beak. Mentum large, coriaceous, membranaceous, covering and concealing the base of the proboscis. Head broader than long, somewhat transverse-ovate, closely adhering to the thorax; eyes large, very remote; ocelli 3 in triangle. Thorax a little broader than the head, nearly quadrate, dilated near the base of the wings, notched anteriorly; scutellum broad and short. Wings very long and rounded, first marginal or mediastinal cell extending one-third the length of the wing; 2nd marginal cell very long, rounded at the end; discoidal cells united, 6 obscure and imperfect nervures extending to the posterior margin. Halteres very distinct and capitate. Abdomen small, nearly conical, peduncled, spongy, coriaceous towards its base. Legs thick, first pair remote from the others, and inserted almost under the head; tarsi 5-jointed, terminal joint the longest; claws lengthened at their base on each side the pulvillus." Possibly the type may be at the Melbourne Museum, where some of Curtis' other specimens are preserved.

Original description of *Ornithobia pallida* Meigen (translated): "Head inserted in an emargination of the thorax, flat, disk-shaped. Lower part of face [fronto-clypeus] short, shiny, separated from the vertex [mediovortex] by a somewhat curved transverse suture; on either side of the face, the small, smooth, bare, wart-shaped antennae are inserted in a small pit; the vertex has a somewhat raised, smooth side margin, and an occiput [postvertex] also raised, bearing two small black pits without ocelli. Head russet-yellow, with only a small, black dot on either side at the inner margin of the antennal pit. Beak [correctly, mouthparts] russet-yellow, shorter than the head; it consists of the two russet-yellow valves [palpi] peculiar to this family; tongue [correctly, proboscis] only a little longer than the valves. A few fine setae to the sides of the tongue. Mesonotum flat, disk-shaped, black, shiny, with russet-yellow, rather large shoulder-spots; medially with two russet-yellow longitudinal lines close together; setose behind, particularly at the sides; scutellum transversely elongate, russet-yellow, with setose hind margin. Halteres white. Abdomen russet-yellow, elongate rounded, setose. Wings nearly hyaline, with pale veins as shown in the figure. Legs russet-yellow, setose, heavy; first four tarsal segments very short, the fifth longer, with two claws of unequal length: the outer claw shorter than the inner one; each claw split into two teeth, as in the preceding genus [*Hippobosca*]. Length: 2 lines [= 4.36 mm.]" The type is lost.

I have been unable to consult the original description of *Ornithomyia nigrirostris* v. Roser. Speiser (1905) saw the type and

recognized it as a winged male of *Lipoptena cervi*. It is preserved at the Stuttgart State Museum.

Original description of *Lipoptena alcis* Schnabl (translated): "♀. A *Lipoptena cervi*, cui proximus, corpore autem multo majore et obscuriore, segmento abdominali primo nigro-piceo, pedibus praeter basim, fuscis, distinctus; caeterum similis *Lipoptenae cervi*. Long. corp.  $2\frac{3}{4}$ -3 lin. [= 5 to 6.5 mm.].—Markedly larger than *L. cervi* and of a darker color; first abdominal segment pitch-black, only often dark brown at the base. Legs dark brown, except the basal third of fore and mid femora and the basal half of hind femora, which are pale brownish-yellow." Type at the Polish Zoölogical Museum, Warsaw. I have seen several cotypes and many other specimens taken from European elk and I have been unable to discover any difference in structure or chaetotaxy from *L. cervi*. Color differences are of no value in this genus and, moreover, some of the specimens I have seen from roe or red deer are as dark as the darkest flies off elk. Séguy (1938) separates *L. cervi* and *L. alcis* as follows:

1. Crossvein MA2c of wing [the one remaining crossvein] ending beyond tip of  $R_1$  [first longitudinal vein]. Three or more orbital bristles [the longer frontals of my terminology] ..... *L. alcis*.
2. Crossvein MA2c of wing ending opposite the tip of  $R_1$ . Two orbital bristles ..... *L. cervi*.

Neither of these characters is reliable enough to be of specific value, as shown by a study of a series of specimens taken from elk, red deer and roe of Europe, as well as from native deer of the north-eastern United States.

Original description of *Lipoptena subulata* Coquillett: "Near *depressa* Say but larger, with a fasciate abdomen and a stout black spine at the apex of the inner side of the front tibiae. Head yellowish, middle of the front opaque brownish, the broad orbits polished and becoming blackish posteriorly, an elongate-oval, transverse, black ocellar spot and a pair of black spots between the antennae. Thorax brown, the anterior part and the scutellum yellowish. Abdomen black, the base reddish-yellow, the medio-dorsal region marked with a pale yellow triangular spot, followed by two fasciae of the same color, the second one at its ends usually prolonged to the hind end of the abdomen; venter black laterally, the middle pale yellow; just before the anal opening in the female is a transverse row of three small chitinized brown spots. Legs light yellow; front and middle tibiae devoid of spines, except at their apices; the front ones with a stout black apical spine reaching to apex of second tarsal joint, the middle tibiae with a long, black spine and a second spine

about one-half as long; hind tibiae bearing a row of three along the inner side and a crown of four at the apex. Length 4 to 5 mm." I have seen the holotype and paratypes at the U. S. National Museum. They are indistinguishable by any reliable character from European specimens of *L. cervi*.

2. *Lipoptena grahami*, new species. Figs. 6A-C.

*Female*.—Head moderately lengthened behind the eyes, which are narrower than usual; mediovertex short, slightly wider than long, much shorter than fronto-clypeus, but about as long as postvertex; fronto-clypeus without trace of the suture originally dividing frons and clypeus, with a fine anterior longitudinal furrow ending in a pit behind; pretilinal area weakly marked, with a deep antero-median fovea; inner orbit about as wide as the eye, with 2 to 4 long setae and a few minute ones, all rather far from the inner margin of the eye; one long vertical bristle; postvertex moderately long, semi-elliptical; ocelli small but distinct, in an equilateral triangle. Palpi slightly shorter than fronto-clypeus. Pro-mesonotal suture deep; suture between pronotum and propleuron weak. Mesothorax: median notal suture weak over nearly entire length; no transverse pre-scutal suture; intrascutal grooves slightly marked, bearing the acrostichals; mesonotal suture extending to near the scutellum; posthumeral suture well marked; mesothoracic spiracle large, at latero-posterior edge of humeral callosity; 7 or 8 acrostichals, in a curved admedian row; laterad of them 7 to 10 latero-centrals, none of them behind the mesonotal suture, arranged into an anterior and (smaller) posterior group separated by a large, triangular, bare admedian area, which also divides them from the acrostichals; 5 to 7 humerals; 4 postalars and 2 pre-scutellars, the two groups far apart; two rows each of 4 to 6 notopleurals, the hind row heavier and longer; usually 6 scutellars, in 3 pairs, the median pair the longest; ventrally, lobes of prosternum with 4 or 5 small setae and 2 longer bristles; mesosternum and basisternum mostly covered with short, thick, loosely scattered setae, a few of them much longer. Abdomen: basal dorsal pleurites (I) very large, transverse, with a distinct posterolateral angle, conspicuously defined from pleurites II, with an apical row of long bristles and many smaller setae scattered over most of the disk; pleurites II to V well set off (as in *L. cervi*), partly sclerotized, II and III with loosely scattered setae of medium length, IV and V with few longer bristles; five

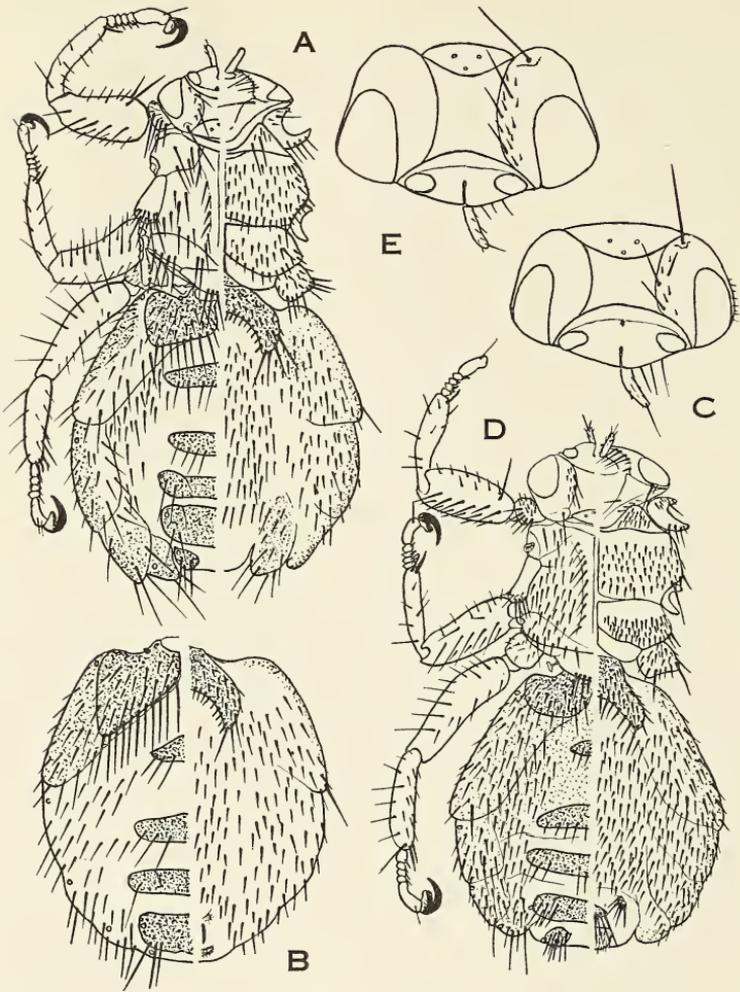


FIG. 6. A-C, *Lipoptena grahami* J. Bequaert: A, female holotype, from above (left) and below (right); B, abdomen of male allotype from above (left) and below (right); C, head of male.—D-E, *Lipoptena japonica* J. Bequaert: D, female holotype, from above (left) and below (right); E, head of female.

median tergal plates: first and second subequal, very wide but short, ribbon-shaped, 3 to 4 times as wide as long, each with a transverse, preapical row of 6 to 8 setae; third larger than first or second, also ribbon-shaped, over 4 times as wide as long, divided into three areas by 2 longitudinal depressions, each of

the lateral areas with 2 præapical setae; fourth narrower and longer than third, rectangular, about 3 times as wide as long, also divided by 2 longitudinal depressions, the relatively small lateral areas each bearing 2 præapical setae; fifth divided into 2 separated plates, each with 2 or 3 setae; remainder of dorsum membranous and extensible, mostly bare with a few scattered setae over part of the sides only. Crescent-shaped basal ventral sclerite more deeply emarginate than usual, the lateral lobes long and narrow, with fairly numerous thick setae all over, those at the hind margin heavier, in a regular row, and some at the tips of the lobes longer; ventral portion of pleurites fairly well set off and partly sclerotized, uniformly setulose; remainder of venter membranous (except for the small anal and genital plates), uniformly setulose. Abdominal spiracles small but distinct; spiracles VI and VII enclosed in the fourth and fifth median tergal plates. Legs heavy and strongly setose; apical spur of fore tibia thick; mid tibia with two apical spurs, one of them much stronger; claws slender, distinctly asymmetrical in each pair. Wing unknown.

*Male*.—Similar to the female in structure and chaetotaxy. Dorsum of abdomen with only four median plates, corresponding to the first to fourth of the female and all much larger; first somewhat triangular; second and third ribbon-shaped; fourth very long, rectangular, about twice as wide as long. Terminalia of the usual type; parameres long and slender.

Length (h. + th.): ♀, 1.7 to 2 mm.; ♂, 1.6 to 1.8 mm.

SPECIMENS EXAMINED.—CHINA: between Kuan-Chien and Uen Chuan Shien, Szechuan Province, July 4 to 7, 1924, female holotype, male allotype, one female paratype and 3 male paratypes, without host (D. C. Graham). Holotype, allotype and paratypes at U. S. National Museum; ♀♂ paratypes at Mus. Comp. Zoöl., Cambridge, Mass.

*Distribution*.—*L. grahami* is known at present only from the Szechuan Province of southwestern China.

*Host Relations*.—The host of *L. grahami* is as yet unknown; but from the affinities of the species it will probably be one of the several species of Cervidae found in western China.

*Affinities*.—*L. grahami* is most closely related to the common Palearctic deer-keel, *L. cervi* (Linnaeus), with which it agrees in the essential structural characters. It differs in details of the chaetotaxy, particularly on the mesoscutum, the more extended postvertex, the narrower eyes, the shorter palpi, the larger first median tergal

plate, and the shape of the basal dorsal and ventral sclerites of the abdomen.

3. *Lipoptena japonica*, new species. Figs. 6D-E.

*Female*.—Head much lengthened behind the eyes, which are relatively short and broad; mediovertex longer than wide and longer than fronto-clypeus or postvertex; clypeus completely fused with frons, its extent only indicated by the very fine median longitudinal groove; inner orbit much narrower than eye, with 3 long setae and several smaller ones; one very long vertical bristle; postvertex short and moderately wide, flattened elliptical; ocelli small but distinct, in a slightly flattened triangle. Palpi slightly shorter than fronto-clypeus. Promesonotal suture very deep, except on the sides; suture between pronotum and propleuron weak. Mesothorax: median notal suture distinct over nearly entire length; no transverse pre-scutal suture; well-marked longitudinal intrascutal grooves; transverse mesonotal suture weak, but extending to near the scutellum; posthumeral suture weak; mesothoracic spiracle large, at latero-posterior edge of humeral callosity; 10 acrostichals, in a curved row between the median notal suture and the intrascutal groove; laterad of them many (about 28) latero-centrals; 4 humerals; 4 postalars and 3 prescutellars, in one continuous row; 4 intra-alars on the disk behind the mesonotal suture; two rows each of 4 notopleurals, the posterior ones heavier and longer; 8 scutellars, in 4 pairs, the median pair the shortest; ventrally, lobes of prosternum with many setae; mesosternum and basisternum mostly covered with many short, thick setae. Abdomen: basal dorsal pleurites (I) large, rather well divided from pleurites II, with an apical row of very long bristles and many smaller setae over the disk; pleurites II to V more or less set off and somewhat sclerotized, III and IV separated, all with many scattered setae; five median tergal plates: first small, with few setae; second and third large, transversely elliptical, about the same size and with a regular transverse row of 10 long setae; fourth as large as third, but widened laterally where it bears a group of 7 setae; fifth divided into a pair of sclerites, each with 7 long setae; integument between median plates and separating them from pleurites mostly membranous and extensible, but somewhat sclerotized over basal half of dorsum, laterally with rather numerous setae. Basal ventral sclerite deeply emarginate at apex, with many heavy setae all

over, those along hind margin much longer; ventral portion of pleurites more or less sclerotized and uniformly covered with many setae; remainder of venter membranous and uniformly setulose; before the anal and genital sclerites, a mostly bare area with three groups of longer setae on small, sclerotized plates. Abdominal spiracles small, but distinct; spiracles VI and VII not enclosed in the fourth and fifth median tergal plates. Legs heavy and strongly setose; apical spur of fore tibia thick; mid tibia with two apical spurs, one of them much stronger; claws slender, slightly asymmetrical in each pair. Wing unknown.

Length (h. + th.): 2.5 mm.

Male unknown.

SPECIMEN EXAMINED.—JAPAN: Hondo (or Nippon), female holotype, off *Capricornis crispus*. Mus. of Comp. Zoöl., Cambridge, Mass.

*Distribution*.—Probably restricted to Japan, although it should be looked for in Formosa, where the host also occurs.

*Host Relations*.—Known only from the dwarf serow of Japan, *Capricornis crispus* Temminck, of which it is probably a specific parasite. It is interesting, in this connection, that *Capricornis* is a near relative of the chamois (*Rupicapra rupicapra*) of Europe, which harbors the *Lipoptena* most closely allied to *L. japonica*.

*Affinities*.—*L. japonica* is very closely related to *L. couturieri*, so much so indeed that I have hesitated for some time to describe it from a single specimen, particularly as I have had only one female of *L. couturieri* for comparison. The following differences seem significant: postvertex shorter; mediovertex much longer than wide and much longer than postvertex; upper outer orbit much widened behind the eye; fewer long bristles on inner orbit; first median tergal plate much smaller. Only a comparative study of series of specimens authentically taken on serow and chamois will definitely settle the status of the two species.

#### 4. *Lipoptena couturieri* Séguy. Figs. 7A–E.

*Lipoptena couturieri* Séguy, 1935, Bull. Mens. Assoc. Natural. Vallée du Loing, XI, p. 86 (♀♂; Massif of the Maladetta, Pyrenees, Spain; off *Rupicapra rupicapra pyrenaica*); 1938, in M. A. J. Couturier, Le Chamois, p. 422, figs. 68 and 69A–E (♀♂; types and others from region of Sajust in the Pyrenees near Luchon, Dept. Haute-Garonne, France; off same host).

*Female*.—Head much lengthened behind the eyes, which are moderately wide; mediovertex a little wider than long, shorter than fronto-clypeus and about as long as postvertex; clypeus completely fused with frons, its extent only indicated anteriorly by the very fine median longitudinal groove; a minute fovea on the preptilinal area; inner orbit about as wide as the eye, with 15 to 17 setae, 3 to 5 of them longer near inner margin; one very long vertical bristle; postvertex long and wide, semi-elliptical; ocelli distinct, in a nearly equilateral triangle. Palpi much shorter than fronto-clypeus. Pro-mesonotal suture very deep, except on the sides; suture between pronotum and propleuron weak. Mesothorax: median notal suture weak, but indicated over most of the length; no transverse prescutal suture; no longitudinal intrascutal grooves; transverse mesonotal suture weak and ending far from the middle; posthumeral suture well-marked; mesothoracic spiracle large, at the latero-posterior edge of the humeral callosity; 10 acrostichals in a curved row on either side of the median notal suture; laterad of them about 28 to 30 latero-centrals; 8 to 12 humerals; a continuous row of 6 or 7 postalars and prescutellars; 6 or 7 intra-alars on the disk behind the mesonotal suture; two rows each of 4 notopleurals, the posterior ones heavier and longer; 8 to 10 scutellars, in 4 or 5 pairs; ventrally, lobes of prosternum with about 7 setae; mesonotum and basisternum mostly covered with many, rather long, thick setae. Abdomen: basal dorsal pleurites (I) large, rather well divided from pleurites II, with an apical row of very long setae and many smaller bristles over the disk; pleurites II to V more or less set off and weakly or not sclerotized, III and IV separated; all with many scattered setae; five unusually large median tergal plates: second and third about the same size, transversely elliptical; first slightly smaller; fourth markedly larger, comprising spiracles VI; first to third with a regular transverse row of 10 long setae; fourth with an irregular row of about 16 long setae; fifth divided into a pair of sclerites, each comprising spiracle VII and with 6 long setae; integument between the median plates and separating them from the pleurites membranous and extensible, bare. Basal ventral sclerite deeply emarginate at apex, with many heavy setae all over, those along the hind margin much longer; ventral portion of pleurites scarcely sclerotized and uniformly covered with many setae; remainder of venter membranous and uniformly setulose, even before the anal and genital sclerites. Abdominal spiracles

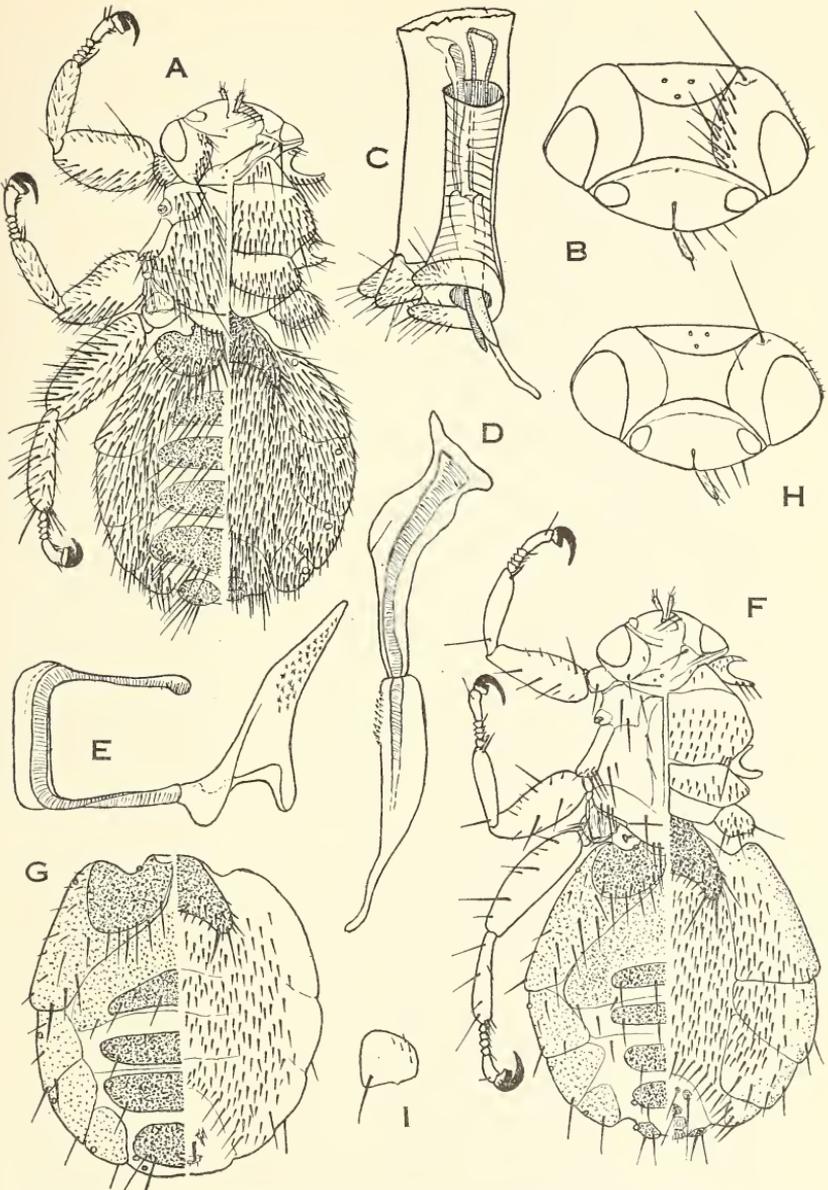


FIG. 7. A-E, *Lipoptena couturieri* Séguy: A, female paratype, from above (left) and below (right); B, head of female; C, male terminalia and genital sclerites in profile; D, aedeagus in profile; E, paramere in profile (C-E, after Séguy).—F-I, *Lipoptena hopkinsi* J. Bequaert: F, female holotype, from above (left) and below (right); G, abdomen of male allotype, from above (left) and below (right); H, head of male; I, fore coxa from above.

large: I at lateral basal edge of basal pleurite; II to V on the ventral side of their pleurites; VI and VII comprised within the edges of the fourth and fifth median tergal plates. Legs heavy and strongly setose; apical spur of fore tibia thick; mid tibia with two apical spurs, one of them much stronger; claws slender, slightly asymmetrical in each pair. Wing unknown.

Length (h. + th.): 2.5 mm.

*Male*.—I have not seen this and must refer to Séguy's description, translated below. I have also copied his drawings of the male terminalia.

*SPECIMEN EXAMINED*.—SPAIN: Massif of the Maladetta, Pyrenees, female paratype, off *Rupicapra rupicapra pyrenaica* (M. A. J. Couturier; received from Mr. E. Séguy).

*Distribution*.—Known at present only from a restricted area in the central Pyrenees, on both sides of the Franco-Spanish frontier, this species should be looked for wherever the several races of the chamois are yet preserved.

*Host Relations*.—*L. couturieri* appears to be a specific parasite of the chamois or gemse, *Rupicapra rupicapra* (Linnaeus), which is now found only over a disconnected area in the most inaccessible mountains of Southern and Central Europe (Cantabrian Mts., Pyrenees, Alps, Jura, Tatras, Abruzzi, Balkans, Caucasus, and Taurus). It has as yet been taken only on the Pyrenean race, or isard, *Rupicapra rupicapra pyrenaica* Bonaparte; but probably the other races harbor it also. In Pleistocene and prehistoric times the area occupied by the chamois was much more extended and fairly continuous.<sup>38</sup>

*Affinities*.—It is of particular interest that the closest relative of the European *L. couturieri* is the Japanese *L. japonica*. The latter is a specific parasite of the dwarf serow, *Capricornis crispus*, itself a close ally of the chamois. *L. couturieri* is markedly more setulose than *L. japonica*, particularly on the inner orbits and the mesonotum. Other striking differences are in the shape of the medio-vertex, postvertex and median tergal plates.

*Original Description*.—Séguy's brief first description of *Lipoptena couturieri* (1935) reads (translated): "♂. Body entirely

<sup>38</sup> See M. A. J. Couturier. 1938. Le Chamois, (Grenoble), 855 pp. This author recognizes ten geographical races of *Rupicapra*. The chamois has also been introduced into New Zealand, where it appears to have become naturalized. It would be of interest to know whether the *Lipoptena* was brought in with the host.

shiny black, submetallic. Mesonotum and abdomen covered with robust bristles. Ocellar plate [postvertex] widened, nearly semi-circular. Orbital setae many and placed in two more or less regular or parallel rows. Legs russet.—♀. Like the male; first abdominal tergite less deeply divided, the lobes yellowish at the sides. Bristles of abdomen less robust than in the male, but long.—Length 3.8 to 4.2 mm.” The author’s later description (1938) is much more complete and also copied (translated in part): “*Mes. Niger nitidus*, in coloris codice universale No. 720 (Lechevalier). Frontis dimidium anteriore, antennae, clypeus, coxae, pedesque flava. Femores interdum posterius, praeter basem et extremitatem apexque posteriorum tibiaram nigra fusca aut infuscata. Setae orbitum in duabus seriebus inaequalibus dispositae. Lamina ocelligera dilata, subcircumdata. Mesonotum nigrum, micans in specimine exsicato. Alae seetae. Halteres: pediculus niger, capitulum pellucidum. Pedes crassi, subflavique, in facie dorsali fuscii. Abdomen nigrum: tergatae dilatatae, densis spinulosis vestitae. Hypopygium parvum, in tubi genitalis apice instructum, exsertile aut retractile. Gonapophysis mediocris, triangularis, spinuligeris. Phallus inermis; paraphallus in parte mediano anterioreque spinosus; penis molle. Long. corp. 3.8–4.2 mm.—*Femina*. Rufa, nigra et flava varia. Setae orbitum externae parvae. Pedes rufuli. Abdomen: membrana conjunctiva pulla, tergatae mediocres disjunctae. Oviductus parvus, negligendus. Long. corp. 4.5–5.5 mm.—*Male*. In dry condition with shiny black body; first three tergal plates rather widened, most of the abdomen covered with a long pilosity of black bristles. Head brown, marked with black. Antennae russet, with brown pilosity. Ocellar plate [postvertex] shiny black, almost semi-circular, more developed than in *L. cervi*, with three deep depressions placed in a triangle; median frontal band [mediovertex] brownish-black, slightly wider than long; orbits [inner orbits] wide, halfmoon-shaped, wider than the eye at mid-height. Clypeus [fronto-clypeus] shiny blackish-brown, with a deep median depression in the upper part near the frontal band, the lower portion with a whitish, club-shaped depression. Palpi short, shiny black. Peristome with stiff, erect, black hairs, longer anteriorly, in one or two rows, hind corner with a long erect bristle. Chaetotaxy of head: an inner, heavy vertical bristle in the supero-internal corner of the orbit near the outer corner of the ocellar plate; orbital bristles [frontals] heavy and prostrate, in two irregular rows on the fronto-orbital margin of the orbital plate. Thorax: mesonotum covered with long and heavy, prostrate bristles, entirely shiny black. Acros-

tichals long and heavy, sometimes crossing over the middle line, placed irregularly. Humeral callus with 8 to 10 bristles; postalar callus with 4 to 6 bristles; lateral mesonotal areas with long setae forming a transverse row at the level of the base of the wing. Scutellum nearly semi-circular, flat, shiny black, slightly brownish on the crests; 8 to 10 postero-marginal bristles [scutellars]. Proster-num bilobed, each lobe subtriangular with rounded apex, the inner margin bearing 6 to 8 small setae and 3 long bristles. Mesonotum elongate trapezoidal, much wider than the mesosternum, the median furrow shallow; mesosternal setae spinulose, regularly placed, semi-prostrate, the postero-marginal ones thickened, except for the long sensorial seta at the level of coxa II; metasternal setae arranged similarly, but weaker. Legs short, very robust, yellow, darker on the outer side. Bristles and setae black. Claws simple, black. Halteres slender, the stalk black, the swelling sometimes paler. Wings shed. Dorsum of abdomen: basal segment of the usual type; succeeding tergal plates reduced, closely crowded; apical tergite more developed. Venter blackish-brown; first sternite horseshoe-shaped, bearing heavy bristles particularly on the hind margin; last visible sternite triangular, pale yellow and russet at hind margin. Mating organ small, at the apex of a thick tube, retractile; pre-genital sternite microscopic; inner forcipes with very small, nearly rounded, independent arms; outer forcipes with more developed and fused arms, placed at the lower portion of the tube and forming the flaring apex of a sclerotized tube in which slide the gonapophyses [parameres] and the simplified penis [aedeagus]. Gonapophyses elongate, subtriangular, provided on their median portion with triangular spinules directed posteriorly; the base of the gonapophyses articulates on the arms of a stirrup-shaped genital sternite with very narrow arms; paraphallus vestigial, replaced by a strongly sclerotized area bearing sawtooth-shaped spines on the upper ridge; theca wanting, the base of the paraphallus articulating directly on the short, elbowed, rod-like apodeme of the penis. Length 3.8 to 4.2 mm.—*Female*. In dry condition mesonotum blackish-brown, russet in young individuals. Abdomen with the first three tergal plates narrow; abdominal pilosity robust, but shorter than in the male, uniformly black. Head as in male; median frontal band pale, russet-brown. Eyes slightly narrower. Palpi brown. Peristome with sparser pilosity than in the male, of some very long setae, placed irregularly, brown or blackish-brown. Chaetotaxy of head like that of male; orbital setae shorter, the inner bristles setose or hair-like. Thorax: acrostichals small, not crossing, inserted regu-

larly at some distance from the median suture, but with a bare area between the two inner rows. Humeral callus with 12 to 16 irregular bristles; postalar callus with 4 bristles decreasing regularly in strength toward the outer corner. Lateral area of mesonotum and scutellum with bristles as in the male. Prosternum of two triangular lobes, the inner margins with 6 short spines and 3 bristles. Mesosternum covered with spinulose setae, irregularly placed, those of the hind margin above coxae II being true spines; metasternal setae weaker. Legs short, yellow, darker toward apex. Bristles and spines black, their bases surrounded by a paler, more or less distinct ring, more marked on the fore femora. Claws very robust, black. Halteres -blackish, with pale swelling. Wings shed. Abdomen: tergal plates widely separated, the last tergite more developed, bilobed; the last two tergites with the spiracles papulose, very prominent. Venter whitish; first sternite horseshoe-shaped, with short triangular spines, stronger on the hind margin; other sternites wanting; ventral side a thick membrane densely covered with bristles. Pregenital sternite (the styles fused) very narrow, fringed behind with long yellow hairs, corresponding to those of the dorsum. Oviduct soft, insignificant. Cerci fused, with long yellow hairs. Length 4.5 to 5.5 mm." The types are at the Paris Museum of Natural History. One paratype, received from Mr. Séguy, is now at the Mus. of Comp. Zoöl., Cambridge, Mass.

5. *Lipoptena capreoli* Rondani. Figs. 8A-G.

*Lipoptena capreoli* Rondani, 1878, Ann. Mus. Civ. Genova, XIII, p. 152 (♀; Cyprus; no host); 1879, Bull. Soc. Ent. Italiana, XI, p. 14 (♀). Bezzi, 1916, Natura, Riv. Sc. Nat., VII, p. 178. Falcoz, 1931, Parasitology, XXIII, pt. 2, p. 264, fig. 1A (♂; Cattaro, Jugoslavia).

*Lipoptena cervi* var. *capreoli* Bezzi, 1905, Kat. Paläarkt. Dipt., IV, p. 283.

*Lipoptena caprina* Austen, 1921, Bull. Ent. Res., XII, p. 122 (♀♂; type ♂ from Jerusalem, Palestine, off domestic goat; type ♀ from Ain Arik, Palestine, off domestic goat; also ♀ off man, Snevece, Macedonia); 1922, Trans. R. Soc. Trop. Med. Hyg., XV, p. 264 (Sohawa, Jhelum District, Punjab); 1925, Bull. Ent. Res., XVI, p. 23 (♂; Chanak, Dardanelles, Asia Minor, off dog; Jerusalem, off camel and cow). Buxton, 1924, Bull. Ent. Res., XIV, p. 324, figs. 5-7 (♀♂, larva; Abu Gosh; Nablus; Nahr el Zerga; all in Palestine). Theodor, 1928, Zeitschr. f. Parasitenk., I, pt. 2, p. 284,

figs. 1-8 (♀♂, puparium; anatomy; flagellate parasite); 1928, Trans. R. Soc. Trop. Med. Hyg., XXI, pt. 6, pp. 489-490. Fletcher and Sen, 1929, Jl. Centr. Bur. An. Husb. Dair. India, III, pp. 51 and 56. P. Buchner, 1930, Tier u. Pflanze in Symbiose, 2d Ed., p. 614. Hoare, 1931, Parasitology, XXIII, p. 478 (*Trypanosoma theodori*). Aschner, 1931, Zeitschr. Morph. Oekol. Tiere, XX, pp. 369, 376-378, and 398-399; Pl. I, figs. 3 and 10-12; Pl. II, fig. 13; Pl. V, figs. 43-44 and 47 (symbionts and *Rickettsia*). Bodenheimer, 1937, Mém. Inst. Égypte, XXXIII, p. 193. Gambles, 1939, Cyprus Agric. Jl., XXXIV, p. 32 (Cyprus).

*Female*.—Head moderately lengthened behind the eyes, which are relatively narrow; mediovertex short, wider than long, much shorter than fronto-clypeus or postvertex; fronto-clypeus with a very faint trace of the suture originally dividing frons and clypeus, with a fine anterior longitudinal furrow ending in a pit behind; pretilinal area distinct, with at least a trace of an antero-median fovea; inner orbit about as wide as the eye, usually bearing 3 or 4 (rarely 5) longer frontal bristles and sometimes 1 or 2 minute setae, all rather far from the inner margin of the eye; one or very rarely 2 long vertical bristles; postvertex very long, almost semi-circular; ocelli small but distinct, in a slightly flattened triangle. Palpi much shorter than fronto-clypeus. Pro-mesonotal suture deep; suture between pronotum and propleuron weak. Mesothorax: median notal suture weak over nearly entire length; no transverse prescutal suture; no distinct intrascutal grooves; mesonotal suture extending to near the scutellum; posthumeral suture weak; mesothoracic spiracle large, at latero-posterior edge of humeral callosity; 8 to 10 acrostichals, in a curved admedian row; laterad of them from 8 to 15 (usually 12 to 14) latero-centrals, none of them behind the mesonotal suture, arranged into an anterior and a posterior group separated by a large, triangular bare admedian area, which also divides them from the acrostichals; 7 or 8 humerals; 3 to 5 postalars and 1 prescutellar, the two groups far apart; two rows each of 3 or 4 notopleurals, the hind row heavier and longer; usually 6 (rarely 4 or 5) scutellars, in 3 pairs, the median pair the longest; ventrally, lobes of prosternum with 5 to 7 heavy setae; mesosternum and basisternum mostly covered with short, thick, loosely scattered setae and a few longer bristles. Abdomen: basal dorsal pleurites (I) large, rather well defined from pleu-

rites II, with an apical row of long bristles and many smaller setae over part of the disk; pleurites II to V scarcely set off and rarely sclerotized in part (usually only pleurites II in old specimens), all with many scattered setae; five median tergal plates:

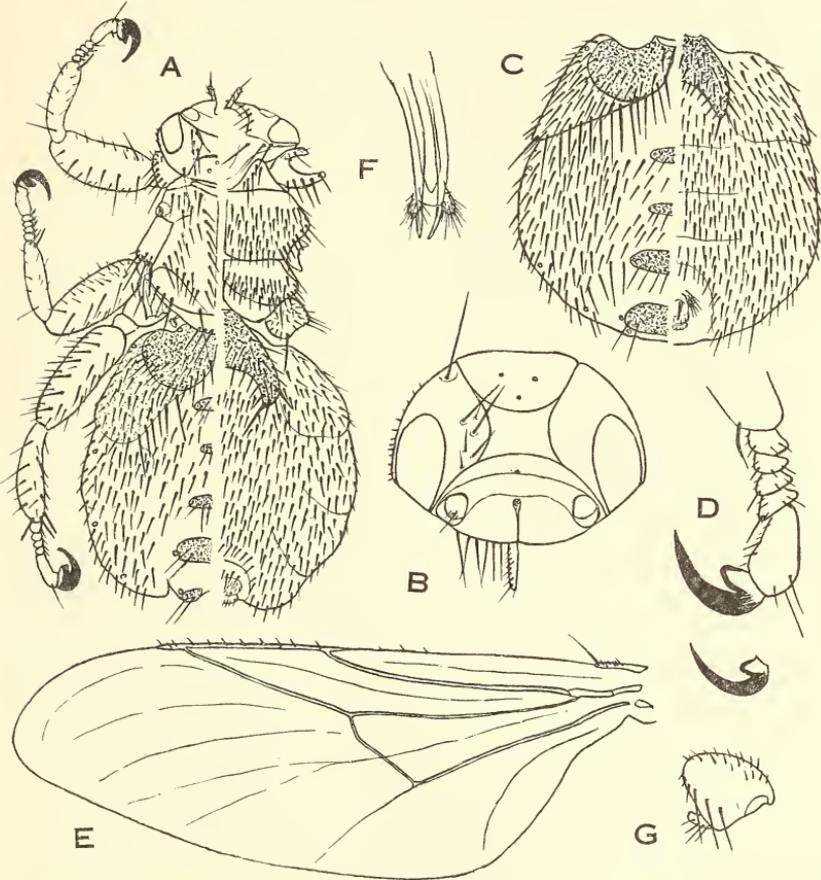


FIG. 8. *Lipoptena capreoli* Rondani: A, female, Jerusalem, from above (left) and below (right).—B, head of male, Mt. Pangaion, Greece.—C, abdomen of male, Limassol, Cyprus, from above (left) and below (right).—D, fore tarsus and claws.—E, wing.—F, male terminalia.—G, fore coxa from above.

first to third very small and with few setae (4 to 8 on each plate); first and third subequal, second smaller than either; fourth large, rectangular, about three times as wide as long, with a slight median longitudinal depression and 4 to 8 setae more or less arranged into two lateral groups; fifth consisting

of a pair of sclerites, each with 2 or 3 bristles; remainder of dorsum membranous and extensible, partly covered with loosely scattered setae. Crescent-shaped basal ventral sclerite deeply emarginate, with fairly numerous heavy setae all over, those at the hind margin in a regular row and one very long at each hind corner; ventral portion of pleurites not sclerotized and indistinctly separated, uniformly setulose; remainder of venter membranous (except for the small anal and genital plates), uniformly setulose. Abdominal spiracles small but distinct; spiracles VI and VII not enclosed in the fourth and fifth median tergal plates. Legs heavy and strongly setose; apical spur of fore tibia thick; mid tibia with two apical spurs, one of them much stronger; claws slender, nearly symmetrical in each pair. Wing similar to that of *L. cervi*, but the third longitudinal vein ends farther from the tip of the wing and in the costa itself, before the latter's apex.

*Male*.—Similar to the female in structure and chaetotaxy. Dorsum of abdomen with only four median plates, corresponding to the first to fourth of the female, the first to third somewhat larger and more transverse. Terminalia of the usual type; parameres long and slender.

Length (h. + th.): ♀, 1.8 to 2.4 mm.; ♂, 1.7 to 2.2 mm.

SPECIMENS EXAMINED.—GREECE: Mt. Pangaion, Macedonia, 1 winged female, June 14, 1933 (R. C. Shannon).—CYPRUS: Limassol, off domestic goat (G. A. Mavromoustakis); Athalassa, off domestic goat.—SYRIA: Becharré, Northern Lebanon, 1,400 m. (H. Zerny).—PALESTINE: Jerusalem, off domestic goat (O. Theodor); Artuf (P. A. Buxton).—INDIA: Sohawa, Jhelum District, Punjab (H. E. Cross).

*Distribution*.—*L. capreoli* is now reported reliably from Dalmatia (Yugoslavia), Macedonia (Greece), Asiatic Turkey (Asia Minor), Syria, Cyprus, Palestine, and northwestern India (Punjab).

*Host Relations*.—The only breeding host known at present with certainty is the domestic goat, *Capra hircus* Linnaeus, the origin of which has been discussed before. Occasionally *L. capreoli* strays onto camels, cattle or dogs. According to Aschner (1931) it does not pass over to domestic sheep, even when these graze together with infested goats. Theodor (1928) fed newly hatched flies in captivity on rabbits, on which they were kept alive for 8 to 10 days, at 25° to 30° C. in a rather moist atmosphere.

*Affinities*.—*L. capreoli* is extremely close to *L. chalcomelaena*, a

species occurring on wild goats in the Sinai Peninsula and the Nubian mountains on the African shores of the Red Sea. The similarity between the two is such, that at one time I regarded them as individual variants or perhaps races only of one species and I am not yet completely satisfied that they are distinct. Perhaps *L. capreoli* may have been derived recently from *L. chalcomelaena*, following the domestication of the wild goat. Nevertheless, the slight differences in the chaetotaxy and relative size and shape of the median tergal plates seem to be reliable in the many specimens examined, from several different lots. They are, moreover, of the same order as the specific differences separating some of the other species of *Lipoptena* and *Echestypus*, and have, so far as I can see, no selective or adaptive value.

*Life-History.*—Deälated *L. capreoli* are abundant on goats in Palestine and Syria throughout the year, but particularly so in summer, when several hundreds of keds may be found on some animals.<sup>39</sup> They prefer the outside of the thighs and the belly and migrate on hot days to the under side of the host, away from the direct rays of the sun. Mating and parturition occur on the host. The larvae are deposited in the hair, but, as they are smooth and dry, they soon drop to the ground. It is very difficult to find puparia where goats rest in the open, but they may be obtained by keeping an infested goat in a small stable with a hard floor, which can be searched every morning. The shiny black, smooth puparium is short oval, 2.5 to 3 mm. long, slightly flattened and with a flattened convex spiracular protuberance at the posterior end. Full-grown larvae begin to turn brownish while yet in the uterus. Gravid goat-keds kept away from the host often void small, immature larvae, which blacken and harden as usual, but never hatch. At about 30° C. viable puparia hatch in 30 days on the average, usually during the daytime. In newly hatched flies of both sexes the wings are at first crumpled up; they expand usually within half to three-quarters of an hour (rarely sooner) and can be used after about two hours. The ked flies off suddenly and covers a rather long distance in a jerky, noiseless fashion. Such young flies survive at most two days without feeding. They are positively phototropic, flying toward the light, while the older, deälated specimens are light-shy. After reaching a goat, they discard the wings within 2 or 3 days;

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<sup>39</sup> The unusual abundance of goat-keds in Palestine and Syria may be correlated with the very long hair of the race of goats (*Capra hircus mambrica*) kept by the Arabs.

usually they start feeding at once, often remaining motionless on the spot for half an hour to several hours. The goats apparently feel the bite, as they attempt to dislodge the sucking keds. Mating lasts a long time, the male sitting astride the abdomen of the female and curving the tip of his body under hers. The female is about three weeks old when she deposits her first larva. She no doubt produces several larvae in the course of her lifetime, but how many is not known.

*L. capreoli* as a rule does not appear to do much harm to the goat, unless it is present in unusually large numbers. According to Theodor (1928), the Arab herdsmen, who recognize the damage done to goats by true ticks, discount that caused by keds. In any case, the goat-ked is not known to carry a specific infectious disease to its host, the blood trypanosome which it transmits being harmless.

*Parasites.*—The internal unicellular parasites of *L. capreoli* are almost as varied as those of *Melophagus ovinus* and very similar.

The intracellular bacteroids, usually regarded as symbionts, were studied by Aschner (1931), in Palestine. They occur normally in some of the epithelial cells of the mid-gut and are similar to those occurring in the same type of cells of *L. cervi*. They are also transferred by way of the milk-glands to the larva.

In the hind portion of the mid-gut, the deeply grooved or pitted inner wall is sometimes covered with *Rickettsia*-like unicellular parasites, similar to *Rickettsia melophagi* of the sheep-ked. This organism also is transmitted from the mother to the larva, but by which mechanism has not yet been ascertained (Aschner, 1931).

The digestive tract of *L. capreoli* also harbors commonly, in Palestine, a flagellate, first seen by Adler in 1926. As shown by Theodor (1928), it is the invertebrate stage of a non-pathogenetic trypanosome of the blood of goat, which has been named *Trypanosoma theodori* by Hoare (1931). The life-cycle of this organism is similar to that of *T. melophagium* of sheep and sheep-ked. Newly hatched *L. capreoli* are always free of it and acquire it by feeding upon an infected goat. The trypanosomes are, however, very scarce in the blood of the goat, where they can scarcely be seen by direct microscopic examination, but must be detected by cultivating them on appropriate media. This explains why the rate of infection of the keds is very variable. In a herd of 15 goats studied by Theodor, all keds of 2 animals were negative; on 11 the proportion of infected keds varied between 6% and 70%; while only on 2 were all keds infected. Young adult flies show the lowest rate of infection and older specimens the highest. As there is no hereditary trans-

mission in the keds, infection must occur by feeding and the chances of infection of a ked increase with the number of times it bites an infected goat. Theodor succeeded in infecting newly hatched flies by keeping them from 5 to 22 days on a goat known to be infected. Infection is restricted to the mid- and hind-gut of the ked, as flagellates were never found in the fore-gut, the proboscis, the salivary glands or other organs. At first they multiply in the hind portion of the ventriculus, producing so-called crithidia-like forms; but, as their number increases, they move forward, eventually reaching the cardiac valve; later they also invade the hind-gut and they may even be found in freshly voided faeces. Reinfection of the goat from the ked is not by active inoculation through the bite nor by means of the faeces, but by the so-called contaminative method, as in the case of *Trypanosoma melophagium* of sheep. Infected keds must be eaten by the goat. Even attempts to infect goats by subcutaneous injections of emulsions of infected flies, were unsuccessful.

*Original Descriptions.*—Original description of *Lipoptena capreoli* Rondani: “♀ Long. 3–3½ mm. *Faem.* distinctissima est a *L. cervi* L. non solum statura fere duplo minore, sed praecipue oculorum forma, et abdominis pictura: nam oculi in nostra manifeste magis angustati praesertim postice, non ut in sp. Linneana ovato-subrotundati. Abdomen fere totum sordide flavum, vel pallide testaceum, vix basi sub-ferrugineum, non obscure brunneum, vittis tribus sordide albidis, transversis in dorso signatum. Difert etiam a faemina sequenti *L. mazamae*, cui partim similis, prae caeteris proboscide crassiuscula, modice elongata, et testaceo-rufa; et etiam pedibus longe, abdomineque breviter nigro setulosus. *Mas* ignotus sed probabiliter ut in congeneri *cervi* alatus.” I have not seen the type, which was described from Bellardi’s collection and may be either at the Zoölogical University Museum in Turin, or, if Rondani retained it for his own collection, at the Zoölogical University Museum of Bologna or of Parma. The specific name *capreoli* is here adopted for Austen’s *L. caprina*, on the strength of specimens which I have received from Cyprus and which agree with Rondani’s description. Falcoz (1931) also used it for the same parasite.

Original description of *Lipoptena caprina* Austen: “♀♂.—Length, ♂ (7 specimens), 3.2 to 3.8 mm. (from anterior margin of clypeus to posterior margin of scutellum, 2 to 2.2 mm.), ♀ (3 specimens), 3.8 to 5 mm. (from anterior margin of clypeus to posterior margin of scutellum, 2.4 mm.); width of head, ♂, 1 to just over 1 mm., ♀, 1.25 mm. Dorsum of thorax (in dried specimens) shining

mummy-brown; chitin plates on dorsum of abdomen small (first three plates in ♀ minute); entire dorsum of abdomen of ♂ from posterior margin of basal segment backwards inclusive, except greater part of the four plates of chitin and area immediately in front of last plate, thickly clothed with relatively long, recumbent, cinnamon-rufous hair; corresponding area of dorsum of abdomen of ♀ clothed for most part with very short hair. Head: dorsal surface, including antennae, ochraceous-tawny, vertical triangle (oceligerous plate) dark brown or dark mummy-brown, nearly semi-circular and extending much further forward than in *L. cervi* L., frontal stripe cinnamon-brown, sepia-coloured or light mummy-brown, about half as broad again as long; each inner orbit at its widest equal to or slightly exceeding extreme breadth of corresponding eye; clypeus generally with a more or less distinct, isolated, pit-like depression in middle line, midway between pit at posterior end of median longitudinal groove and its hind margin, a dark brown horseshoe-shaped mark (more or less complete or widely interrupted in middle line), usually fairly well defined, and with forwardly directed concavity, encircling pit at end of median longitudinal groove, each arm of the horseshoe running along inner edge of corresponding antennary pit, but not reaching front margin of clypeus, a second, narrower, dark brown, curved mark, interrupted in middle line by posterior pit-like depression, behind horseshoe and midway between it and posterior margin of clypeus, arms of posterior curved mark not extending so far forward as those of horseshoe, area adjacent to pit at posterior end of median longitudinal groove brownish; palpi dark brown, short; hair on ventral surface of anterior border of head brownish at base, glistening ochraceous-tawny toward distal extremity. Cephalic chaetotaxy: one bristle close to inner upper angle of each orbit, on a level with posterior ocelli; two bristles side by side on each inner orbit, in a row extending obliquely forwards and inwards on a level with upper margin of eye; one bristle (occasionally two bristles) on inner margin of each orbit close to upper boundary of clypeus. Thorax: dorsum clothed with hair and bristles of moderate length, dark brown at base, glistening cinnamon-rufous towards their distal extremities; middle line of mesonotum bordered on each side with a curved row of bristles, commencing anteriorly a little in advance of hind margin of humeral callus; humeral calli each with six or seven bristles, postalar calli each with three bristles; lateral area of mesonotum on each side clothed fairly thickly with bristles, of which those forming a transverse row on upper surface of protuberance in front of base of each

wing-stump are stouter and recurved; scutellum sometimes showing a pit-like depression (perhaps due to *post-mortem* shrinkage) near each lateral angle, sometimes also with a similar depression in middle line; hind margin of scutellum with six bristles. Each half of mesosternum roughly quadrate in outline when seen from below, considerably larger than corresponding half of metasternum, and closely beset with very short dark brown bristles, those on hind margin, apart from usual long, hair-like bristle in front of socket of middle leg, larger and stouter than elsewhere; short bristles on metasternum smaller and fewer than those on mesosternum, though in this case also bristles on hind margin are stouter than remainder. Abdomen: dorsum of ♂ with basal segment of usual type, followed in middle line by four small, transversely elongate plates of shining dark brown chitin, widely separated by pinkish buff or cinnamon-buff integument; transverse diameter of last two plates about the same (0.6 mm.), but last plate considerably deeper (*i.e.*, longer when measured from front to rear) than penultimate, the two anterior plates very small, one-third or considerably less than half the size of the penultimate, basal segment, except hind margin, clothed with short, appressed, dark brown hair; venter cinnamon-buff, with a large horseshoe-shaped, dark neutral grey mark not extending to distal extremity, and entire surface thickly clothed with short hair, similar in colour and character to that on dorsum; dorsum of abdomen of ♀ with basal segment similar to that of ♂, followed in middle line by four plates of chitin widely separated by light ochraceous-buff integument, the terminal plate, consisting of dark brown chitin, situate at bottom of notch or depression in hind margin of abdomen, and about equal in size to corresponding plate in ♂, remaining plates very small, light mummy-brown in colour and transversely elliptical or elliptical oval in shape, the penultimate plate and the plate immediately following the basal segment between one-third and one-fourth of the terminal plate in size, the antepenultimate plate considerably smaller than either of the two plates between which it is situate; dorsum in ♀ sparsely clothed with appressed, dark brown, chestnut-brown or cinnamon-rufous hair, very short except on hind margin of basal segment and on lateral margins of posterior half of abdomen, and, with exceptions stated, much shorter than corresponding hair in ♂, each of the four median chitinous plates with a more or less complete row of short hairs, varying in number, on or close to its hind margin; venter cinnamon-buff, fairly densely clothed with minute, appressed, dark brown, chestnut-brown, or cinnamon-rufous hair. Legs, except tarsi, buff-yellow or

orchraceous-buff, front and middle femora brownish above towards distal extremities, anterior surfaces of front and middle tibiae also more or less brownish; tarsi cinnamon-brown or chestnut-brown; bristles and hairs on legs dark brown to cinnamon-rufous, stouter bristles dark brown at base, then paler." Types at the British Museum, where I have seen them.

6. *Lipoptena chalcomelaena* Speiser. Figs. 9A-C.

*Lipoptena chalcomelaena* Speiser, 1904, Zeitschr. Syst. Hym. Dipt., IV, p. 178 (♀ ♂; Sinai Peninsula, off "*Capra caucasica*" = *Capra nubiana sinaitica*); 1905, *op. cit.*, V, p. 354 (shores of Red Sea, Egypt, off "*Capra beden*" = *Capra nubiana*; Cilician Taurus, Asia Minor, off "*Aegoceros aegragus*" = *Capra hircus aegragus*). Bezzi, 1905, Kat. Paläarkt. Dipt., IV, p. 283; 1908, Bull. Soc. Ent. Italiana, XXXIX, (1907), p. 198; 1916, Natura, Riv. Sc. Nat., VII, p. 178. Bodenheimer, 1937, Mém. Inst. Egypte, XXXIII, p. 193.

*Lipoptera chalcomelaena* H. H. King, 1911, 4th Rept. Wellcome Res. Lab. Khartoum, vol. B, p. 126 (Port Sudan, Anglo-Egyptian Sudan).

*Lipoptena chalcomelena* Falcoz, 1930, Encycl. Entom., B, Diptera, V, (1929), p. 51 (♀ ♂; Gebel Eich, Egypt, off *Capra nubiana*).

*Lipoptena hirta* "Loew" Speiser, 1905, Zeitschr. Syst. Hym. Dipt., V, p. 354 (as a synonym of *L. chalcomelaena* Speiser; label on specimen from shores of the Red Sea).

*Lipoptera ibicis* Theobald, 1906, 2d Rept. Wellcome Res. Lab. Khartoum, p. 88, figs. 45-47 (♀ ♂; Red Sea Province, Anglo-Egyptian Sudan, off "*Ibex sp.*" = *Capra nubiana*).

*Lipoptena ibicis* Austen, 1921, Bull. Ent. Res., XII, p. 124. Bodenheimer, 1937, Mém. Inst. Egypte, XXXIII, p. 193. Goeldi, 1913, Sanitarisch-Pathologische Bedeutung Insekten, p. 83, fig. 71.

*Female*.—Head moderately lengthened behind the eyes, which are relatively narrow; mediovertex short, wider than long, much shorter than fronto-clypeus or postvertex; fronto-clypeus with scarcely a trace of the suture originally dividing frons and clypeus, with a fine anterior median furrow ending in a pit behind; pretilinal area distinct, without fovea; inner orbit about as wide as the eye, with 4 to 8 (usually 5 or 6) longer frontal bristles and a few minute setae, 3 of the bristles gen-

erally in a transverse row in the upper half of the orbit; one or very rarely 2 long vertical bristles; postvertex slightly shorter than in *L. capreoli*, more semi-elliptical; ocelli small but distinct, in a slightly flattened triangle. Palpi much shorter than fronto-clypeus. Pro-mesonotal suture deep; suture between pronotum and propleuron weak. Mesothorax: median notal suture weak over nearly entire length; no transverse prescutal suture; no distinct intrascutal grooves; mesonotal suture extending to near the scutellum; posthumeral suture weak; mesothoracic spiracle large, at latero-posterior edge of humeral callosity; 8 to 11 acrostichals, in a curved admedian row; laterad of them from 15 to 25 (usually 20 to 22) latero-centrals, none of them behind the mesonotal suture, covering the disk fairly uniformly and separated from the acrostichals only by a narrow longitudinal bare strip; 7 or 8 humerals; 3 to 5 postalars and 1 prescutellar, the two groups far apart; two rows each of 3 or 4 long notopleurals; usually 6 (rarely 5 or 7) scutellars, in 3 pairs, the median pair the longest; ventrally, lobes of prosternum with 5 to 7 heavy setae; mesosternum and basisternum mostly covered with short, thick, loosely scattered setae and a few longer bristles. Abdomen: basal dorsal pleurites (I) larger, more transverse (shorter and wider) than in *L. capreoli*, rather well defined from pleurites II, with an apical row of long bristles and many smaller setae over the disk; pleurites II to V superficially set off and usually not sclerotized, all with many scattered setae; five median tergal plates: first to third very small, with very few setae (3 to 6 on each plate); first and second subequal, much smaller than third; fourth large, reniform, with a deep posterior inward curve and a slight median longitudinal depression, each half with 3 or 4 long setae; fifth consisting of a pair of widely separated sclerites, each with 2 or 3 bristles; remainder of dorsum membranous and extensible, partly covered with loosely scattered setae. Crescent-shaped basal ventral sclerite shallowly emarginate, with fairly numerous heavy setae all over, those at the hind margin in a regular row and one very long at each hind corner; ventral portion of pleurites not sclerotized and indistinctly separated, uniformly setulose; remainder of venter membranous (except for the small anal and genital plates), uniformly setulose. Abdominal spiracles small but distinct; spiracles VI and VII not enclosed in the fourth and fifth median tergal plates. Legs heavy and strongly setose; apical spur of fore tibia thick; mid tibia with

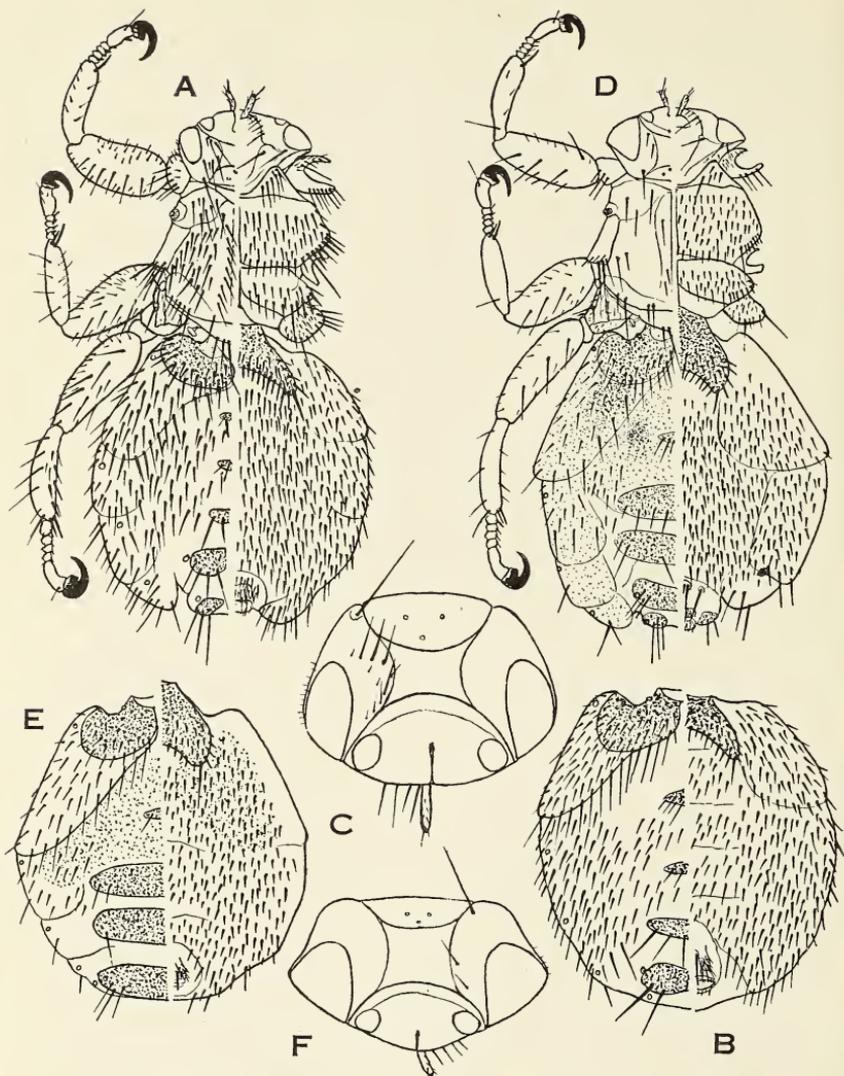


FIG. 9. A-C, *Lipoptena chalcomelaena* Speiser: A, female, Sinai Peninsula, from above (left) and below (right); B, abdomen of male, same locality, from above (left) and below (right); C, head of male.—D-F, *Lipoptena paucisetata* Edwards: D, female, Phong Saly, Indo-China, from above (left) and below (right); E, abdomen of male, same locality, from above (left) and below (right); F, head of male.

two apical spurs, one of them much stronger; claws slender, slightly asymmetrical in each pair. Wing unknown.

*Male*.—Similar to the female in structure and chaetotaxy, but the setae all longer. Dorsum of abdomen with only four median plates, corresponding to the first to fourth of the female and relatively larger and more transverse. Male terminalia of the usual type; parameres long and slender, straight.

Length (h. + th.): ♀, 1.8 to 2.0 mm.; ♂, 1.6 to 1.8 mm.

*SPECIMENS EXAMINED*.—SINAI PENINSULA: Wady Ferran, off *Capra nubiana sinaitica* (G. A. Allen and W. M. Mann); Selah, off *Capra nubiana sinaitica* (Merrill).

*Distribution*.—*L. chalcomelaena* is at present known with certainty only from the Sinai Peninsula and the Nubian mountains of Egypt and the Anglo-Egyptian Sudan (near the shores of the Red Sea). Speiser (1905) referred also to this species specimens taken by Kotschy (1854, Verh. Zool. Bot. Ver. Wien, IV, p. 207) in the Cilician Taurus of Asia Minor, off *Capra hircus aegagrus*, one of the wild ancestors of domestic goat. He may, however, have confused it, in this case, with the very closely allied *L. capreoli*, which apparently he had not yet recognized at that time.

*Host Relations*.—*L. chalcomelaena* appears to be a specific parasite of the ibex or Nubian wild goat, *Capra nubiana* F. Cuvier. It has been found on the typical form of Nubia, as well as on the race *sinaitica* Hemprich and Ehrenberg of the Sinai Peninsula. As mentioned before, the occurrence on the wild goat, *Capra hircus aegagrus*, is open to question.

*Affinities*.—*L. chalcomelaena* is exceedingly close to *L. capreoli*, the most striking difference being in the chaetotaxy of the inner orbits and mesoseutum, as given in the key to the species. There are also some minor, though possibly reliable characters in the shape or relative size of the median tergal plates and basal ventral sclerite.

*Original Descriptions*.—Original description of *Lipoptena chalcomelaena* Speiser (translated): "Length 3.5 to 4.5 mm., from anterior margin of head to hind margin of scutellum, 1.75 mm. Hard sclerotized parts (head, thorax and basal segment of abdomen) of ♀ dark blackish-brown with bronze sheen; legs umber-brown with dark brown dorsal margins on tibiae; abdomen gray, the ♂ generally brownish-yellow, only the vertical triangle [postvertex] darker. Head: four-cornered, somewhat depressed, dull median area, corresponding to the frontal vitta of the Muscidae [mediovertex], surrounded by four smooth and shiny parts, the vertical triangle [postvertex], the two very broad inner orbits and the clypeus

[fronto-clypeus]. Vertical triangle broad and short, with a pair of symmetrical depressions on the disk, blackish-brown with yellowish-brown anterior margin and middle line. Inner orbits wide, wider than the eyes, pointed anteriorly and narrow between eyes and antennae, their yellowish-brown inner margin curved in a hyperbole toward the middle of the frons. Chaetotaxy: 2 bristles on each side close to the sides of the vertical triangle; a row of 4 at the level of the upper eye margin, running obliquely forward and inward; close before these a single bristle; and 1 or 2 on each side anteriorly near the ptilinal suture. Clypeus of the usual shape, divided into two halves by a deep longitudinal furrow which widens into a small pit a little before the ptilinal suture, yellowish-brown at posterior and anterior margins. Under side of head gray. Antennae small, button-shaped, yellowish-brown. Palpi shorter than the clypeus, narrow and short, blackish-brown. Thorax blackish-brown with a bronze, slightly violaceous sheen; before the scutellum on the hind margin of the mesonotum two small yellowish-brown spots; sides of scutellum similarly colored. Longitudinal suture distinct; no transverse suture. Longitudinal suture accompanied by a pair of bristle rows, which, starting from the humeral angles, curve some distance from the middle line and diverge only slightly behind. Lateral areas of mesonotum covered with many, rather strong, not peculiar bristles, of which only 3 or 4 are prominent on each side at the hind corner before the scutellum. Hind margin of scutellum with 3 pairs of bristles; 6 or 7 on each side on the pleura before the wing-stumps. Prosternum as usual represented only by two triangular, blunt lobes, separated by a deep curve; suture between meso- and metasternum perpendicular on the longitudinal suture; meso- and metasternum of about the same length. Pilosity of sternum abundant, but without peculiarities. Legs short; all femora, but especially those of the fore legs, somewhat thickened, as always in this genus, brownish-yellow, without peculiarities. Abdomen of ♂; dorsally a basal segment deeply divided into two broad plates to the very base; behind these 3 distinct plates, which are setose at the margin as well as on the disk, and then the apical segments, without peculiarities. Ventrally a tough basal segment, with an almost straight hind margin, which is only very slightly curved inward in the middle. Abdomen of ♀: dorsally a basal segment of two plates, separated by a deep median notch; behind this a segment covering the sides like a mantle, but separated from the next segment by a less hairy strip. In the soft integument of the next segment lie three very small dark-brown sclerites, traces of fused segments.

The anterior sclerite is the smallest, about the size of the knob of the halter; the second, placed exactly in the middle of the abdomen, is about twice as large, but also rounded; the third, placed rather close before the inward bow of the hind margin of the abdomen, is a transverse plate, about 4 times as wide as long. The small segments of the hind margin of the abdomen have moved in a deep inward bow (much as in *Melophagus rupicaprinus* Rond.), beyond which the sides project posteriorly like long, pointed lobes. Ventrally nothing is to be noted beyond a broad basal segment ending in a flattened but deep inward curve." The types are at the Berlin Zoölogical Museum. I have not seen them.

Original description of *Lipoptera ibicis* Theobald: "*Female*. Deep brown, with testaceous brown legs. Head wider than the anterior, narrower than the posterior part of the thorax, deeply sunk into the thorax. Antennae completely imbedded in the sockets, with three terminal bristles, the median slightly the longest. The two plates forming the sheath of the proboscis short and blunt, terminating in several short and two lateral long bristles; eyes narrowly oval, between them on each side are two groups of three equidistant thick spines, two ocelli on the basal region of the head. The thorax is narrowed in front, widening out posteriorly; the prothorax is a small plate extending across the thorax, openly wedge-shaped posteriorly. The mesothorax is the major area, and has numerous long thick needle-like spines; it has a distinct humeral swelling over the mesothoracic legs. In front, just behind the prothoracic legs, are two swellings, somewhat ragged or irregular apically, the remnants of the wings. The scutellum is uni-lobed with apparently six large black bristles on the posterior border. The whole of the thorax is fused into one piece. There is a distinct median and transverse suture. The abdomen is oval, deeply indented apically, the apical segments being enclosed in a pit formed by the prolongation of the anterior segments as two blunt processes on each side. The whole abdomen is covered with thick, black thorn-like spines, which are particularly long on the apices of the lateral lobes; the small imbedded apical segments have fine hair-like chaetae. Anterior legs with the short thick femora spinose; the tibiae with a few fine hairs and a strong internal apical spine; basal tarsal segment spinose, the rest hirsute; ungues much curved, thick, the inner edge finely serrated with a large blunt basal process; the median process short and thick, with hairs on each side, terminating bluntly; mid legs very similar but shorter and thicker than the fore and the ungues thicker; in the hind legs the tibiae are also spinose and the ventral tarsal

spines are more pronounced than in the anterior legs, and the ungues are less curved, and the median plumose spine is acute. Length, 4 to 4.5 mm.—*Male*. Three ocelli present. Thorax narrower and smaller than in the female, the scutellum relatively larger and three-lobed, and the spines on the thorax are fewer. Abdomen more rounded apically than in the female, and the external genitalia are prominent and consist of two chitinous lateral valves with the penis projecting between. The ungues are rather shorter and broader, and the median bristle is thin and acuminate with a few hair-like spines pointing forwards on each side. Length, 4 mm.” I do not know where the types are preserved.

7. *Lipoptena hopkinsi*, new species. Figs. 7F–I.

*Female*.—Head moderately lengthened behind the eyes, which are relatively short and broad; mediovertex nearly square, shorter than fronto-clypeus, but slightly longer than postvertex; clypeus completely fused with frons, its extent only indicated anteriorly by the very fine median longitudinal furrow; inner orbit much narrower than the eye, either without frontal bristles or with 1 or 2 minute setae; one long vertical bristle; postvertex very short and wide, flattened semi-elliptical; ocelli very small, but distinct. Palpi much shorter than fronto-clypeus. Pro-mesonotal suture very deep, except on the sides; suture between pronotum and propleuron weak. Mesothorax: median notal suture distinct over nearly entire length; no transverse prescutal suture; well-marked longitudinal intrascutal grooves; mesonotal suture weak, but extending to near the scutellum; posthumeral suture weak; mesothoracic spiracle large, at the latero-posterior edge of the humeral callosity; usually 2 acrostichals, placed centrally in the intrascutal groove; no latero-centrals; 2 preälars, the outer one very long; 3 humerals; 3 or 4 postalars; 1 prescutellar, far from the postalars; two rows each of 3 heavy notopleurals, the posterior ones much longer; 4 scutellars (in 2 pairs), the median pair the longer; ventrally, lobes of prosternum with 2 or 3 small setae; setae of mesosternum and basisternum mostly short and rather more spaced than usual. Abdomen: basal dorsal pleurites (I) large, but not very sharply divided from pleurites II, with an apical row of very long setae and a few smaller setae over the posterior part of the disk; pleurites II to IV more or less set off and sclerotized according to age, the third and fourth separated; all with few, mostly long setae; five median tergal plates:

first to fourth very large, transversely elliptical or rectangular with rounded edges, each with one or two pairs of long setae; first comprised within a more or less sclerotized triangular area occupying most of central basal half of dorsum; fifth consisting of a pair of sclerites, each with 2 long setae; membranous portion of dorsum with very few setae. Basal ventral sclerite with moderately deep apical inward curve, with relatively few heavy setae, 2 or 3 very long ones at each hind corner; ventral portion of pleurites more or less sclerotized, partly covered with small setae; remainder of venter membranous and uniformly setulose; posteriorly a transverse, curved row of longer setae; anal area mostly bare, medially, before the small and densely hairy anal and genital sclerites, with five small sclerotized areas, one placed medially and apically and bearing 2 setae, the others each with one seta and forming two pairs. Abdominal spiracles small but distinct; spiracles VI and VII not enclosed in the fourth and fifth median tergal plates. Legs heavy, moderately setose; apical spur of fore tibia thick; mid tibia with two apical spurs, one of them much stronger; claws slender, slightly asymmetrical in each pair. Wing unknown.

*Male*.—Similar to the female in structure and chaetotaxy. Only four median tergal plates, corresponding to the first to fourth of the female; all of them much larger and the first more triangular.

Length (h. + th.): ♀, 2 to 2.2 mm.; ♂, 1.6 to 1.8 mm.

*SPECIMENS EXAMINED*.—UGANDA: Nyarusanza, Lower Muhavura, Kigezi District, female holotype and male allotype, off *Cephalophus nigrifrons kivuensis* (G. H. E. Hopkins); Entebbe, 2 female paratypes, off *Cephalophus caerulus aequatorialis*.—KENYA COLONY: N'Gong, one female paratype, off "pigmy antelope," *Nesotragus moschatus* (R. C. van Someren).—BELGIAN CONGO: Kibati, Kivu District, 6 female and 2 male paratypes, off *Tragelaphus scriptus* (H. Schouteden). Holotype, allotype and paratypes at Mus. Comp. Zoöl., Cambridge, Mass.; paratypes at Congo Museum (Tervueren) and British Museum.

*Distribution*.—Known thus far from Kenya, Uganda and the extreme eastern Belgian Congo, all areas within the East African zoögeographical region.

*Host Relations*.—*L. hopkinsi* probably occurs on most small East African antelopes. Four different hosts are known at present, belonging to three genera. The blue duiker, *Cephalophus caerulus* (Ham. Smith), occurs in several races throughout East, Central and

South Africa. The Uganda race is *C. c. aequatorialis* Matschie. The black-fronted duiker, *Cephalophus nigrifrons* Gray, occurs throughout equatorial Africa, from Gaboon to Kenya. The race of the Kivu highlands is *C. n. kivuensis* Lönnberg. The bushbuck, *Tragelaphus scriptus* (Pallas), covers most of Africa, south of the Sahara. The suni or pigmy antelope, *Nesotragus moschatus* von Dueben, is strictly East African (in Kenya and Tanganyika Territory).

*Affinities.*—*L. hopkinsi* is most closely related to some of the Oriental species, such as *L. efovea*, *L. pauciseta* and *L. rusaecola*. The chaetotaxy is even more reduced than in any of these.

8. *Lipoptena pauciseta* Edwards. Figs. 9D–F.

*Lipoptena pauciseta* Edwards, 1919, Jl. Feder. Malay States Mus., VIII, pt. 3, p. 55, Pl. VI, figs. 27 and 28 (♀♂; Sungei Kumbang, 4,500 ft., Sumatra; off *Muntingiacus muntjak montanus*).

*Female.*—Head moderately lengthened behind the eyes, which are relatively wide; mediovertex about as long as wide, as long as fronto-clypeus and about twice as long as postvertex; clypeus completely fused with frons, its extent only indicated by the very fine median longitudinal furrow; pretilinal area distinct, often with a median fovea; inner orbit a little over half as wide as the eye, with very few (usually 2) frontal bristles; one very long vertical bristle; postvertex short and wide, semi-elliptical; ocelli very small, in a slightly flattened triangle. Palpi much shorter than fronto-clypeus. Pro-mesonotal suture deep; suture between pronotum and propleuron weak. Mesothorax: median notal suture distinct over nearly entire length; well-marked longitudinal intrascutal grooves; mesonotal suture weak, narrowly interrupted medially; posthumeral suture weak; mesothoracic spiracle large, at latero-posterior edge of humeral callosity; 3 acrostichals between the median notal suture and the intrascutal groove, the anterior one far from the two posterior ones; 2 or 3 latero-centrals close to the base of the wing; 3 humerals, 2 postalars and 2 prescutellars, the two groups far apart; 2 rows each of 3 or 4 notopleurals, the posterior ones heavier and longer; 4 scutellars (in 2 pairs), the median pair the longer; ventrally, lobes of prosternum with 4 short setae and one long bristle; mesosternum and basisternum mostly covered with many short, thick setae and a few longer bristles. Abdomen: basal dorsal pleurites (I) large, trans-

versely reniform, fairly well set off from pleurites II, with a marginal row of long bristles and a few setae on the disk; pleurites II to V more or less set off and sclerotized, III and IV separate, II large and short triangular; all with a few scattered setae; five median tergal plates: first very small, close to the base, with 5 or 6 setae (sometimes broken up in a series of small sclerites around the individual setae); second and third large, transversely elliptical, with a transverse row of 6 to 8 setae; third three to four times as wide as long; fourth slightly smaller than third, rectangular with rounded corners, with a group of 3 setae on each side; fifth consisting of a pair of sclerites, each with 3 or 4 long setae; remainder of dorsum partly sclerotized anteriorly (in the area between pleurites II), mostly bare; a small patch of setae near sides of second tergal plate. Basal ventral sclerite moderately emarginate, with broad lateral lobes and scattering heavy setae in posterior half and at margin, 1 or 2 longer ones at the tip of each lobe; ventral portion of pleurites more or less set off, scarcely sclerotized, fairly uniformly setulose; pleurites III and IV fused; anal area mostly bare, medially (before the small anal and genital sclerites) with three very small sclerotized plates bearing a few long setae. Abdominal spiracles small, but distinct; spiracles VI and VII enclosed within the fourth and fifth tergal plates. Legs heavy and moderately setose; apical spur of fore tibia thick; mid tibia with two apical spurs, one of them stronger; claws rather heavy, nearly symmetrical in each pair. Wing unknown.

*Male*.—Similar to the female in structure and chaetotaxy. Only four median tergal plates, corresponding to the first to fourth of the female; second to fourth slightly larger and more transverse than in female. Terminalia similar to those of *L. efovea*; parameres long and slender, straight.

Length (h. + th.): ♀, 1.4 to 1.6 mm.; ♂, 1.5 mm.

**SPECIMENS EXAMINED.**—INDO-CHINA: Phong Saly, off *Muntiacus muntjak vaginalis* (Ralph Wheeler).—SIAM: Doi Angka, off *Muntiacus muntjak curvostylis* (H. Coolidge, Jr.).—CHINA: Suifu, Szechuan Province, without host (D. C. Graham).

*Distribution.*—*L. pauciseta* is known at present from Sumatra, Siam, Indo-China, and southwestern China.

*Host Relations.*—*L. pauciseta* has been taken on three races of the Indo-Malayan muntjac: *Muntiacus muntjak montanus* Robinson and Kloss, *M. m. vaginalis* (Boddaert), and *M. m. curvostylis* (Gray). It may be expected to occur on some of the other races and species of the Indo-Malayan genus *Muntiacus*.

*Affinities.*—*L. pauciseta* is related to *L. efovea*, which is known thus far only from Ceylon. The two species differ mainly in the chaetotaxy of the thorax, which is decidedly less developed in *L. pauciseta*. Speiser attached great importance to the supposed absence in *L. efovea* of the fovea of the preptilinal area (lunula) of the head, but this is of little value as a specific character. *L. pauciseta* is even closer to *L. rusaecola*, off the Philippine sambar, as shown in the discussion of that species.

*Original description of Lipoptena pauciseta* Edwards: "Colour brownish, membranous parts lighter, bristles all black or blackish; thorax with three darker stripes, of which the middle one is longer and narrower than the others; clypeus with two blackish spots. Head: Eyes large, but not quite reaching the side margins of the head. Lunula considerably longer than broad. Oral margin with the usual six downwardly-projecting bristles. Only two pairs of rather small fronto-orbital bristles, the anterior pair more widely separated than the posterior. One pair of vertical bristles which are more than twice as long as the fronto-orbital. Vibrissae and small bristles on the under and posterior surface of the head as in *L. cervi*. Thorax: Mesonotum with four pairs of bristles on the anterior half, all approximately equal in size, of which one might be described as humeral, one presutural, and two dorso-central, of the two last the anterior pair is more widely separated than the posterior. On the posterior half of the mesonotum are two pairs of supra-alar bristles, two pairs of small dorso-central, closer together than those on the anterior half, and eight pre-scutellar; the last are arranged in four groups of two, one very long (internal) and one very short (external). Scutellum with four bristles on its median lobe, the outer pair not much shorter than the inner; lateral lobes with three short bristles. Mesopleurae with two rows of bristles at the upper posterior corner, the anterior row consisting of four short bristles, the posterior row of three long ones which are nearly but not quite in a line with the two supra-alar bristles of the mesonotum. Prosternal lobes each with one long pointed and four short blunt bristles. Mesosternum as in *L. cervi* with five irregular rows of about 20 short bristles and one posterior more regular row with about 30 short and 2 long ones. Metasternum with about 12 pairs of bristles in the posterior row, of which the inner 5 pairs are much longer and more pointed than the others and are more widely separated than in *L. cervi*. Abdomen: Tergite I deeply emarginate but not quite completely divided into two; each lobe with about 12 small bristles on the surface and a row of 6 or 7 longer and stronger ones along the

posterior margin. Tergite 2 less strongly chitinized than tergite 1, large, completely divided into two rather widely separated portions, which are bluntly rounded apically and extend as far as the middle of the abdomen; each lobe bears about 20-25 small bristles, and about 6 longer ones towards its posterior margin; these six do not however form one definite line with the 6 or 7 on tergite I, as is the case with the corresponding bristles in *L. cervi* and *L. gracilis*. Tergite 3 situated close to tergite 1, broadly oval in the male, rounded in the female; in both sexes with a row of 6 evenly spaced and rather slender bristles along its posterior margin. Tergite 4 broadly oval in both sexes, with 8 marginal bristles arranged in groups of two. Tergite 5 of the same shape as tergite 4, with 4 marginal bristles; in the male two of these bristles are situated at each posterior corner of the tergite, the inner one being long, the outer very short; in the female the four bristles are all equidistant, the two outer ones being rather longer than the inner ones. Tergite 6 in both sexes with a group of 3 long slender bristles at each posterior corner. Tergite 7 absent in the male; in the female it has similar bristles to those of tergite 6. First sternite as deeply but less widely emarginate than in *L. cervi*, the bristles similar; remainder of ventral surface of abdomen membranous and covered with small bristles. Two pairs of rather longer and slender bristles immediately before the genitalia in the female, the inner pair close together and divergent. The paramere of the male genitalia is relatively much smaller than in *L. cervi*, and of rather a different shape. Legs formed much as in *L. cervi*, but the front and middle femora are a little stouter and more convex dorsally, and the hind femora are a little more slender, while the chaetotaxy differs greatly. Front legs: Anterior surface of femora with four long bristles, one subventral near the base, three subdorsal, equidistant; otherwise there are only a few minute hairs; posterior surface with two moderate bristles near the base, one nearly ventral, the other median; ventral surface with two rows of short bristles. Tibiae with a moderately long hair near the base on the anterior surface, and with some scattered minute hairs; one apical spur which is rather slender and pointed. Middle legs like the front except that on the femora the anterior subventral and posterior median basal bristles are absent; the small hairs are a little stronger and more numerous; there are two tibial spurs, one much shorter than the other. Hind legs: Anterior surface of femora with one strong subapical bristle and numerous short ones; posterior surface with three moderate equidistant subdorsal bristles and very few short ones; dorsal surface

with a few small bristles, one subapical and rather longer than the rest. Tibiae with three strong anterior subventral bristles, nearly equidistant on the middle half; two long subdorsal hairs; one long posterior apical bristle; spurs as in the middle legs; some small hairs on the ventral surface. Length of body, ♂, 2 mm.; ♀, 4 mm." The types are partly at the Federated Malay States Museum (Kuala Lumpur) and at the British Museum. I have seen those at the British Museum.

9. *Lipoptena rusaecola*, new species. Figs. 1A-D and 10A-E.

*Female*.—Head moderately lengthened behind the eyes, which are relatively long and moderately wide; mediovertex slightly longer than wide, as long as fronto-clypeus and about twice as long as postvertex; clypeus completely fused with frons, its extent only indicated by the very fine median longitudinal furrow; pretilinal area distinct, with a weak median fovea; inner orbit over half as wide as the eye, with very few (usually 2) medium-sized frontal bristles; one very long vertical bristle; postvertex short and wide, semi-elliptical; ocelli very small, in a slightly flattened triangle. Palpi nearly as long as fronto-clypeus. Pro-mesonotal suture deep; suture between pronotum and propleuron weak. Mesothorax: median notal suture distinct over nearly entire length; well-marked longitudinal intrascutal grooves; mesonotal suture weak, narrowly interrupted medially; posthumeral suture weak; mesothoracic spiracle large, at latero-posterior edge of humeral callosity; 3 acrostichals between the median notal suture and the intrascutal groove, the anterior one far from the two posterior ones; usually 2 latero-centrals close to the base of the wing; 3 humerals; 2 postalars and prescutellars, the two groups far apart; 2 rows each of 3 or 4 notopleurals, the hind ones heavier and longer; 4 scutellars (in 2 pairs), the median pair the longer; ventrally, lobes of prosternum with 4 or 5 short setae and one long bristle; mesosternum and basisternum mostly covered with many short, thick setae and a few longer bristles. Abdomen: basal dorsal pleurite (I) large, transversely reniform, fairly well set off from pleurite II, with a marginal row of long bristles and a few shorter setae on the disk; pleurites II to V fairly well set off and sclerotized in older specimens, III and IV separate, II large and elongate triangular; all with a few scattered setae; only four median tergal plates differentiated, the second to fifth of other species of *Lipoptena*; first only

indicated by a median transverse row of 2 to 4 bristles, which row is, however, continued on the sides by several bristles connecting it with the patch of setae of the postero-lateral areas of the dorsum; sometimes the integument is sclerotized in patches around the bases of the median bristles; second to fourth plates much smaller than in *L. pauciseta*, being relatively longer and narrower; third the largest, about two and one-half times as wide as long; second with a transverse row of 5 or 6 setae; third with 1 or 2 setae and fourth with 2 or 3 setae, on each side; fifth consisting of a pair of sclerites, each with 3 or 4 long bristles; remainder of dorsum in older specimens very extensively sclerotized as far as the apical margin of the third tergal plate and setulose as described above. Basal ventral sclerite deeply emarginate, with narrow lateral lobes and scattering heavy setae in posterior half and at margin, 1 or 2 longer bristles at the tip of each lobe; ventral portion of pleurites more or less set off and somewhat sclerotized, fairly uniformly setulose; anal area mostly bare, medially with three minute sclerotized plates each with 2 or 3 bristles and preceded by a curved transverse row of 5 or 6 setae. Abdominal spiracles small, but distinct; spiracles VI and VII enclosed in the fourth and fifth tergal plates. Legs heavy and moderately setose; apical spur of fore tibia thick; mid tibia with two apical spurs, one of them stronger; claws rather heavy, slightly asymmetrical in each pair. Wing similar to that of *L. cervi*: costa and third longitudinal vein ending together a rather short distance from the tip of the wing, without any knob-like swelling.

*Male*.—Similar to the female in structure and chaetotaxy. Abdomen with only three median tergal plates, the second, third and fourth of other species of *Lipoptena*; pair of sclerites corresponding to the fifth of the female, lacking; spiracles VII placed in the soft integument; ventrally, inner portions of pleurites II strongly sclerotized, forming a distinct and extensive elongate-elliptical area on each side; ventral portions of pleurites IV and V also partly sclerotized. Male terminalia of the usual type; parameres very long and slender.

Length (h. + th.): ♀, 1.5 to 1.7 mm.; ♂, 1.3 to 1.5 mm.

**SPECIMENS EXAMINED.**—PHILIPPINES: Galog River, Mt. Apo, 6,000 ft., Davao Province, Mindanao, female holotype, male allotype, 2 female paratypes and 3 male paratypes (all deälated), off *Cervus (Rusa) unicolor philippinus*; Bakrayon, Mt. Apo, 7,000 ft., Davao Province, Mindanao, 29 female paratypes and 23 male paratypes

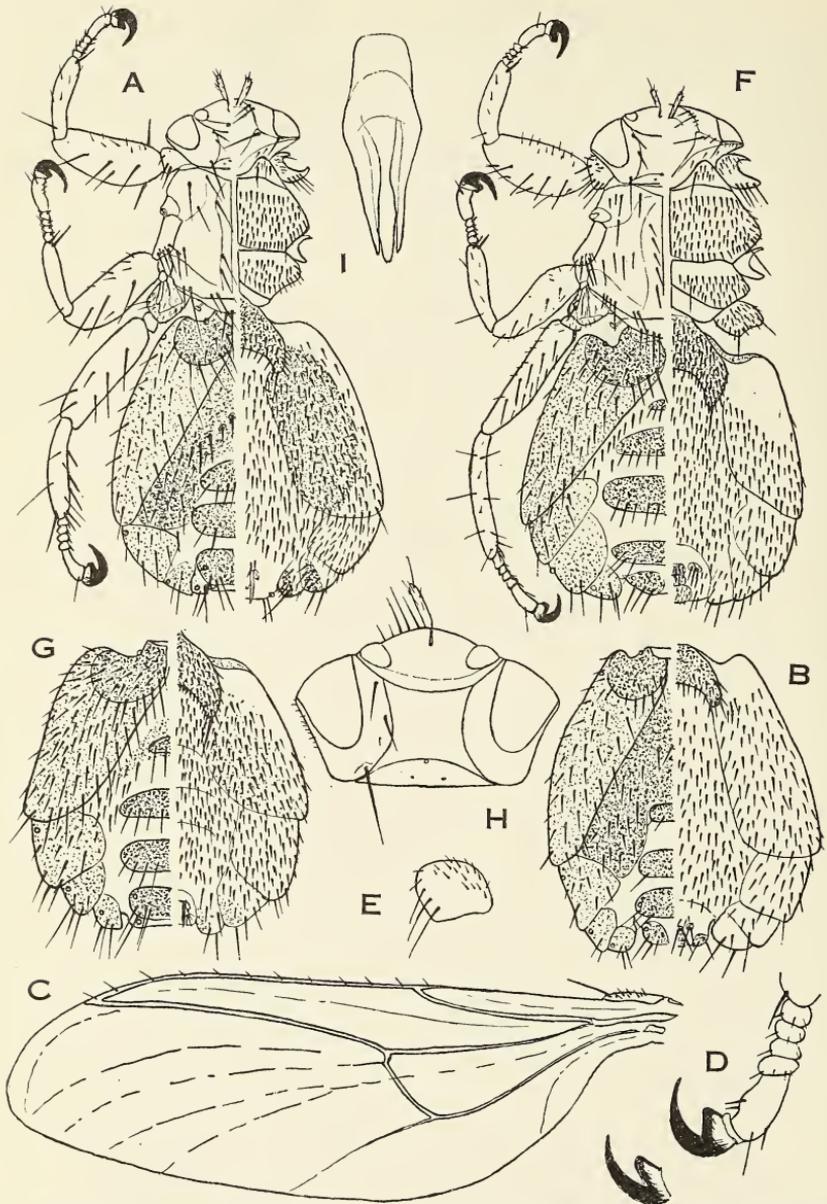


FIG. 10. A-E, *Lipoptena rusaecola* J. Bequaert: A, male allotype, Galog River, Philippines, from above (left) and below (right); B, abdomen of female holotype, same locality, from above (left) and below (right); C, wing of male paratype, Mainit River, Philippines; D, tarsus and claws of fore leg; E, fore coxa from above.—F-I, *Lipoptena efovea* Speiser: F, female, Nikkawewa, Ceylon, from above (left) and below (right); G, abdomen of male, same locality, from above (left) and below (right); H, head of male; I, male terminalia.

(deälated), off *Cervus (Rusa) unicolor philippinus*, and one winged female paratype; Mainit River, Mt. Apo, 6,000 ft., 2 winged male paratypes, September 9 (all specimens collected by C. F. Clagg); Mt. Maquiling, Luzon, one winged female paratype (C. F. Baker). Holotype, allotype and paratypes at Mus. of Comp. Zoöl., Cambridge, Mass.; paratype in Stanford University Museum.

*Distribution.*—*L. rusaecola* is known thus far from the Philippines only. It should, however, be looked for wherever *Cervus unicolor* occurs.

*Host Relations.*—The only host known is the Philippine race of sambar deer, *Cervus (Rusa) unicolor philippinus* H. Smith. Possibly it occurs also on some of the other races of *Cervus unicolor* Bechstein.

*Affinities.*—*L. rusaecola* is extremely close to *L. pauciseta*, the chaetotaxy being identical in both species. In *L. rusaecola*, the inner orbits are relatively wider and the palps longer; pleurites II are more elongate; the first median tergal plate is not differentiated and the second to fourth plates are longer and narrower; while the ventral portion of pleurites II, IV and V of the male bear strongly sclerotized areas which I have not observed in *L. pauciseta*. Other differences are mentioned in the key.

10. *Lipoptena efovea* Speiser. Figs. 10F–I.

*Lipoptena efovea* Speiser, 1905, Zeitschr. Syst. Hym. Dipt., V, p. 352 (♂; Ceylon; no host). Bezzi, 1916, Natura, Riv. Sci. Nat., VII, p. 178. G. B. Thompson, 1938, Ann. Mag. Nat. Hist., (11) I, p. 317, fig.; Pl. XI, figs. 1–2 (♀♂; Nikkawewa near Kantalai, E. P., Ceylon, off *Cervus axis ceylonensis*; and Anuradhapura, Ceylon, off *Panthera pardus fusca*).

*Female.*—Head moderately lengthened behind the eyes, which are relatively long and moderately wide; mediovertex about as long as wide, longer than fronto-clypeus and about three times as long as postvertex; clypeus completely fused with frons, its extent indicated only by the very fine median longitudinal furrow; pretilinal area distinct; inner orbit less than half as wide as the eye, with very few (usually 2) medium-sized frontal bristles and sometimes 1 or 2 minute setae; one very long vertical bristle; postvertex very short and wide, flattened semi-elliptical; ocelli very small, in a slightly flattened triangle. Palpi slightly shorter than fronto-clypeus. Promesonotal suture deep; suture between pronotum and propleuron weak. Mesothorax: median notal suture distinct over

nearly entire length; no transverse prescutal suture; well-marked longitudinal intrascutal grooves; mesonotal suture weak, broadly interrupted medially; posthumeral suture weak; mesothoracic spiracle large, at latero-posterior edge of humeral callosity; 5 or 6 acrostichals, in a curved row between the median notal suture and the intrascutal groove; 4 or 5 laterocentrals in a wavy, transverse row; 5 or 6 humerals; 4 postalars and 2 or 3 prescutellars, the two groups far apart; 2 rows each of 3 or 4 notopleurals, the posterior ones heavier and longer; 6 to 8 scutellars (in 3 or 4 pairs), the median pairs the longest; ventrally, lobes of prosternum with 6 or 7 short setae and one long bristle; mesosternum and basisternum mostly covered with many short, thick setae and a few longer bristles. Abdomen: basal dorsal pleurite (I) large, transversely reniform, fairly well set off from pleurite II, with a marginal row of long setae and a few shorter bristles on the disk; pleurites II to V more or less set off and sclerotized, III and IV separate; II large and elongate triangular; all with a few scattered setae; five median tergal plates: first very small, close to the base, with 5 or 6 setae; third very large, rectangular with rounded corners and a transverse row of about 10 setae; second and fourth about equal, but much smaller than third, flattened elliptical; second with a transverse row of about 10 setae; fourth with a group of 3 setae on each side; fifth consisting of a pair of sclerites, each with 3 or 4 long setae; remainder of dorsum mostly membranous and soft, sometimes partly sclerotized anteriorly with a few setae on the sides, elsewhere bare. Basal ventral sclerite deeply emarginate, with fairly numerous heavy setae all over, one or two longer ones at each hind corner; ventral portion of pleurites more or less set off and sometimes partly sclerotized, uniformly setulose except anteriorly; remainder of venter membranous and uniformly setulose; anal area mostly bare, medially (before the small anal and genital, finely hairy sclerites) with three small sclerotized plates bearing a few long setae. Abdominal spiracles small, but distinct; spiracles VI and VII included within the fourth and fifth tergal plates. Legs more slender than usual, particularly the hind legs, which contrast sharply with the fore legs; apical spur of fore tibia thick; mid tibia with two apical spurs, one of them stronger; claws rather heavy, slightly asymmetrical in each pair. Wing unknown.

*Male*.—Similar to the female in structure and chaetotaxy. Pleurites II to V of abdomen usually not or very little sclero-

tized and pleurite II shorter and broader, less triangular; fifth (paired) tergal plate of female lacking, and first to fourth plates much smaller, more transverse. Male terminalia with long slender, bluntly pointed parameres and a heavy aedeagus gradually narrowed to a broadly rounded tip.

Length (h.+ th.): ♀, 2.4 to 2.5 mm.; ♂, 2.2 to 2.3 mm.

**SPECIMENS EXAMINED.**—CEYLON: Nikkawewa, near Kantalai, off *Cervus axis ceylonensis* (W. W. A. Phillips); Anuradhapura, off *Panthera pardus fusca*; Maha Illupalama, off *Muntiacus muntjak malabaricus* (J. C. F. Fryer).

**Distribution.**—*L. efovea* is known at present from Ceylon only, but I expect it to occur also in Peninsular India, possibly throughout the range of *Cervus axis* and *Muntiacus muntjak*.

**Host Relations.**—*L. efovea* has now been taken on two species of Indian deer, which may be regarded as the normal breeding hosts: the Ceylonese race of the chital or spotted deer, *Cervus (Axis) axis ceylonensis* (Fitzinger), and one of the races of the Indian muntjac, *Muntiacus muntjak malabaricus* Lydekker. It should be looked for on the other races of these two species of deer, which are widely distributed over India. The Indian panther, *Panthera pardus fusca* (Meyer), from which a single specimen was taken, is evidently an accidental host.

**Affinities.**—*L. efovea* is close to *L. cervi*, with which it agrees essentially in structure, differing mainly in the much reduced chaetotaxy of head and thorax. The eyes are also decidedly narrower, and the legs much more slender. The presence or absence of a fovea on or near the preptilinal area is a variable feature, and without specific value in *Lipoptena*.

**Original description** of *Lipoptena efovea* Speiser (translated): "Length, 3.5 mm.; from anterior margin of head to hind margin of scutellum, 2 mm. Color of body midway between umber-brown and russet-brown; legs somewhat pale; dull abdomen somewhat darker. Head and the whole sculpture much as in *L. cervi* L. Frontal vitta ["Stirnstrieme" = mediovertex] very little longer than wide; lunula [preptilinal area] aberrant in being entirely smooth, hence the specific name; in the genus *Lipoptena* the lunula is unusually well developed and in *L. cervi* it bears a fovea, as a rule well marked. Orbits each with three strong bristles, one above close to the vertical triangle [postvertex], one in the middle and one close to the lunula. Clypeus [fronto-clypeus] without peculiarities, of one color; palpi short and narrow, slender. Thorax exactly like that of *L. cervi* in shape and chaetotaxy. Legs also without peculiarities; femora ap-

parently somewhat swollen, particularly those of the fore legs. Basal sternite of abdomen peculiar; whereas in *L. cervi* it is longer than wide and so deeply emarginate behind that the sides of the notch form straight lines directed almost vertically toward the hind margin, in the new species it is much shorter than wide, the posterior emargination is not so deep, more like an even curve, so that the apical lobes are shorter. Dorsally one notices on the dry specimen a tougher first tergite consisting of two rounded plates touching each other medially and a second tergite which covers the sides of the abdomen to the tip like a mantle; behind this 2 or 3 other limits of segments marked by rows of setae and an anal sclerite. Nothing is to be seen of the venter, as the abdomen is curled up. The penis projects between two valves from a genital aperture without peculiar features." The type is at the Berlin Museum. I have not seen it.

Subgenus *Lipoptenella* new subgenus

11. *Lipoptena depressa* (Say). Figs. 1E-F and 11A-F.  
*Melophagus depressus* Say, 1823, Jl. Acad. Nat. Sci. Philadelphia, III, p. 104 (no sex; off "*Cervus virginianus*" = *Odocoileus virginianus*; North America, without more definite locality, but probably from somewhere in Colorado); 1837, Oeuvres Entomologiques (ed. by Gory), p. 104; 1857, Complete Writings (ed. by J. L. Leconte), II, p. 88. Osten Sacken, 1858, Cat. Dipt. North America, p. 86. Brodie and White, 1883, Check List Ins. Dominion Canada, p. 57.  
*Melophaga depressa* Wiedemann, 1830, Aussereurop. Zweifl. Ins., II, p. 614 (new description based on cotype).  
*Lipoptena depressa* Osten Sacken, 1878, Cat. Dipt. North America, 2d Ed., p. 214. Speiser, 1904, Ann. Mus. Civ. Genova, XLI, p. 334. Aldrich, 1905, Cat. North Amer. Dipt., p. 653. Coquillett, 1907, Ent. News, XVIII, p. 291 (Humboldt Co., California; off *O. h. columbianus*). Speiser, 1907, *op. cit.*, XVIII, p. 103. F. C. Clarke, 1913, California Fish Game Comm., Game Bull. 1, p. 8 (north of San Francisco Bay, California; off *O. h. columbianus*). Bezzi, 1916, Natura, Riv. Sci. Nat. VII, p. 178. McIndoo, 1918, Jl. Comp. Neurology, XXIX, p. 467 (olfactory pores). Ferris and Cole, 1922, Parasitology, XIV, p. 182, figs. 1, 2B, 2D and 2F (♀♂; California: Humboldt Co., off *O. h. columbianus*; Sobre Vista, Mt. Wilson; Gualala and Laytonville, Mendocino Co. British Columbia: Deer Park).

- Essig, 1928, *Insects Western North America*, p. 619, fig. 499. Dixon, 1934, *California Fish and Game*, XX, p. 279. Shaw, Dixon and Huth, 1934, *Oregon State Agric. Expt. Sta., Station Bull. 322*, p. 21 (Douglas Co., Oregon; off *O. h. columbianus*). J. Bequaert, 1935, *Bull. Brooklyn Ent. Soc.*, XXX, p. 170; 1937, *op. cit.*, XXXII, p. 98 (♀♂). Hatch, 1938, *Univ. of Washington, Publ. Biol.*, I, pt. 4, p. 198 (State of Washington; off *O. h. columbianus*). Hearle, 1938, *Publ. Dept. Agric. Canada*, No. 604, p. 64, figs. 58-59 (♀; puparium). G. J. Spencer, 1938, *Proc. Ent. Soc. British Columbia*, XXXIV, p. 42 (Vancouver Id.: Sooke Lake, Comox; Campbell River. Lasqueti Id., British Columbia. All off *O. h. columbianus*); 1939, *op. cit.*, XXXV, p. 17 (Vancouver Id.: North End; Howe Sound; Englishman River; all off *O. h. columbianus*). Herms, 1939, *Medical Entomology*, 3d Ed., p. 377, fig. 139.
- Lipoptera depressa* E. A. Bruce, 1931, *Rept. Vet. Dir. Gen., Dept. Agric. Canada*, (1930-31), p. 73. Buckell, 1935, *Proc. Ent. Soc. British Columbia*, XXXI, (1934), p. 15.
- Liptotena depressa* O'Roke, 1936, *Proc. Soc. Expt. Biol. Med.*, XXXIV, p. 739 (Marin Co., California, according to O'Roke, *in litt.*).

*Female*.—Head moderately lengthened behind the eyes, which are relatively short and broad; mediovertex short and wide, about half as long as fronto-clypeus and shorter than postvertex; fronto-clypeus with a weak transverse suture at the limit of clypeus and frons, the extent of the clypeus also indicated by the very fine median longitudinal furrow; pretilinal area distinct; inner orbit about as wide as the eye, bearing 2 to 4 long frontal bristles and usually 1 to 3 smaller ones; one very long vertical bristle; postvertex long and broad, almost semi-circular; ocelli distinct, in a nearly equilateral triangle. Palpi shorter than fronto-clypeus. Pro-mesonotal suture well marked. Mesothorax: median notal suture only indicated anteriorly; transverse prescutal suture present; traces of longitudinal intrascutal grooves; mesonotal suture weak, broadly interrupted medially; posthumeral suture weak, but complete; mesothoracic spiracle large, at latero-posterior edge of humeral callosity; 2 to 4 acrostichals in an irregular row; 8 to 10 laterocentrals, more or less placed in two irregular, oblique rows; 3 or 4 humerals; 3 postalars; 4 or 5 prescutellars; two rows each of 3 or 4 notopleurals, the posterior ones much longer; 2 scutellars

(1 pair); ventrally, lobes of prosternum with 6 to 8 setae; mesosternum and basisternum mostly covered with scattering short, thick setae. Abdomen: basal dorsal pleurite (I) large, wider than long, fairly well set off from pleurites II, with an apical row of long setae and a few on the disk; pleurite II very long, well sclerotized in older specimens, triangular with the inner sides converging to the basal notch between pleurites I, uniformly but rather sparsely covered with long setae, those along inner margin in a row; remaining pleurites membranous and scarcely set off, with a few, scattered setae; only three median tergal plates in the apical third, corresponding to the third to fifth of other species of *Lipoptena*, gradually decreasing in size: third with 4 and fourth with 6 setae in transverse rows; fifth with 10 to 12 setae arranged in 2 transverse lateral groups; spiracles VI and VII not enclosed in the fourth and fifth tergal plates; remainder of dorsum membranous posteriorly, but more or less sclerotized and microscopically wrinkled or alutaceous (often also darker) in the broad triangular area between pleurites II; uniformly but very sparsely setose. Basal crescent-shaped ventral sclerite deeply emarginate, the lateral lobes broad, with relatively few heavy setae over the disk and in a marginal row; ventral portion of pleurites not sclerotized, not set off and with few setae; remainder of venter uniformly and rather densely setulose; a small, median sclerotized plate, bearing a few stiff bristles, before the anal and genital sclerites. Legs heavy, strongly setose; fore coxa without the oblique row of long setae present in most species of *Lipoptena*; apical spur of fore tibia very thin, hair-like; mid tibia with one strong apical spur; claws distinctly asymmetrical. Wing with the costa ending far from the tip in a broad, stigma-like thickening.

*Male*.—Similar to the female in structure and chaetotaxy. Pleurite II somewhat shorter; only two median tergal plates in apical third, corresponding to the third and fourth of other species of *Lipoptena*. Terminalia much smaller than usual: parameres broad, stout, straight and with broadly rounded apices; aedeagus broad with rounded and somewhat notched apex.

Length (h.+ th.): ♀, 2 to 2.3 mm.; ♂, 1.8 to 2 mm.

SPECIMENS EXAMINED.—BRITISH COLUMBIA: Cranbrook, off *O. h. columbianus*; Vancouver Id. (Victoria; Comox; Englishman's River; Sooke; North End), off *O. h. columbianus*; Lasqueti Id., Straits of Georgia, off *O. h. columbianus*;<sup>40</sup> Deer Park; Little Cam-

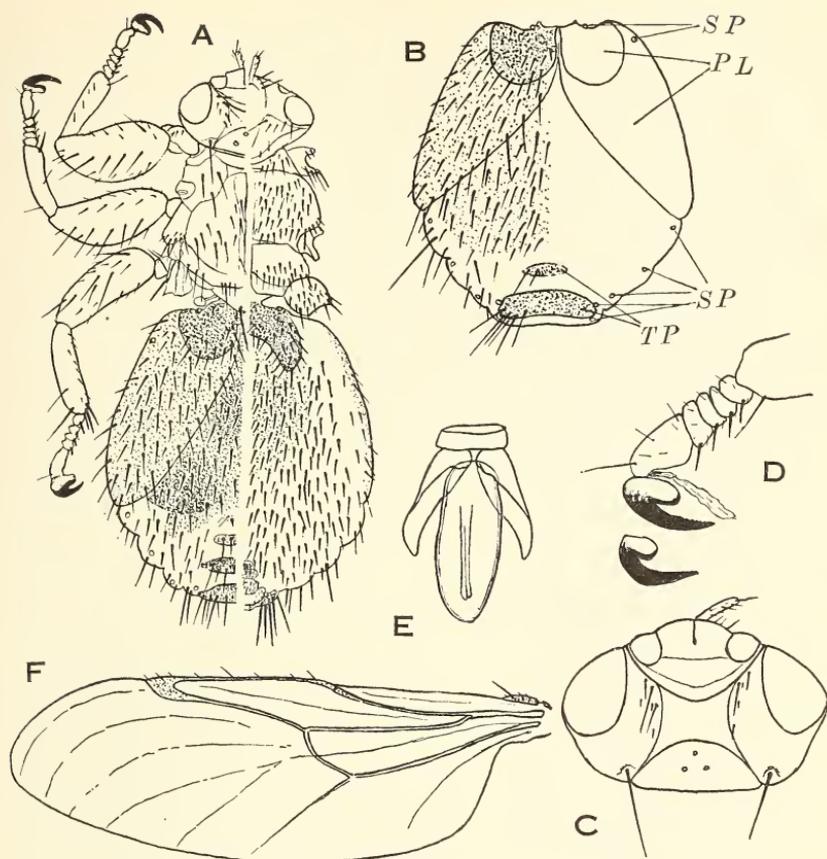


FIG. 11. *Lipoptena depressa* (Say): A, female, Mt. Palomar, California, from above (left) and below (right).—B, abdomen of male, Howe Sound, British Columbia, from above: *SP*, spiracles; *PL*, pleurites; *TP*, tergal plates.—C, head of female.—D, tarsus and claws (inner and outer) of fore leg.—E, male terminalia from above.—F, wing.

bon; Trinity Valley (K. Graham); Bobby Burns Mt., Okanagan (J. Grant); Howe Sound, off *O. h. columbianus* (G. J. Spencer); Lumby, off *O. h. hemionus* (A. Denny).—STATE OF WASHINGTON: Orcas I., San Juan Co., off *O. h. columbianus*; Carson, Skamania Co., off *O. h. columbianus*.—OREGON: Malheur National Forest, Harney Co., off *O. h. hemionus*; Dayville, Grant Co.; Cascadia,

<sup>40</sup> The host of the British Columbia specimens was given by error as the "Columbia white-tailed deer" in my earlier paper (1937).

Linn Co.; Riddle, Douglas Co.; Alsea, Benton Co., off *O. h. columbianus*; Florence, Lane Co., off *O. h. columbianus*; Blaine, Tillamook Co., off *O. h. columbianus*; Paisley, Lake Co., off *O. h. hemionus*; Brownsville, Linn Co., off *O. h. columbianus*; Summit Prairie, off *O. h. hemionus*; Kimberly, off *O. h. hemionus*; Canyon Creek, Grant Co., off *O. h. hemionus* (J. E. Davis); Prineville, Crook Co., off *O. h. hemionus* (B. G. Thompson); Murderer's Creek, Grant Co., off *O. h. hemionus*; Riddle, Douglas Co. (C. M. Gjullin).—CALIFORNIA: Logan Creek, Riverside Co. or San Bernardino Co.; San Jacinto Mts., Riverside Co.; Big Bear Lake, San Bernardino National Forest, Minnelusa, San Bernardino Co.; San Bernardino, San Bernardino Co.; Coachella, Riverside Co., off *O. h. columbianus*; 18 miles E. of Mokelumne Hill, Calaveras Co.; Denny, Trinity Co.; Cypress Ridge, Marin Co.; Carson Creek, Marin Co.; Asilomar, Monterey Co.; 17 mile Drive near Carmel, Monterey Co.; Monterey, Monterey Co. (D. W. Craik); Red Bluff, Tehama Co. (J. E. Hare); Yolo Bolo, Yolo Co., off *O. h. columbianus* (J. E. Hare); Beverly Glen, Los Angeles Co. (G. Augustson); Lake Arrowhead, Mendocino Co., off *O. hemionus californicus* (J. C. Couffer); Mt. Diablo, Contra Costa Co., 1,500 ft., ♀♂ in flight, October 8, 1939, May 18, 1940, March 26, 1941, and April 24, 1941 (J. E. Hare); Potwisha, Sequoia National Park, Tulare Co.; Havilah, Kern Co.; Piedmont, Alameda Co.; 10 miles NE of Mariposa, Mariposa Co.; Gualala, Mendocino Co., off *O. h. columbianus*; Westwood, Lassen Co., off *O. h. columbianus*; Tehama Co., supposedly off *Lophortyx californica*; Ventura Park, Ventura Co.; Green River Camp, Lower Sa. Ana Canyon, Orange Co.; Mt. Pinos, Sa. Barbara Co.; Sulphur Springs, Lake Co.; Craig Lake, 50 miles NW of Los Angeles, Los Angeles Co.; San Gabriel Mts. near Pasadena, Los Angeles Co.; Claremont, Los Angeles Co. (R. H. Beamer); Monrovia Canyon, Los Angeles Co.; Bair's Ranch, Redwood Creek, Humboldt Co., off *O. h. columbianus*; Mt. Hamilton, San José, Sa. Clara Co.; Mt. Palomar, San Diego Co.; Atascadero, San Luis Obispo Co. (J. D. Beamer); Kelly's Resort, Lassen National Park; Yosemite National Park, 3,800 to 4,000 ft., off *O. h. hemionus* (R. H. Smith); Jamesburg, Monterey Co. (J. D. Beamer); Lucerne (J. D. Beamer); Woodacre, Marin Co.; San Diego, San Diego Co., off *O. h. hemionus* (G. Heid); Oakland, Alameda Co. (E. S. Ross); Shaver Lake, off *O. h. hemionus* (J. E. Hare); San Benito Co.—IDAHO: Moose Creek, Idaho Co., off *O. virginianus leucurus* (Turner).—MONTANA: Trout Creek, Sanders Co.; Lo-Lo, Missoula Co., off *O. h. hemionus*; West Fork, Ravalli Co., off *O. h. hemionus*; Trout Creek (E. Button);

East Fork of Bitter Root River, Ravalli Co., off *O. h. hemionus* (H. Hartson); Girds Creek, E. of Hamilton, Ravalli Co., off *O. h. hemionus*; 25 miles S. of Darby, Ravalli Co., off *O. h. hemionus* (W. V. King).—SOUTH DAKOTA: Custer State Park, Hermosa, Custer Co., off *Cervus canadensis*.

*Distribution.*—*L. depressa* is now definitely known from British Columbia, the State of Washington, Oregon, California, Idaho, Montana and South Dakota. No doubt it occurs in the other Rocky Mountain States, and should also be looked for in Alberta, Lower California and Sonora. Falcoz's (1930) *L. depressa* from "Mexico," collected by Sallé, probably came from the southern half of that country, in which case it was more likely *L. mazamae*.

I regard as erroneous all statements as to the supposed occurrence of *L. depressa* in the eastern United States. Say originally gave no locality, but I believe that he obtained his specimens west of the Missouri and possibly in the Rocky Mountains of Colorado, while a member of Stephen H. Long's expedition of 1819-1820 (see Say's introductory remarks to the paper in which he described *L. depressa*; 1823, *op. cit.*, p. 9).<sup>41</sup> Wiedemann (1830), having received a cotype sent by Say from Philadelphia, merely assumed that it had been collected in Pennsylvania and later authors (Osten Sacken, 1858 and 1878; C. H. T. Townsend, 1897; Speiser, 1904; Aldrich, 1905) copied this locality.

*Host Relations.*—*L. depressa* is a common and normal parasite of the deer of western North America, which are also frequently infested with *N. ferrisi*: the two races of *Odocoileus hemionus* (Rafinesque), namely the black-tailed or coast deer, *O. h. columbianus* (Richardson), and the mule deer, *O. h. hemionus*; as well as the western white-tailed deer, *Odocoileus virginianus leucurus* (Douglas). It may also be a normal parasite of the wapiti or American elk, *Cervus canadensis* (Erxleben), although there is as yet only one record from this host (some 50 flies were collected from one wapiti in this case).

I am inclined to doubt the label of the seven winged *L. depressa* supposedly taken from California valley quail, *Lophortyx cali-*

<sup>41</sup> It should be noted that the paper entitled "Descriptions of Dipterous Insects of the United States" (1823), appears to be one of a series dealing with insects collected on Long's Expedition. This is expressly mentioned in the titles of the papers on the Hymenoptera, Neuroptera and Coleoptera, but was somehow omitted from that of the paper on the Diptera.

*formica* (Shaw), in Tehama Co. Nevertheless, the occasional occurrence on this bird deserves to be investigated more carefully.

*Life-History.*—Deälated keds of both sexes of *L. depressa* have been found on deer throughout the fall and the winter, from September to January, and most probably occur on them throughout the year. The largest number taken on one deer by G. J. Spencer in British Columbia was 81, and this observer noted a decided predominance of females over males. Breeding seems to go on all year round. Mr. W. L. Jellison sent me a slide of a mated pair taken January 2, 1937, on *O. virginianus leucurus* in Idaho, by Mr. Turner. Both specimens of this pair are deälated and thoroughly sclerotized, so that they must have hatched several weeks before. The male sits on the dorsum of the female abdomen, his palpi reaching the scutellum; his apical tergal plates are curved under the tip of the female, where the terminalia are inserted in the vulvar opening. Mating is probably repeated from time to time by both sexes; in any case it is interesting to note that it may occur even in mid-winter.

As in the case of *L. cervi*, flights of many winged, newly hatched individuals of both sexes are often observed in the fall, when they frequently alight on people and are said to bite readily.

The puparium was figured by Hearle (1938). It is relatively broader and more regularly elliptical than that of *Melophagus ovinus*, but shows also two curved rows each of seven muscular impressions, dorsally and ventrally, placed nearer the side margins than in the sheep-ked. The anal spiracular plates are also more prominent.

*Original Description.*—Description of *Melophagus depressus* Say: "Pale testaceous; eyes subovate. Body polished, a little hairy, but appearing perfectly glabrous to the eye; hypostoma yellow, with two brown lines; vertex dusky, with three indented punctures; thorax unequal, with an impressed line in the middle, with a dark reddish-brown posterior and lateral edge; feet slightly hairy, claws black; pectus with transverse rows of very short, black spines; tergum depressed, punctured, two impressed lines diverge from near the base to the margin beyond the middle; venter paler than the tergum, with short prostrate black hair-like spines, and an arquated series of spines near the base. Length less than 3/20 of an inch." Say also noted that his species appeared to be smaller than *M. ovinus* and had slight rudiments of wings.

(To be continued in number 3)

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# ENTOMOLOGICA AMERICANA

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## A MONOGRAPH OF THE MELOPHAGINAE, OR KED- FLIES, OF SHEEP, GOATS, DEER AND ANTE- LOPES (DIPTERA, HIPPOBOSCIDAE)

BY J. BEQUAERT

(Continued from number 2)

Wiedemann's description (translated); "Mellea; oculis sub-ovatis. Honey-yellow, with oval eyes. Length  $1\frac{1}{3}$  lines [= 2.88 mm.]. Very deep honey-yellow, the abdomen brown, smooth everywhere. Under side of head with two brown stripes. Vertex with three sunken dots [ocelli]. Mesonotum uneven, with an impressed median line. Sternum with transverse rows of very short black spines. Abdomen at the base with two rounded shiny areas, bounded by shallow furrows or impressed lines; behind these two impressed lines which diverge posteriorly and broadly to the sides. Venter paler, with short appressed bristles or small spines; close to the base a bow-shaped row of similar small spines."

Say's types are lost, unless the cotype which he sent to Wiedemann might yet be found in the latter's collection at the Vienna Museum. The descriptions reproduced above clearly show that *M. depressus* was either the species here called *L. depressa* or *L. mazamae* Rondani, but are insufficient to decide between the two. Coquillett (1907) was the first to apply Say's name to specimens taken from a definite locality in the western United States, and his example was followed by Ferris and Cole (1922). I see no real reason to depart from this procedure, for the present.

12. *Lipoptena mazamae* Rondani. Figs. 12A-C.

*Lipoptena mazamae* Rondani, 1878, Ann. Mus. Civ. Genova, XII, p. 153 (♀; Central and South America; off "*Cervus mexicanus*" = *Odocoileus virginianus mexicanus*). Speiser, 1904, *op. cit.*, XLI, p. 334. Aldrich, 1905, Cat. North Amer. Dipt., p. 653. Ferris and Cole, 1922, Parasitology, XIV, p. 185, figs. 2A and 2E (♀ ♂, larva; Yacuiba, Bolivia; off *Mazama* sp.). Cole, 1927, Proc. California Ac. Sci., (4) XVI, p. 453 (♂ terminalia). Falcoz, 1930, Encycl. Entom., B, Diptera, V, (1929), p. 51 (Chaco de Santiago del Estero, on the Rio Salado near Icaño, Argentina). Ferris, 1930, Canad. Entom., LXII, p. 70 (Camp Pital, Chiriqui Prov., Rep. Panama; off *Mazama tema reperiticia*). J. Bequaert, 1931, Psyche, XXXVIII, p. 191; 1933, The Peninsula of Yucatan, Carnegie Publ. 431, p. 570. Dunn, 1934, Psyche, XLI, p. 175. J. Bequaert, 1935, Bull. Brooklyn Ent. Soc., XXX, p. 170; 1937, *op. cit.*, XXXII, pp. 92 and 100; 1940, Rev. Acad. Colombiana Cienc. Ex. Fis. Nat., III, pt. 12, p. 415.

*Lipoptena depressa mazamae* Bau, 1930, Konowia, IX, p. 211, fig. (♀ ♂; Pozo del Tigre, Bolivia, off *Mazama simplicicornis*; S. José, Chiquitos, Bolivia).

*Lipoptena depressa* var. *mexicana* C. H. T. Townsend, 1897, Ann. Mag. Nat. Hist., (6) XX, p. 289 (♀ ♂; Paso de Telaya, Vera Cruz, Mexico; off *Odocoileus virginianus mexicanus*); 1897, Trans. Texas Ac. Sci., II, pt. 1, p. 41. van der Wulp, 1903, Biol. Centr.-Amer., Dipt., II, p. 432. Speiser, 1904, Ann. Mus. Civ. Genova, XLI, p. 334. Aldrich, 1905, Cat. North Amer. Dipt., p. 653. Speiser, 1907, Ent. News, XVIII, p. 103. Bezzi, 1916, Natura, Riv. Sci. Nat., VII, p. 178.

*Lipoptena conifera* Speiser, 1905, Zeitschr. Syst. Hym. Dipt., V, p. 354 (♀ ♂; Brazil; off *Mazama simplicicornis*); 1908, Zeitschr. Wiss. Insektenbiol., IV, p. 304. Bezzi, 1916, Natura, Riv. Sci. Nat., VII, p. 178.

*Lipoptena surinamensis* Bau, 1930, Stettin. Ent. Zeitg., XCI, pt. 2, p. 175 (♀ ♂; "Macaraibo," misspelling of Paramaribo, Surinam; no host).

*Lipoptena* sp. Austen, 1903, Ann. Mag. Nat. Hist., (7) XII, p. 261 (Orizaba, Mexico).

?*Lipoptena depressa* Falcoz, 1930, Encycl. Entom., B, Diptera, V, (1929), p. 51 (Mexico). Not of Say, 1823.

*Lipoptena cervi* Calzada, 1939, Bol. Mens. Dir. Ganadería, Uruguay, XXIII, pp. 466-469, figs. 1-3 (♀♂; Sierras of the Depts. of Rocha and Maldonado, Uruguay; off *Mazama* sp.). Not of Linnaeus, 1758.

*Female*.—Head moderately lengthened behind the eyes, which are relatively short and broad; mediovertex short and very wide, about half as long as fronto-clypeus and shorter than postvertex; fronto-clypeus with a weak transverse suture at the limit of clypeus and frons, the extent of the clypeus also indicated by the very fine median longitudinal furrow; pretilinal area distinct; inner orbit slightly narrower than the eye, usually with only 1, rarely with 2 frontal bristles; one very long vertical bristle; postvertex long and broad, almost semi-circular; ocelli distinct, in a nearly equilateral triangle. Palpi shorter than fronto-clypeus. Pro-mesonotal suture well marked. Mesothorax: median notal suture only indicated anteriorly; transverse prescutal suture present; traces of longitudinal intrascutal grooves; mesonotal suture weak, broadly interrupted medially; posthumeral suture weak, but complete; mesothoracic spiracle large, at latero-posterior edge of humeral callosity; 2 or 3 acrostichals near the middle line; 2 or 3 laterocentrals, in one transverse row close to the base of the wing; 3 or 4 humerals; 2 or 3 postalars; 2 or 3 prescutellars; 3 to 5 notopleurals, usually placed in one row; 2 scutellars (1 pair); ventrally, lobes of prosternum with 5 or 6 small setae; mesosternum and basisternum mostly covered with scattering, short setae and 1 or 2 longer bristles. Abdomen: basal dorsal pleurite (I) large, wider than long, fairly well set off from pleurite II, with very few setae toward hind margin; pleurites II very long, well sclerotized in older specimens, triangular with the inner sides converging to the basal notch between pleurites I, with few uniformly scattered long setae, those along inner margin in a row; remaining pleurites scarcely set off, but often partly sclerotized, almost without setae (except ventrally); only two short, transverse median tergal plates near the apex of the body, corresponding to the fourth and fifth of other species of *Lipoptena*, each with about 6 long setae in a transverse row; spiracles VI and VII not enclosed in the tergal plates; remainder of dorsum membranous posteriorly, but more or less sclerotized and microscopically wrinkled or alutaceous (usually also darker) in the broad triangular area between pleurites II, uniformly but very sparsely setose. Basal,

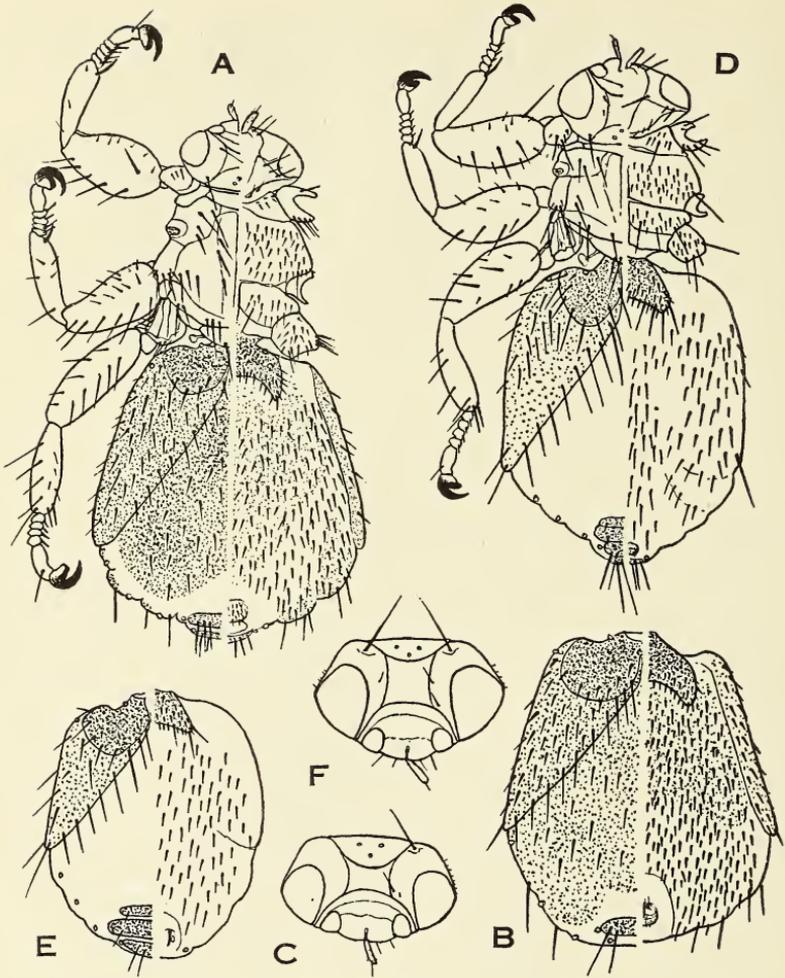


FIG. 12. A-C, *Lipoptena mazamae* Rondani: A, female, Manaus, Brasil, from above (left) and below (right); B, abdomen of male, Chiriqui, Panama, from above (left) and below (right); C, head of male.—D-F, *Lipoptena gracilis* Speiser: D, female, Bantam, Java, from above (left) and below (right); E, abdomen of male, same locality, from above (left) and below (right); F, head of male.

crested-shaped ventral sclerite deeply emarginate, the lateral lobes bluntly triangular, with relatively few heavy setae over the posterior half of the disk and in a marginal row; ventral portion of pleurites usually partly sclerotized, with a few scattered setae; remainder of venter uniformly and rather sparsely

setulose; only the regular anal and genital sclerites present; the remainder of the venter usually becomes partly sclerotized with age. Legs heavy and strongly setose; fore coxa dorsally without the usual oblique row of long setae; apical spur of fore tibia heavy, spine-like; mid tibia with one strong apical spur; claws nearly symmetrical. Wing as in *L. depressa*, with the costa ending far from the tip in a broad, stigma-like thickening.

*Male*.—Similar to the female in structure and chaetotaxy. Abdomen with only one median tergal plate, just before the apex and corresponding to the fourth of other species of *Lipotena*, with 2 long setae on each side. Terminalia longer and more elongate than in *L. depressa*, the parameres being slender and more pointed.

Length (h. + th.): ♀, 1.4 to 1.8 mm.; ♂, 1.3 to 1.5 mm.; much smaller than *L. depressa*.

SPECIMENS EXAMINED.—UNITED STATES: SOUTH CAROLINA: Charleston, off *O. v. virginianus*; Mount Holly, Orangeburg Co., off *O. v. virginianus*; Bull's Island, off *O. v. virginianus* (H. S. Peters); Georgetown Co., off *O. v. virginianus*.—GEORGIA: Wassaw Island near Savannah, Chatham Co., off cattle.—FLORIDA: 20 miles E. of Naples, Collier Co., off *O. v. virginianus*.—TEXAS: Victoria, Victoria Co.; Kerrville, Kerr Co.; San Antonio, Bexar Co.; Altavi, Colorado Co., off *O. v. virginianus* (R. H. Baker); Llano Co. (A. S. Nicholson); 12 miles W. of Lufkin, Angelina Co., off *O. v. virginianus* (R. H. Baker); 25 miles SE of Eagle Lake, Colorado Co., off *O. v. virginianus* (T. T. Waddel).—MEXICO: Compostela, Nayarit; Orizaba, Vera Cruz; Chitzen Itza, Yucatan.—GUATEMALA: Peten (O. Ricketson, Jr.).—HONDURAS: Las Limas Comay (J. B. Edwards).—PANAMA: Ancon, C. Z.; Alajuela, C. Z.; Miraflores, C. Z.; Chagres River Valley, off *O. virginianus rothschildi*; Camp Pital, Prov. Chiriqui, off *M. tema reperticia*; El Real, Darien, off *M. tema reperticia* (L. H. Dunn).—TRINIDAD: Caparo; Guaico, off *M. americana*.—VENEZUELA: La Rubiera; Sabanas de Guaniquito, Est. Guanico, off *O. virginianus gymnotes*.—BRITISH GUIANA: Kartabo, off *M. americana* (W. Beebe); Oko River, a tributary of the Cuyuni River, off *M. simplicicornis* (N. Weber); Mt. Shiriri, Rupununi River (J. G. Myers).—SURINAM (DUTCH GUIANA): Paramaribo (cotypes of *L. surinamensis*); Moenyo.—BRAZIL: Manaus, Est. Amazonas; Pará; Hansa, Est. Sa. Catharina, off *M. americana*; Nova Teutonia, Est. Sa. Catharina, off *M. americana* and *M. tema* (F. Plaumann).—PARAGUAY: Buena Vista, Dept. Sa. Cruz (Wees).—BOLIVIA: Yacuiba, off *Mazama* sp.; Champlaya, off *M. americana*.—ECUADOR: San José, W. of Huigra, 1,750 ft., off *Tayra barbara*.

*Distribution.*—*L. mazamae* occurs over most of Central and South America and extends into North America over the southeastern United States as far as South Carolina. It is now definitely recorded from South Carolina, Georgia, Florida, Texas, Mexico, Guatemala, Honduras, Panama, Trinidad, Venezuela, British Guiana, Dutch Guiana, Paraguay, Bolivia, Ecuador, Uruguay, Brazil and northern Argentina. No doubt it will be found also in Alabama, Mississippi, Louisiana, El Salvador, Costa Rica, Nicaragua, Colombia, Peru, and French Guiana.

*Host Relations.*—*L. mazamae* is probably a normal parasite of all species and races of deer (*Odocoileus*) and brocket (*Mazama*) of its territory. At present there are definite records from *Odocoileus virginianus virginianus* Boddaert of the southeastern United States; *O. v. rothschildi* (Thomas) of Panama; *O. v. gymnotes* of Venezuela; *Mazama tema* Rafinesque and its race *M. t. repticia* Goldman; *M. simplicicornis* (Illiger); and *M. americana* (Erxleben). The keds are often abundant on these animals. Townsend (1897) found as many as 153, of both sexes, on one Mexican white-tailed deer. Mr. W. Beebe collected 40 deãlated specimens from one female *M. americana* shot near Kartabo, December 13, 1920; they were scattered through the thinner parts of the fur, on neck, belly and thighs, and lived for three days after removal from the host. The species has also been found as an accidental parasite on domestic cattle and on the grison, *Tayra barbara* Linnaeus. It has not yet been observed biting man.

*Affinities.*—*L. mazamae* and *L. depressa* are so closely related that Ferris and Cole wrote: "there are slight differences in the arrangement of the setae, but no more than might be included within the possible range of variation." I have, however, studied several hundred specimens of both species and have found the characters given in the key reliable in every instance. At present their areas are not known to overlap, but they may eventually be found to do so in western or central Mexico, or perhaps even in southern Arizona or New Mexico.

*Original Descriptions.*—Original description of *Lipoptena mazamae* Rondani: "♀ Long. mm.  $2\frac{1}{4}$ – $2\frac{1}{2}$ . Faem. similis faem. *L. capreoli*, sed minor et pallidior. Difert a sp: *cervi*, ut praecedens, praeter staturam satis minorem, praesertim colore abdominis toto et aequaliter pallide rufo, basi tantum obscuriore, non transversim in dorso pallide vel sub-albidi fasciati. A *L. capreoli* praecedente etiam distinctissima, statura minore et praecipue proboscide brevissima, nigra, et exile: non rufo-testacea, mediocriter longa et crassi-

uscula. Ab utraque vero diversa, corpore manifeste minus piloso et setuloso, scilicet pedibus parce et breviter setigeris, et abdomine sub-nudo." The type is at the Genoa Museum, where it was seen by Speiser. As it was from Bellardi's collection and was obtained on *Cervus mexicanus*, it no doubt came from Mexico.

Original description of *Lipoptena depressa* var. *mexicana* Townsend (somewhat shortened): "The specimens agree fairly well with Say's description of *depressa*. The antennae are yellowish. I can distinguish no brown lines on hypostoma, unless Say and Wiedemann refer to the two halves of the labrum which might have been appressed to the under surface in their specimens, or to the two linear spots above on each side of base of labrum. There are often, doubtless normally, three soft brownish longitudinally-elongate spots on posterior portion of tergum, the middle one the largest and heaviest, and situated a little farther posteriorly than the lateral ones. The middle one is often heightened, and the lateral ones obscured, by the developing larval case or puparium within the abdomen of the female, thus giving the appearance of a single heavy dark spot. All the specimens are wingless, but the wings are represented by well-developed rudiments. The lateral pointed elytra-like raised portions of the tergum are shaded with soft brown, only the bases and tips being yellowish. From memory I can say that the soft brown and yellow colours blended so as to give a very pretty effect, and I could hardly describe the insect as generally pale testaceous or yellow. Both Say and Wiedemann in their descriptions, convey the idea that the tergum of abdomen is unicolorous, whereas in the present form the color is well contrasted between soft brown and yellow in life, changing to brown and pale yellowish in alcoholic specimens. There is also, as I remember, a creamy bloom on the yellow portions in life, which heightens the color effect. The legs are yellowish. The thorax has the darker lateral and posterior margins. The specimens vary in length from 2 to 4 millim., the usual size being 3 to 3½ millim. Twenty-six of the females contain each a black puparium within the abdomen, well formed and nearly ready to escape. Others show it less advanced. Twenty-one of the specimens have a much narrowed form, the abdomen being the same width as thorax, and about the same size as latter. This form represents individuals that have recently emerged from the puparium. It may be noted that in these the lateral elytra-like pieces of tergum are not wrinkled or compressed to any extent; but the rest of the tergum, which in the fully adult is spatulate and widened behind, is much wrinkled and compressed, indicating its recent escape from

the puparium. The puparium is 2 millim. long;  $1\frac{1}{2}$  millim. wide at widest, which is across middle; and 1 millim. thick at thickest, in centre as seen from a lateral view. It is polished chestnut-brown, with a well-defined yellowish stripe around whole edge except at cephalic end. The cap is shining blackish. Whole puparium is shining, rather short oval in dorsal outline, the cephalic end more tapering; slightly flattened or less convex on ventral surface, so as not to give a symmetrical profile view. The abdomen of the male is rounded behind, rather entire in outline on posterior edge, hypopygium concealed, genital orifice removed a little from posterior edge of ventral surface. The abdomen of female is truncate behind, the posterior margin rather deeply emarginate on each side of genital orifice, which is situated on or close to the posterior edge of ventral surface. The male organ itself is moderately stout and blunt at tip, rather than pointed." I have been unable to discover where any of the types are preserved. Possibly they are lost.

Original description of *Lipoptena confifera* Speiser (translated): "Length, 3.5 to 4 mm.; from anterior margin of head to hind margin of scutellum, 1.6 mm. Pale umber-brown; hind margin of head, margins of thorax and tarsi darker. Head characterized by an extraordinarily short frontal vitta ["Stirnstrieme" = mediovertex], which is scarcely more than a dull transverse slit between the vertical triangle [postvertex] and the very wide lunula [preptilinal area]. Eyes narrow, scarcely more than half as wide as high. Palpi short and slender. Thorax dorsally with the usual sculpture of the other species, but much more sparsely setose; the two curved rows of setae on the sides of the middle line or dorso-centrals, are represented here by only 2 or 3 setae on each side. Scutellum with only 2 setae in the middle of the hind margin. Ventrally, mesosternum twice as long as metasternum and separated from the latter by a deep curve; metasternum setulose over its hind half only. Legs without peculiarities; femora relatively not as swollen as in the other species. Abdomen peculiar in showing no segmentation beyond the two basal segments. First tergite represented only by two separate tough, bare and shiny sclerites, forming a half-collar around the base of the abdomen; second tergite extending over two-thirds of the length on the sides of the abdomen, but with the hind margins curved inwardly to near the base, the tergite uniformly covered with short setae. Remainder of dorsum sparsely and uniformly setose, without peculiarities; median notch of hind margin with a pair of dark sclerotized areas, which, however, do not assume the shape of tergal plates. First sternite wider than

long, emarginate into a bow at hind margin, so that the hind corners project as points; remainder of venter uniformly setose; before the genital opening of the female a small, tough sclerite. In the male there is a slender, conical, smooth and straight papilla on each side before the genital opening." The types, which I have not seen, are possibly in Speiser's private collection.

Original description of *Lipoptena surinamensis* Bau (translated): "*Female*. 3.25 to 3.9 mm. Head yellowish-brown, paler beneath, more brownish-yellow. Vertical triangle [postvertex] shaped like a flattened bow, somewhat striate, with 3 ocelli. Frons occupying over half the width of the head. Frontal vitta [mediovertex] over three times as wide as long, on each side at the orbits with a short seta directed backward; orbits [inner orbits] shiny. Eyes gray, semi-globular. Clypeus [fronto-clypeus] with a slight depression above the middle. Antennae shiny dark brown, with two terminal setae. Palpi narrow and short, scarcely as long as the height of the clypeus [fronto-clypeus]. Thorax above reddish-brown to brownish-yellow, more or less distinctly ruffled along five irregular longitudinal lines, on which are placed very small, black and widely spaced setae. The edges of the mesonotum project somewhat sharply before the wings and bear three very short, black setae, placed close together. Hind margin of thorax with short setae placed in a comb. Scutellum small, triangular to semi-circular, with 2 apical setae. Thorax beneath reddish-brown; mesosternum more than twice as long as metasternum, strongly transversely striate. Legs pale brownish-yellow. All femora, especially those of fore legs, thickened, above with 5 setae, of which the 3 middle ones are the largest, below with a few setae, of which one at the base is especially long. Fore and mid tibiae outwardly with a longer seta at the base and inwardly with a small preapical seta. Hind tibiae outwardly with 4 longer and inwardly with a few shorter setae and one long preapical seta. Hind tarsi inwardly with short setae arranged in a comb, the last tarsal segment with two erect setae outwardly. Wing stumps without peculiarities. Abdomen: first tergite small, transversely kidney-shaped, curved inward at hind margin, with a deep longitudinal suture, so that the two halves stand out almost as half spheres. Second tergite forming two pointed triangles separated to the bases, their apices reaching two-thirds of the side margins of the abdomen; dark reddish-brown to almost blackish-brown, yellowish-brown in a few specimens, strongly rugoso-punctate and with very short setae in the punctures. Remainder of abdomen (which is narrow anteriorly, wider posteriorly) membranous, not

segmented, without sclerotized plates. Upper side with scattered punctures and short setae, with longer bristles on the sides and at the truncate apical margin. The small, shiny, yellowish-brown, sclerotized genital ring lies in a shallow emargination of the apical margin, of which it occupies scarcely one-third of the width.—*Male* of about 3 mm., showing no differences from the female in dried specimens. This form resembles *L. depressa* with its var. *mexicana*, *L. mazamae* and *L. conifera* in the shape of the second abdominal tergite. The first two of these have two small transverse sclerites on the membranous portion of the abdomen, which are absent in *L. surinamensis*; *L. mazamae* is also smaller, only  $2\frac{1}{4}$  to  $2\frac{1}{2}$  mm. long. The present species differs from *L. conifera* in the wider frontal vitta [mediovertex] (this is only a very narrow furrow in *L. conifera*, according to Speiser) and in lacking the slender, conical, smooth straight lobes on either side of the genital opening of the male.” The types are at the Hamburg Museum. I have examined paratypes belonging to the Stanford University Museum and I am unable to differentiate them from other specimens of *L. mazamae*.

13. *Lipoptena gracilis* Speiser. Figs. 12D–F.

*Lipoptena gracilis* Speiser, 1903, Fasciculi Malayenses, Zool., I, p. 121 (♀; Jalor, Patani States, Siamese part of Malay Peninsula; off *Tragulus kanchil affinis*). Bezzi, 1916, Natura, Riv. Sci. Nat., VII, p. 178. Edwards, 1919, Jl. Feder. Malay States Mus., VIII, pt. 3, p. 57. Russell, 1922, Jl. Bombay Nat. Hist. Soc., XXVIII, p. 960.

*Lipoptena traguli* Ferris and Cole, 1922, Parasitology, XIV, p. 185, figs. 2G and 3 (♀♂; ♀ holotype and paratype, Lingga Id., Rhio Lingga Group, off *Tragulus kanchil subrufus*; ♂ allotype and paratype, Tuangku Id., Banjak Group, off *Tragulus kanchil russeus*; Pulo Bintang, Rhio Archipelago, off *Tragulus kanchil rubeus*). Cole, 1927, Proc. California Ac. Sci., (4) XVI, p. 453 (♂ terminalia). Wu, 1940, Cat. Insect. Sinensium, V, p. 469.<sup>42</sup>

*Female*.—Head moderately lengthened behind the eyes, which are rather long but broad; mediovertex about as long as wide or slightly longer, nearly as long as fronto-clypeus and nearly twice as long as postvertex; fronto-clypeus with a weak transverse suture at the limit of clypeus and frons, the extent

<sup>42</sup> *L. traguli* was included in the Catalogue of Chinese insects by error. Wu was misled by the term “China Sea.” All the islands where *L. traguli* was taken lie near the Straits of Singapore.

of the clypeus also indicated by the very fine median longitudinal furrow; preptilinal area distinct; inner orbit scarcely over half as wide as the eye, usually with 1 or 2 frontal bristles (sometimes none); one very long vertical bristle; postvertex short but broad, flattened semi-elliptical; ocelli distinct, in a nearly equilateral triangle. Palpi much shorter than frontoclypeus. Pro-mesonotal suture well marked. Mesothorax: median notal suture weakly developed in anterior two-thirds; no transverse prescutal suture; weak longitudinal intrascutal grooves; mesonotal suture weak, narrowly interrupted medially; posthumeral suture weak and incomplete; mesothoracic spiracle large, at latero-posterior edge of humeral callosity; usually no acrostichals (rarely 1 very small); 2 latero-centrals, placed one behind the other close to the base of the wing; 3 humerals; 2 postalars; 1 prescutellar; 2 long and 2 short notopleurals, more or less in 2 rows; 4 scutellars (2 pairs); ventrally, lobes of prosternum with 6 to 8 setae, one very long; mesosternum and basisternum mostly covered with scattering short and a few longer setae. Abdomen: basal dorsal pleurite (I) large, about as long as wide, distinctly set off from pleurite II, with an apical row of long setae and scarcely any on the disk; pleurites II very long, well sclerotized in older specimens, triangular with the inner sides converging to the basal notch between pleurites I, with a row of long setae along inner margin and a few scattered setae on outer basal half; remaining pleurites membranous and scarcely set off; four median tergal plates, small, transverse, crowded near the apex: one pair of short setae on first and second, 2 pairs of long bristles on third and fourth; spiracles VI and VII not enclosed in third and fourth tergal plates; remainder of dorsum membranous posteriorly, more or less sclerotized and microscopically wrinkled anteriorly, entirely bare. Basal, crescent-shaped ventral sclerite very shallowly curved inward at hind margin, the lateral lobes very broad, with scattered heavy setae over most of the disk and in an apical row, 2 or 3 of them very long on the lobes; ventral portion of pleurites not sclerotized, scarcely or not set off, with relatively few, scattered setae; no sclerotized ventral plates, except the usual genital and anal sclerites; remainder of venter with few, rather unevenly distributed setae. Legs heavy, moderately setose; fore coxa dorsally with a few long setae posteriorly; apical spur of fore tibia heavy, spine-like; mid tibia with one strong apical spur; claws nearly symmetrical. Wing unknown.

*Male*.—Similar to the female in structure and chaetotaxy. Only three median tergal plates, corresponding to the first to third of the female, all larger than in the female. Terminalia with relatively short and heavy parameres, ending in sharp, straight points; aedeagus triangular, sharply pointed.

Length. (h. + th.): ♀, 0.9 to 1.2 mm.; ♂, 1 mm. The smallest species of the genus.

SPECIMENS EXAMINED.—SIAM: Kao Luang, off *Tragulus kanchil* subsp.—Islands near the Straits of Singapore: Lingga Id., off *Tragulus kanchil subrufus* (holotype and paratype of *L. traguli*); Tuangku Id., off *Tragulus kanchil russeus* (allotype of *L. traguli*); Pulo Bintang, off *Tragulus kanchil rubeus* (paratype of *L. traguli*).—MALAY FEDERATED STATES: off *Tragulus kanchil fulviventris*.—MERGUI ARCHIPELAGO: St. Luke's Id., off *Tragulus kanchil lampensis* (Abbott).—JAVA: Tamandjaija, Bantam, off *Tragulus kanchil pelandoc* (O. Bryant).

*Distribution*.—*L. gracilis* is known at present from the Malay Peninsula (including the Siamese part), the Mergui Archipelago, the islands near the Straits of Singapore (near the East coast of Sumatra) and western Java. It probably will be found wherever *Tragulus kanchil* and related mouse-deer occur.

*Host Relations*.—*L. gracilis* is known thus far with certainty only from the following races of one species of chevrotain or mouse-deer, *Tragulus kanchil* (Raffles), which occurs throughout southern Tenasserim, Lower Siam, Annam, Cochin-China, Cambodia, the Malay Peninsula and adjoining islands, Sumatra, Java and Borneo: *T. k. rubeus* Miller, *T. k. lampensis* Miller, *T. k. russeus* Miller, *T. k. affinis* Gray, *T. k. pelandoc* (H. Smith) (Syn.: *Moschus javanicus* Gmelin, not *Cervus javanicus* Osbeck), *T. k. fulviventris* Gray, and *T. k. subrufus* Miller. It may be expected on the other races of *T. kanchil* and perhaps even on the three remaining species of the genus: *T. meminna* (Erxleben), of Peninsular India and Ceylon; *T. stanleyanus* (Gray), of the Malay Peninsula; and *T. javanicus* (Osbeck), which has much the same distribution as *T. kanchil*, but extends also into the Philippines.

*Original Descriptions*.—Original description of *Lipoptena gracilis* Speiser (translated): "Closest in size to *L. pteropi* Denny, *L. capreoli* Rondani and *L. capensis* Walker (described as an *Ornithobia*, from a ♂), but the last-named does not concern us, because of its aberrant color. *L. gracilis* is readily distinguished from the other two by the peculiar, elegant pilosity of the abdomen, described below. Moreover, the somewhat problematic *L. capreoli*, of Cyprus,

belongs among the species with particularly narrow eyes, which does not fit the new species. Finally it may be separated also from *L. pteropi* by the absence of a dark brown spot at the tip of the femora. Length 2.5 mm.; from margin of mouth to hind margin of scutellum fully 1 mm. Head short and broad, with broad eyes, which almost bulge somewhat. The inner orbits a little narrower than the eyes, forming almost parallel borders to the dull median area of the frons [mediovertex]. Clypeus [fronto-clypeus] black, with a median yellow furrow at anterior margin; remainder of head russet-yellow, with a black spot on the vertical triangle between the ocelli. Head without setae, except one on either side of the hind margin of the vertical triangle [postvertex]. Antennae button-shaped. Palpi short, scarcely one-third the length of the clypeus. Thorax as long as wide, if the humeral angles are not included; russet-yellow, with a paler longitudinal stripe on either side of the middle line. Transverse suture of mesonotum placed far back. Humeral angles broadly conic, about one-third of the length of the remainder of the thorax; with 3 or 4 medium-sized setae. Praescutum mesonoti divided by a very distinct longitudinal suture into two halves, each anteriorly with one rather large and 2 or 3 smaller setae, before the hind margin on either side of the middle line a minute seta, close to the dorso-pleural suture on each side one strong seta and before this a minute seta. On the narrow scutum mesonoti, before the scutellum, a row of four long, strong, evenly spaced setae. Scutellum bare, except for 4 setae in the middle of the hind margin, the median pair long, the thinner pair short. On the pleura, before the base of the wing, on each side 4 or 5 medium-sized setae. Ventral side of thorax with a distinct prosternum, consisting of two side lobes and limited behind by a straight line; mesosternum twice as long as metasternum, which is emarginate behind by a pointed bow; limit of mesosternum and metasternum perpendicular on the middle line. Entire ventral side of thorax uniformly covered with short setae. Legs of the usual shape and with the usual proportion between the parts, but fore femora somewhat swollen, spindle-shaped, without peculiar arrangement of setae. Only the short, lobe-like wing stumps present, with irregularly torn hind margin and distinct venation. Abdomen dorsally with 5 or 6 distinct segments. A large segment at the base, deeply notched in the middle of the hind margin almost to the base and covering the entire sides of the abdomen like the soft elytra of *Meloë* (a comparison also used by Wiedemann for his *Lipoptena moschi*, described as a *Melophaga*); russet-yellow, with a semi-circular, somewhat darker plate,

setulose only along the hind margin, on each side at the base. I do not know whether this pair of plates might not be the true first segment. The large, mantle-shaped segment with long setae all over and a row of them along the hind margin, so that the middle of the abdomen bears an elegant row of bristles, bent into an angle. Behind the margin of this segment a whitish-yellow, wholly bare area, in which lies a spiracle on each side close to the hind margin of the abdomen. At the hind margin lie crowded together the three transverse plates characteristic of *Lipoptena*, covering a distinctly limited, trapezoidal area of about one-fourth of the length of the abdomen; they are narrow, about 6 times as long as wide ("wide" here used for the middle line, and "long" as perpendicular to this). The first two plates bear only a pair of minute setae before the hind margin, the third three stronger setae on each side. Wart-like elevations on each side before the anal opening also with 3 setae. Ventrally a rougher basal sclerite, limited by a straight line, with 3 or 4 long setae on each side at the hind margin; beyond this a middle third unsegmented and two side thirds in which may be seen the limits of the large mantle-shaped segment and of the succeeding soft segments. Before the genital opening only a slightly darker plate, without characteristic shape." Described from a single female, now at the British Museum, where I have seen it.

Original description of *Lipoptena traguli* Ferris and Cole: "*Female*. Length (on slide) 2.75 mm. General colour, pale brown or yellowish. Head with narrow, elongate frontal vitta; the ocellar area much reduced; the front almost destitute of setae, those which may be present rather small; ventral side with but few setae. Thorax dorsally with but few setae; pre-alars slender; two pairs of slender pre-scutellars and two pairs of scutellars, the outer pair of the latter small. Sternum thickly beset with small, stout setae. Anterior and middle tibiae with a single, stout inner apical seta, the posterior tibiae with two or three such setae; claws of each pair of equal size. Wings and halteres broken off in all the specimens examined. Abdomen with the dorsum marked by two diagonal lines which diverge from the base to the lateral margins well toward the apex, the base of each of the lateral areas thus delimited with a more or less circular, more heavily chitinized area, the whole sparingly beset with rather large setae. Remainder of the dorsum practically destitute of setae and membranous except for a small pre-apical plate. Basal sternite but slightly emarginate, thickly beset with small, stout setae and with a few longer setae. Remainder of the venter with numerous small, slender setae.—*Male*. Length

(on slide) 2.25 mm. In general very closely resembling the female. Genitalia with a pair of short external lobes which are beset with small setae; internally with the inner ring-like piece very sharply pointed at the apex.' I have seen the types, now in the collections of Stanford University Museum.

Genus *Echestypus* Speiser

*Echestypus* Speiser, 1907, Wiss. Ergebn. Schwed. Zool. Exped. Kilimandjaro, II, pt. 10, p. 3 (for two species: *Lipoptena sepiacea* Speiser, 1905; and *Echestypus parvipalpis* Speiser, 1907); 1908, Denkschr. Med.-Naturw. Ges. Jena, XIII, pt. 1, p. 176 (for two species: *Lipoptena sepiacea* Speiser, 1905; and *Echestypus binoculus* Speiser, 1908).

*Eschestypus* Curson, 1928, South Afric. Jl. Nat. Hist., VI, pt. 3, p. 182 (misspelling of *Echestypus*).

Speiser described the genus in two different publications; but it should be dated from its first appearance in 1907 and one of the two species then included should be the genotype. I have selected as such (1940, Psyche, XLVII, p. 85) *Lipoptena sepiacea* Speiser, 1905. Aldrich (1923, Insec. Inscit. Menstr., XI, p. 77) had previously selected "*E. binoculatus* Speiser" (misspelling of *binoculus*) as genotype; but, as this is not one of the species mentioned in 1907, the designation is invalid.

Head broad, transversely elliptical; the slightly convex occipital margin fitting in the shallowly concave anterior slope of the pronotum. Antennae short, subglobular, without dorsal prolongation, flattened in the antennal pits, which are completely surrounded by a continuous rim. Compound eyes large, oval, extending both dorsally and ventrally, of many minute ommatidia. Ocelli absent. Fronto-clypeus with truncate anterior margin, not lobed, but divided by a linear longitudinal furrow ending in a pit; postvertex less than twice as long as mediovertex, which is at least as wide as the inner orbit. Palpi very short or rudimentary. Thorax: dorsally, pronotum well developed, though short, separated by a distinct suture from the mesonotum; median notal suture at least partly present; intrascutal grooves wanting; transverse mesonotal suture interrupted medially; post-humeral suture weak; humeral callosities hardly projecting anteriorly, the angles broadly rounded off; mesothoracic spiracles placed dorso-laterally; scutellum large, flat. Wings as in *Lipoptena* and with similar venation. In the two species in which they are known, the third longitudinal

vein ends in the tip of the costa at an acute angle, rather far from the apex of the wing, and without knob-like swelling. Halteres as in *Lipoptena*. Legs much more slender than in most *Lipoptena*, particularly the hind legs. Claws robust, slightly asymmetrical in each pair. Apical spur of fore tibia stout; mid tibia with two apical spurs; fore coxa dorsally without retrograde spur, but obliquely swollen and bearing a row of setae. Abdomen dorsally with a pair of basal sclerotized pleurites (I); succeeding pleurites short, lozenge-shaped; female with five median tergal plates of variable size and shape; male with four such plates; ventrally, the basal sclerotized sternite crescent-shaped.

*Echestypus* is structurally closer to *Lipoptena* proper, than to the subgenus *Lipoptenella*. In all essential characters it agrees with *Lipoptena*, from which it differs only in the absence of ocelli (a character of relatively little importance in Hippoboscidae) and the short or vestigial palpi (the length of which varies widely among the species of *Lipoptena* and *Melophagus*; in some of them the palpi are barely longer than in *E. sepiaceus* and *E. binoculus*). I should much prefer to treat *Echestypus* as a subgenus of *Lipoptena*, were it not contrary to the prevailing fashion of overmultiplying genera. Until recently it might have been claimed that *Echestypus* was a peculiarly Ethiopian branch of Melophaginae, adapted to antelopes; but the recent discovery of a true *Lipoptena* (*L. hopkinsi*), with well-developed ocelli, on some Central African antelopes, nullifies this argument.

KEY TO THE SPECIES OF ECHESTYPUS

1. Palpi vestigial, not or barely visible from above beyond the anterior margin of the fronto-clypeus. Mediovertex nearly as long as or slightly longer than wide; inner orbit narrower than the eye; postvertex as long as or slightly shorter than mediovertex. Two (rarely 3) pairs of scutellars. *E. paradoxus*.
- Palpi short but distinctly protruding beyond the anterior margin of the fronto-clypeus and nearly half as long as fronto-clypeus ..... 2.
2. Mediovertex as wide as long or slightly wider; inner orbit narrower than the eye; postvertex nearly as long as or slightly shorter than mediovertex. Two pairs of scutellars. *E. sepiaceus*.

Mediovertex longer than wide; inner orbit as broad as or broader than the eye; postvertex about half the length of mediovertex. One pair of scutellars ..... *E. binoculus*.

1. *Echestypus paradoxus* (Newstead). Figs. 13A-B.

*Lipoptena paradoxa* Newstead, 1907 (February), Ann. Trop. Med. Paras., I, p. 91, figs. 19-20 (♀; Kasongo, Belgian Congo; off *Tragelaphus scriptus*). Austen, 1909, Illustr. African Blood-Suck. Flies, p. 209. Bezzi, 1916, Natura, Riv. Sci. Nat., VII, p. 178.

*Echestypus paradoxus* D. Bruce, Hamerton, Mackie and Lady Bruce, 1911, Rept. Sleeping Sickn. Comm. Roy. Soc., XI, p. 228 (Singo, Uganda; off *Tragelaphus scriptus*). C. W. Howard, 1912, Bull. Ent. Res., III, p. 218 (Portuguese East Africa; "from an owl"). S. A. Neave, 1912, *op. cit.*, III, pp. 311, 314, 315, 320 and 322 (Msoro's, 50 miles W. of Ft. Jameson, N. E. Rhodesia, off *Tragelaphus scriptus*; 35 miles E. of Ft. Jameson, off *Strepsiceros strepsiceros*; near Kota Kota, Nyasaland, off *Tragelaphus scriptus*; Makindu, Kenya, off *Strepsiceros imberbis*). Mason, 1916, Ann. Rept. Dept. Agric. Nyasaland for 1915-16, p. 19 (Nyasaland, off *Tragelaphus scriptus* and *Phacochoerus aethiopicus*). Anderson, 1924, Kenya Med. Jl., Suppl. No. 1, p. 9; and Suppl. No. 2, p. 4. Bedford, 1927, 11th and 12th Repts. Dir. Vet. Res. South Africa, I, pp. 300 and 782 (Pietersburg District, Transvaal, off *Strepsiceros strepsiceros*; Zululand, off *Strepsiceros strepsiceros*; Ubombo Flats, Zululand, off *Tragelaphus angasii*; Ntambanana, Zululand, off *Tragelaphus scriptus sylvaticus* [also by error off *Redunca fulvorufula*]; Emakosini, Zululand, off *Redunca arundinum*; Sekukuniland, Bechuana-land, off *Tragelaphus scriptus sylvaticus*). Ferris, 1930, Parasitology, XXII, pt. 3, p. 278, figs. 3 and 4A-C (♀♂; off *Tragelaphus angasii* and *Sylvicapra grimmia*, in South Africa). Bedford, 1932, 18th Rept. Dir. Vet. Serv. An. Ind. South Africa, p. 421 (Umfolosi, Zululand, off *Sylvicapra grimmia*). Cuthbertson, 1937, Proc. Trans. Rhodesia Scientif. Assoc., XXXV, pt. 1, p. 33 (S. Rhodesia: Gatoona, Hartley District, off *Sylvicapra grimmia*; Inyati, Matabeleland, off *Sylvicapra grimmia*). J. Bequaert, 1940, Psyche, XLVII, p. 22, fig. 1 (♀♂).

*Eschetypus paradoxus* Curson, 1928, South Afric. Jl. Nat. Hist., VI, pt. 3, p. 182.

*Echestypus parvipalpis* Speiser, 1907, Wiss. Ergebn. Schwed. Zool. Exped. Kilimandjaro, II, pt. 10, pp. 3 and 5 (♀ ♂; Mt. Kilimanjaro, Tanganyika Territory; off *Tragelaphus scriptus* "roualeyni" [probably really subsp. *massaicus*]). Austen, 1909, Illustr. African Blood-Suck. Flies, p. 202. S. A. Neave, 1912, Bull. Ent. Res., III, p. 317. Morstatt, 1913, Der Pflanze, IX, p. 509. Bezzi, 1916, Natura, Riv. Sci. Nat., VII, p. 178. Speiser, 1924, Beitr. Tierkunde, Widmungsschr. M. Braun, p. 104. Falcoz, 1930, Encyclop. Entom., B, Diptera, V, (1929), p. 52 (♀ ♂; Portuguese East Africa: Pongwe Valley; tendos of Urema, Gorongoza Prov.; forest of Inhaconde. 350 m., Gorongoza Prov.).

Mettam's (1935, Uganda Prot., Ann. Rept. Vet. Dept. for 1934, p. 22) records of *Echestypus* from Uganda, off red forest duiker and bushbuck, may have been based on more than one species.

*Female*.—Head moderately lengthened behind the eyes, which are rather broad; mediovertex nearly as long as or slightly longer than wide, about as long as fronto-clypeus and slightly longer than postvertex. Clypeus completely fused with frons, the median longitudinal furrow rather short and ending in an elongate pit; pretilinal area distinct, but very short; inner orbit narrower than the eye, with 2 to 4 (usually 3) setae, all far from the margin; one very long vertical bristle; postvertex short and very wide, flattened semi-elliptical. Palpi vestigial, not or barely visible from above beyond the anterior margin of the fronto-clypeus. Pro-mesonotal suture distinct. Mesothorax: median notal suture weak over anterior two-thirds; no intrascutal grooves; transverse mesonotal suture weak, broadly interrupted medially; posthumeral suture well marked; mesothoracic spiracle large, at latero-posterior edge of humeral callosity; 6 acrostichals in a curved row, some distance from middle line; 2 latero-centrals, close to notopleuron; 3 humerals; two rows each of 4 or 5 notopleurals, those of hind row very long; usually 4 (rarely 5 or 6) scutellars, in two pairs, the inner pair very long; ventrally, lobes of prosternum with 3 setae; mesosternum and hind half of basisternum with relatively short setae, more or less in transverse rows. Abdomen: basal dorsal pleurite (I) large, transverse, with a regular marginal row of long bristles and an angular row of shorter setae on the disk; pleurites II to V well set off and somewhat sclero-

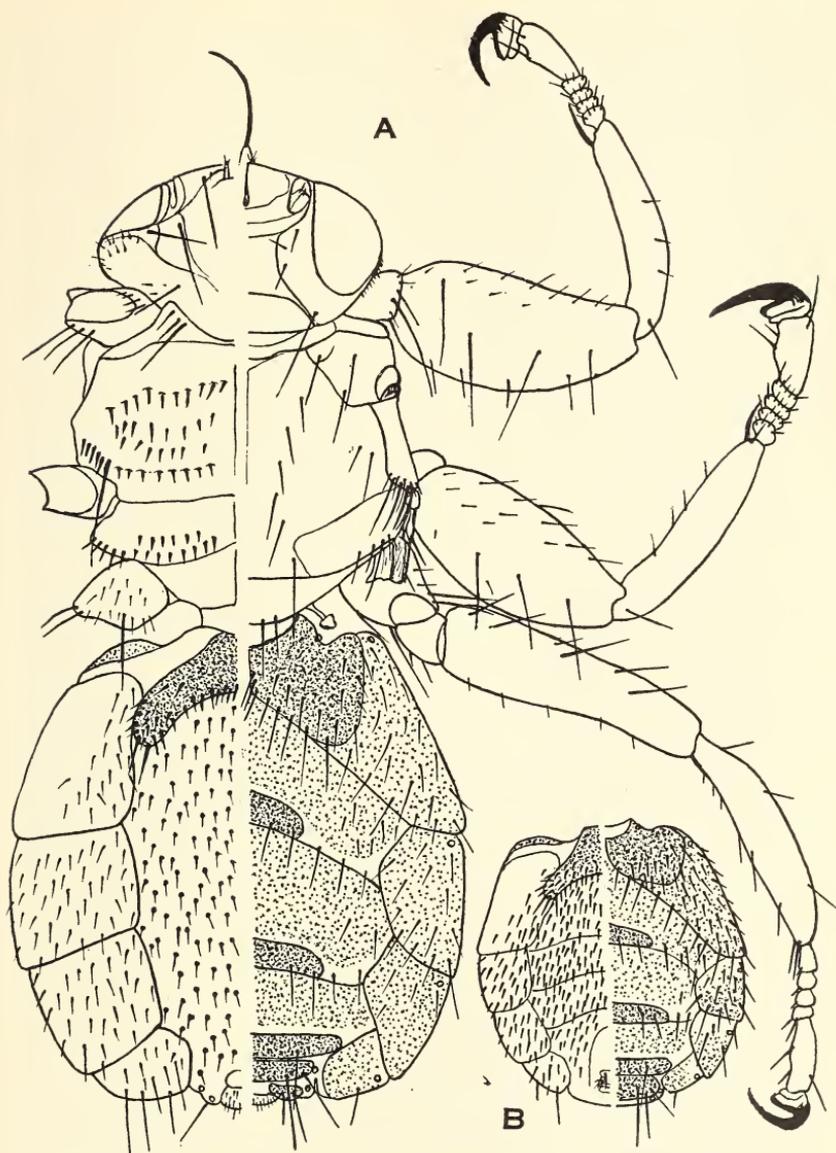


FIG. 13. *Echestypus paradoxus* (Newstead): A, female, Elisabethville, Belgian Congo, from above (right) and below (left).—B, abdomen of male, Ruo, Nyasaland, from above (right) and below (left).

tized, with a few, uniformly spaced setae; five median tergal plates, all short and transverse, smaller than in the other species, gradually increasing in size from first to third, the fourth again smaller; first and second with a transverse row of 4 or 5 setae, interrupted medially; third and fourth with 1 or 2 setae in each corner; fifth divided into two sclerites, each bearing 2 setae; remainder of dorsum usually extensively sclerotized, with traces of segmentation, with a few setae toward the sides. Basal ventral sclerite broadly emarginate at apex, somewhat more shallowly than in the other two species, with broader lobes to the crescent; with many heavy setae along hind margin and a few on the disk, two of them very long near the tip of each lobe; ventral portion of pleurites well set off, more or less sclerotized, with fairly uniformly scattered setae; remainder of venter membranous, with uniformly spaced setae arising from thickened bases. Abdominal spiracles small, but distinct; spiracles VI and VII almost enclosed in the fourth and fifth tergal plates. Legs moderately heavy, rather sparsely setulose; apical spur of fore tibia long and thick; mid tibia with two apical spurs, one of them very small; fore coxa dorsally with an oblique marginal row of setae, one of them very long; claws very slender, slightly asymmetrical. Wing as in *E. sepiaceus*.

*Male*.—Similar to the female in structure and chaetotaxy. Only four median tergal plates, corresponding to the first to fourth of the female, somewhat larger than in that sex, particularly the first and second. Terminalia similar to those of most *Lipoptena*; parameres long, slender, straight, sharply pointed; aedeagus a narrow, sharply pointed cone.

Length (h. + th.): ♀, 1.8 to 2.1 mm.; ♂, 1.6 to 1.8 mm.

SPECIMENS EXAMINED.—BELGIAN CONGO: Luofu, Kivu District, off *Tragelaphus scriptus*; Rutshuru, Kivu District, off *Tragelaphus scriptus*; Katofio, Katanga, off *Sylvicapra grimmia*; Elisabethville, Katanga, off *Sylvicapra grimmia*; Kasepa River near Elisabethville, off *Sylvicapra grimmia*; Malenda River (a tributary of the Bushibila River), near Elisabethville, off *Sylvicapra grimmia*; Kilwa, on Lake Moero, off *Sylvicapra grimmia*; Kapiri, Katanga, without host; Kibombo, Manyema, off *Tragelaphus scriptus*; Doruma, Uele, off an antelope; Nyanza, Urundi.—UGANDA: Entebbe, off *Tragelaphus scriptus*; Akwa River, Gulu District, off *Tragelaphus scriptus* (T. W. Charley); Stogem, off *Tragelaphus scriptus*; West Nile, off *Tragelaphus scriptus*; without more definite locality, off *Tragelaphus scriptus*; Toro, without host; Matuba Island, Lake

Victoria.—ETHIOPIA: Addis Abeba, off *Tragelaphus scriptus*.—KENYA COLONY: Zuwani, without host; Guaso Nyiro, off *Strepsiceros imberbis*.—TANGANYIKA TERRITORY: Kilossa, off *Tragelaphus scriptus* and *Sylvicapra grimmia*.—ANGOLA: 80 miles from the coast, off *Strepsiceros strepsiceros*.—NORTHERN RHODESIA: Kafue River, off *Tragelaphus scriptus*.—SOUTHERN RHODESIA: Gatoona, Hartley District, off *Tragelaphus scriptus*; Matetsi, Wankie District, off *Strepsiceros strepsiceros*.—NYASALAND: Maperera Stream, Lower Shire River, off *Tragelaphus scriptus*; Henga River, and Kayuni, N. Nyasa, off "gawpi"; Karonga, without host; Tangazi River, Namulambo, Ruo District, off *Taurotragus oryx pattersonianus* and *Strepsiceros strepsiceros*; Chikonje, Ruo District, off *Strepsiceros strepsiceros* and *Tragelaphus scriptus*; Ruo District, off *Aepyceros melampus*, *Sylvicapra grimmia*, and *Tragelaphus angasii*; mouth of the Nkumbaleza River, 20 miles south of Kotakota, off *Tragelaphus scriptus* (S. A. Neave).—TRANSVAAL: without more definite locality, off *Tragelaphus scriptus*; Guernsey, District Pilgrim's Rest, off *Strepsiceros strepsiceros*.—ZULULAND: Ubombo Flats, off *Tragelaphus scriptus sylvaticus* and off *Tragelaphus angasii*; Umfolosi, off *Sylvicapra grimmia*; White Umfolosi River, off *Tragelaphus scriptus sylvaticus* and *Kobus ellipsiprymnus*; Lower Umfolosi River, off *Tragelaphus angasii*, and *T. scriptus sylvaticus*; Umkuzi River, off *Tragelaphus scriptus sylvaticus*.—CAPE PROVINCE: Port Elizabeth, without host; if the locality label is to be trusted, this specimen was possibly taken from some animal in captivity.

*Distribution.*—*E. paradoxus* is known in the wild state from Ethiopia, Uganda, the eastern and southeastern Belgian Congo, Kenya Colony, Tanganyika Territory, Nyasaland, Northern Rhodesia, Southern Rhodesia, Angola, Bechuanaland, Transvaal, Portuguese East Africa and Zululand. It is definitely an insect of the savanna and plains country of East, Central and South Africa, avoiding the Rain Forest of the Congo Basin, as well as West Africa proper.

*Host Relations.*—There are now reliable records of *E. paradoxus* from nine antelopes. The bushbuck, *Tragelaphus scriptus* (Pallas), by far the most common host, is found over practically the whole of Africa south of the Sahara, in several races. G. M. Allen (1939) recognizes 27 valid races and lists many more synonyms. The nyala, *Tragelaphus angasii* Gray, is restricted to southeastern Africa. The kudus are closely related to the foregoing, from which some authors do not separate them generically. The lesser kudu, *Strepsiceros imberbis* Blyth, is restricted to Northeast Africa. The greater kudu,

*Strepsiceros strepsiceros* (Pallas), occurs throughout the savanna areas of Africa south of the Sahara. Both are frequent hosts of *E. paradoxus*. The duiker, *Sylvicapra grimmia* (Linnaeus), also a common host, has about the same distribution as the greater kudu. The following four hosts are perhaps more accidental: the reedbuck, *Redunca arundinum* (Boddaert); the eland, *Taurotragus oryx patersonianus* Lydekker; the impalla, *Aepyceros melampus* (Lichtenstein); and the waterbuck, *Kobus ellipsiprymnus* (Ogilby). These antelopes are found in the savannas of South, Central and East Africa. The two anomalous records off wart-hog and owl are perhaps unreliable.

*Synonymy.*—The types of *E. paradoxus* are at the Liverpool School of Tropical Medicine. Although I have not seen them, there can be no doubt that the species here called *paradoxus* is the one described and figured by Newstead and later figured by Ferris (1930) under the same name.

Speiser evidently could not have been acquainted with Newstead's *paradoxus* when he erected his genus *Echestypus*. There seems to be no reason why the three species he knew should not be the same as those recognized in the present paper. Both his *E. sepiaceus* and *E. binoculus* may, I believe, be recognized with certainty from the descriptions, as shown in the sequel. Hence, *a priori*, Speiser's third species, *E. parvipalpis*, may be Newstead's *paradoxus*, particularly in view of the fact that this is the most common and most widely distributed of the three. The types of *E. parvipalpis* are at the Stockholm Museum and I have not seen them. The statement about the unusually short palpi clearly applies only to *E. paradoxus* and the remainder of the description also fits this species better than either of the others.

The descriptions of *E. paradoxus* and *E. parvipalpis* were published the same year, but that of *paradoxus* appeared first. The issue of the Ann. Trop. Med. Paras., containing the description, was dated February 1st. The paper on the Diptera Pupipara of the Kilimanjaro Expedition, by Speiser, was first recorded as printed at the meeting of April 10, 1907, of the Stockholm Academy of Sciences (Kungl. Svenska Vetenskapsakad. Årsbok for 1908, p. 33).

*Original Descriptions.*—Original description of *Lipoptena paradoxa* Newstead: "*Female.*—Specimens preserved in Canada balsam and alcohol are red-brown inclining to orange-brown at the sides of the abdomen; claws black; base of abdomen with a bilateral patch of darker chitin, the median area of the remaining segments also with darker markings, but these are both irregular and inconstant

in the preserved examples. Head as wide as the anterior part of the thorax; ocelli absent. Mouth parts rudimentary. Outer margin of eyes with a double series of spinose hairs. Thorax narrower in front than behind, with a submedian series of about nine long spinose hairs forming a curved line, and a short submarginal series of usually four similar ones terminating opposite the insertion of the mid legs; posterior margins with four long spinose hairs on either side of the scutellum; the last-named organ is also furnished with four similar hairs. Abdomen short ovate, almost subcircular, with numerous spinose hairs arranged as shown in the figure. Venter with numerous short spinose hairs; median convex area with numerous minute equidistant tubercles bearing slender spinose hairs, the spaces between the tubercles finely but strongly rugose. Legs short, stout, sparsely clothed with hairs of varying lengths and varying degrees of thickness; the posterior pair not extending beyond the tip of the abdomen; tibial spine to anterior and mid legs stout; tibial spine to posterior legs long, slender; pulvillus broadly dilated from the middle outwards, finely spinose; feather-bristle strongly spinose; the upper surface with only one series of spines, the inner with two or three; unguis very faintly and irregularly toothed on the inner margin. Length 4 mm.; width of abdomen 2 mm. The absence of ocelli in the female is rather remarkable. There is also an almost entire absence of external mouth parts, including the labial sheath; the only indication of these organs being a minute truncated cone, the exact nature of which could not be determined in the limited supply of material."

Original description of *Echestypus parvipalpis* Speiser (translated): "Length 4 to 5 mm., from oral margin to scutellum 1.6 mm. Brown in several shades, the membranous parts of the abdomen whitish-yellow. Head broader than long; clypeus [fronto-clypeus] extending over a little more than anterior third; dull frontal vitta [mediovertex] longer than wide; eyes large; inner orbits each with 2 setae, one stronger near the upper end, next to the vertical triangle [postvertex], one shorter in the middle and somewhat outward from the greatest convexity of the orbits. Antennae without peculiarities; sheath of proboscis, formed by the appressed maxillary palpi, unusually short, protruding beyond the anterior margin of the clypeus only by the short setulae which it bears, scarcely longer than wide at base. General shape of thorax as usual in *Lipoptena* and *Echestypus*. Humeral callosity with 3 strong bristles, not so distinctly defined by a suture as in the typical species of *Echestypus*; on either side of the longitudinal suture, a row of 5 bristles some-

what in a hyperbolic curve; short scutum mesonoti on each side with 4 bristles; pleura, before the base of the wing, with 2 rows of 4 bristles each, the anterior shorter, the posterior longer. Scutellum with 4 bristles, sometimes with a supernumerary fifth on one side. Wing stumps with scarcely recognizable remnants of veins. Halteres whitish-yellow, large and fully developed. General shape of abdomen as in the typical species of *Echestypus*. First tergite lying as a pair of dark brown plates on the softer second tergite, on each side close to the hind margin with 4 thin, short setae. Hind margin of second tergite with a deep, pointed median notch which bears on each side 5 long and rather strong bristles, the sides with spaced, shorter setae. Behind this lie 4 tough, sclerotized tergites, with 3 corresponding softer, sharply defined pleurites. The tergites have a characteristic shape: III is almost entirely tough and sclerotized except for a whitish membranous portion which fills the pointed notch of tergite II, transversely rugose and dark brown; in the middle of its hind margin lies a somewhat semi-elliptical paler brown plate bearing 2 weak apical setae on each side; otherwise the tergite bears setae on the sides only, on each side 3 at the hind margin and 2 about midway before these. Two succeeding tergites similar, but the dark sclerotization is more restricted to the sides; the specially defined pale area is somewhat wider on IV and even more so on V, and bears on IV 2 setae and on V 1 seta, on each side; sides of tergite IV with only 3, of V without setae. Tergite VI without corresponding pleurite, forming a transverse plate, with 3 bristles on each side near the hind corners and two dark sclerotized lateral spots on the disk. Succeeding anal segment with 2 pairs of spiracles defining it as tergites VII + VIII, bare except for a ring of setae about the anal opening. Pleurite corresponding to tergite III with uniformly and widely spaced short setae; that corresponding to tergite IV setulose over anterior half only; that corresponding to tergite V bare, except for 2 setae at margin. The foregoing refers to the dorsal aspect of the pleurites; ventrally they are all uniformly covered with short setae, like the unsegmented venter. The dark brown basal sternite may be described as an equilateral triangle, whose hind corners extend posteriorly into semicircular (somewhat swollen) lobes so as to form a semicircular emargination; the hind and side margins, as well as the lobes, are entirely covered with short, spine-like bristles, while the basal half bears only a few weak bristles. The foregoing features are alike in both sexes, differences being present only in the genital area. In the male, the genital opening is flanked by two slight protuberances covered with the

usual setae of the venter; in the female, a broad, unguiform, somewhat tough and sclerotized plate lies before the genital opening and is very densely covered with rather fine setae, in 3 or 4 rows before its hind margin. Before this plate lies a smaller one, seemingly corresponding to the hind margin of a (VI ?) sternite, dark yellowish-brown and with 3 or 4 setae; and before this an irregular, double row of setae, not corresponding to the limit of a segment. Legs stout; coxae strongly setose; fore and mid femora somewhat thickened; hind femora with a conspicuous strong bristle on the fore side at the beginning of the apical third. Tibiae all nearly bare on the upper or dorsal side, with strong setae ventrally only."

2. *Echestypus sepiaceus* (Speiser). Figs. 14A-C and 15.

*Lipoptena sepiacea* Speiser, 1905, Zeitschr. Syst. Hym. Dipt., V, p. 353 (♀; Witu, Lamu and Wangi, Kenya; and Caffraria; no host). Bezzi, 1908, Bull. Soc. Ent. Italiana, XXXIX, (1907), p. 198.

*Echestypus sepiaceus* Speiser, 1907, Wiss. Ergebn. Schwed. Zool. Exped. Kilimandjaro, II, pt. 10, p. 3; 1908, Denkschr. Med.-Naturw. Ges. Jena, XIII, pt. 1, pp. 176 and 178. Austen, 1909, Illustr. African Blood-Suck. Flies, pp. 187 and 196. H. H. King, 1911, 4th Rept. Wellcome Res. Lab. Khartoum, vol. B, p. 126, Pl. VI, fig. 5 (♀; Kio, Anglo-Egyptian Sudan). S. A. Neave, 1912, Bull. Ent. Res., III, p. 320. Bezzi, 1916, Natura, Riv. Sci. Nat., VII, p. 178. W. B. Johnson, 1918, Nigeria, Ann. Med. Sanit. Rept. N.S. Prov. for 1917, p. 165 (Katagum, N. Nigeria; off *Gazella rufifrons* and *Cephalophus* sp.). Davey and Newstead, 1921, Ann. Trop. Med. Paras., XV, p. 461 (Upper Shire River, S. of Lake Malombe, Nyasaland; off *Strepsiceros strepsiceros*). Anderson, 1924, Kenya Med. J., Suppl. No. 1, p. 9. Bedford, 1927, 11th and 12th Repts. Dir. Vet. Res. South Africa, I, p. 782. Zavattari, 1930, Relazione della Missione Scientifica Eritrea, p. 71 of reprint (Barentu, Eritrea; off *Gazella tilonura*). Bedford, 1932, 18th Rept. Dir. Vet. Serv. An. Ind. South Africa, p. 421. J. Bequaert, 1940, Psyche, XLVII, p. 97, figs. 2 and 3 (♀ ♂).

?*Lipoptena cervi* E. A. Lewis, 1931, Ann. Rept. Dept. Agric. Colony Prot. Kenya for 1930, p. 162 (South Masai Reserve, Kenya; off Grant's Gazelle, *Gazella granti*). Not of Linnaeus, 1758.

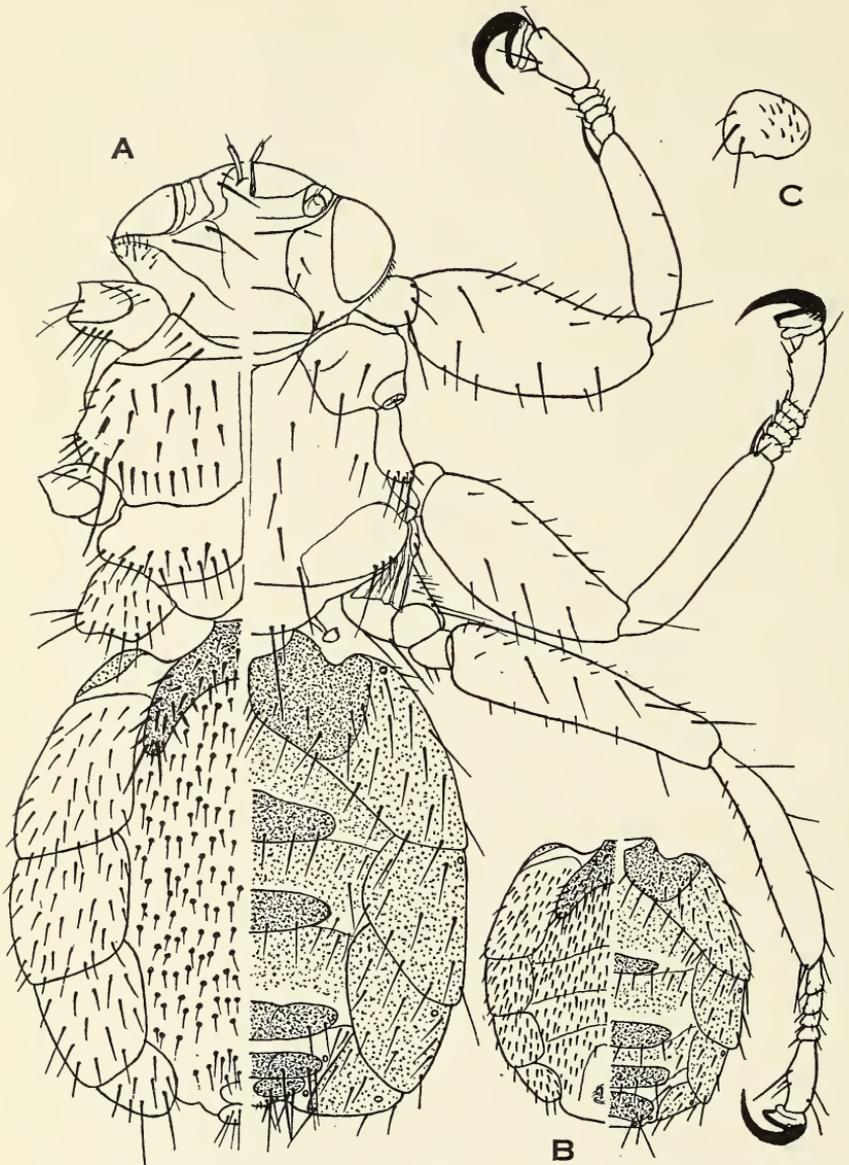


FIG. 14. *Echestypus sepiaceus* (Speiser): A, female, Bulukatoni, Uganda, from above (right) and below (left).—B, abdomen of male, same locality, from above (right) and below (left).—C, fore coxa from above.

*Echestypus* sp. J. J. Simpson, 1914, Bull. Ent. Res., V, pp. 24, 25, 30 and 35 (Gold Coast: Sawla, off *Cephalophus* sp.; Banda N'Kwanta, off *Cephalophus rufilatus*; Bandewa, off *Ourebia ourebi*).

*Female*.—Head moderately lengthened behind the eyes, which are rather wide; mediovertex as wide as long or slightly wider, about as long as postvertex and as fronto-clypeus. Clypeus completely fused with frons, the median longitudinal furrow rather short and ending in an elongate pit; pretilinal area distinct, but short; inner orbit narrower than the eye, with 2 or 3 setae, all far from the margin; one very long vertical bristle; postvertex rather long, flattened semi-circular. Palpi well developed, but much shorter than fronto-clypeus. Promesonotal suture distinct. Mesothorax: median notal suture weak over anterior two-thirds; no intrascutal grooves; transverse mesonotal suture weak, broadly interrupted medially; posthumeral suture well-marked; mesothoracic spiracle large, at latero-posterior edge of humeral callosity; 5 acrostichals in a curved row, some distance from middle line; 2 latero-centrals, close to notopleuron; 3 humerals; 3 postalars; two rows each of 3 or 4 notopleurals, those of hind row very long; two pairs of scutellars, the inner pair very long; ventrally, lobes of prosternum with 3 setae, one very long; mesosternum and hind half of basisternum with relatively few short setae, more or less in transverse rows. Abdomen: basal dorsal pleurite (I), large, transverse, with an irregular marginal row of setae and a few on the disk (fewer than in *E. paradoxus*); pleurites II to V well set off and somewhat sclerotized, with a few uniformly spaced setae (more numerous than in *E. binoculus*); five median tergal plates: first to third large and transversely elliptical, larger than in *E. paradoxus*, but smaller than in *E. binoculus*; fourth and fifth gradually smaller, the fifth divided into two sclerites; first and second with a transverse row of 5 or 6 setae near hind margin; third with 2, and fourth and fifth with 3 setae in each hind corner; remainder of dorsum membranous and extensible, showing traces of segmentation, with a few setae at the sides. Basal ventral sclerite deeply but broadly emarginate at apex, the lateral lobes of the crescent unusually long and narrow, with many heavy setae over most of the disk and along hind margin, two of them very long near the tip of each lobe; ventral portion of pleurites well set off, more or less sclerotized, with uniformly scattered setae; remainder of venter membranous, and with uniformly spaced

setae arising from thickened bases. Abdominal spiracles small, but distinct; spiracles VI and VII not enclosed in the fourth and fifth tergal plates. Legs moderately heavy, rather sparsely setulose; apical spur of fore tibia long and thick; mid tibia with 2 apical spurs, one of them very small; fore coxa dorsally with an oblique row of setae, one of them very long; claws very slender, slightly asymmetrical. Wing with the apical portion of the costa and the third longitudinal vein ending far from the tip without knob-like swelling.

*Male*.—Similar to the female in structure and chaetotaxy. Only four median tergal plates, corresponding to the first to fourth of the female, all slightly larger than in that sex. Terminalia with the parameres heavier than in *E. paradoxus*.

Length (h. + th.): ♀, 1.8 to 2.1 mm.; ♂, 1.7 to 1.8 mm.

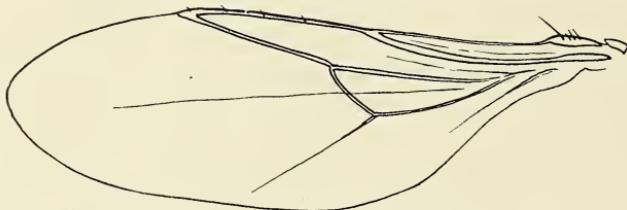


FIG. 15. *Echestypus sepiaceus* (Speiser), wing of female, Bulukatoni, Uganda.

**SPECIMENS EXAMINED.**—GOLD COAST: Sawla, off *Cephalophus* sp.; Banda N'Kwanta, off *Cephalophus rufilatus*; Bandewa, off *Ourebia ourebi quadriscopa*; Guripe, off *Cephalophus* sp.; all three localities North of the Volta River.—ANGLO-EGYPTIAN SUDAN: Dar-raba, Dinder River, off *Ourebia ourebi montana*; Mongalla Province, off *Ourebia ourebi ugandae* (T. W. Charley); Bongo, River Nile, Equatoria, off Abyssinian blue duiker, a race of *Cephalophus caerulus*.—UGANDA: Bulukatoni, West Nile, off *Tragelaphus scriptus*; Bulu District, off *Ourebia ourebi ugandae* (T. W. Charley).

**Distribution.**—*E. sepiaceus* is now known with certainty from the Gold Coast, Northern Nigeria, the Anglo-Egyptian Sudan, Eritrea, Uganda, Kenya Colony and Nyasaland. The only record for South Africa proper is based on the old specimen from "Caffraria," which Speiser included among the types. Perhaps it might be well to examine this fly more carefully, to see whether it is strictly conspecific with the cotype from Kenya Colony.<sup>43</sup> Like *E. paradoxus*, *E.*

<sup>43</sup> In case the Caffraria specimen was of a different species, I herewith restrict the name *sepiaceus* to the form represented by the type from Witu, Lamu and Wangi, on the coast of Kenya Colony.

*sepiaceus* is evidently an insect of the savanna and plains country of Central and East Africa, but it extends much farther west, across the Sudan. It should be looked for in French Guinea and Senegambia.

*Host Relations.*—*E. sepiaceus* has been definitely recorded from seven antelopes. The red-flanked duiker, *Cephalophus rufilatus* Gray, is strictly West African (Upper Guinea to northeastern Belgian Congo). The blue duiker, *Cephalophus caerulus* (Ham. Smith), occurs in several races in South and East Africa, as far north as the eastern Sudan. The distribution of the bushbuck, *Tragelaphus scriptus* (Pallas) and of the greater kudu, *Strepsiceros strepsiceros* (Pallas), are discussed under *E. paradoxus*, as these antelopes harbor both species of *Echestypus*. The ouribi, *Ourebia ourebi* (Zimmermann), occurs in several races in the savannas of most of Africa south of the Sahara. Heuglin's gazelle, *Gazella tilonura* (Heuglin), is restricted to the southeastern Sudan and Eritrea. The korin or red-fronted gazelle, *Gazella rufifrons* Gray, is peculiar to the western Sudan. An eighth probable host is Grant's gazelle, *Gazella granti* Brooke, which is found in East Africa from Southern Abyssinia to Tanganyika Territory.

*Original Description of Lipoptena sepiacea* Speiser (translated): "♀. Length, 3.8 to 4.2 mm.; from oral margin to scutellum, 2.2 mm. Russet-brown, with somewhat paler fore legs and bases of femora, and grayish-brown abdomen. Head rounded with large eyes, which are little narrower than high. Frontal vitta [medio-vertex] somewhat wider than long; lunula without fovea, defined by its paler leather brown color. Clypeus also paler brown at anterior margin, with a fine median line. Maxillary palpi short. Thorax somewhat paler brown on its fore portion than behind. Sculpture and chaetotaxy as usual. Metasternum half the length of mesosternum. Legs more or less pale chestnut-brown with dark knees and tarsal segments. Abdomen similar to that of *L. cervi* L. First tergite as usual only developed as two tough plates on the sides of the abdominal base, touching the second. Second less tough than in *L. cervi*, with wavy hind margin, retracted in the middle. Third tergite longer than in *L. cervi*, only weakly sclerotized at its anterior margin, which touches the emargination of the basal segments I and II; toughly sclerotized at the hind margin into a rectangular transverse plate, to which correspond the three succeeding, similarly shaped tergites. Basal sternite so deeply emarginate at hind margin that it consists only of two tongue-shaped diverging lobes, fused anteriorly over their whole width. Ventral side otherwise uni-

formly setose and only with a little tough and brownish sclerotization before the genital opening." This description was based upon two females at the Berlin Museum, one dry, labelled "Caffraria, Drège"; the other in alcohol, labelled "Witu, Lamu u. Wangi 23/8, 95, Denhardt." I have not seen the types. That Speiser's and my *sepiaceus* are the same is shown by the following statements in the original description: "Stirnstrieme etwas breiter als lang. . . . Maxillarpalpen kurz." It is further confirmed by the comparison drawn by Speiser (1907), in a key, between *E. sepiaceus* and his *E. parvipalpis* (= *paradoxus* Newstead).

3. *Echestypus binoculus* Speiser. Fig. 16.

*Echestypus binoculus* Speiser, 1908, Denkschr. Med.-Naturw. Ges. Jena, XIII, pt. 1, p. 176, fig. (♀ ♂; Kalahari, S. Africa; off *Raphicerus campestris*). Bezzi, 1916, Natura, Riv. Sc. Nat., VII, p. 178. Bedford, 1932, 18th Rept. Dir. Vet. Serv. An. Ind. South Africa, p. 420 (♀ ♂; Middelburg, Cape Province, off *Antidorcas marsupialis*). J. Bequaert, 1940, Psyche, XLVII, p. 101, fig. 4 (♀).

*Echestypus binoculatus* "Speiser" Aldrich, 1923, Insector Inscit. Menstr., XI, p. 77 (error for *binoculus*).

*Female*.—Head moderately lengthened behind the eyes, which are narrower than in the other species; mediovertex longer than wide, slightly longer than fronto-clypeus, and much longer than postvertex. Clypeus completely fused with frons, the median longitudinal furrow long and ending in an elongate pit; inner orbit broader than the eye, bearing a few (about 5) setae, all far from the inner margin; one very long vertical bristle; postvertex short and wide, flattened semi-elliptical. Palpi short, but distinct. Pro-mesonotal suture distinct. Mesothorax: median notal suture weak over anterior two-thirds; no intrascutal grooves; transverse mesonotal suture distinct; posthumeral suture well marked; mesothoracic spiracle large, at latero-posterior edge of humeral callosity; 5 acrostichals in a curved row over posterior two-thirds, some distance from middle line; only 2 latero-centrals, close to notopleuron; 3 humerals; 2 postalars; two rows each of 3 or 4 notopleurals, those of hind row very long; one pair of scutellars; ventrally, lobes of prosternum with 3 setae, one very long; mesonotum and hind half of basisternum with few, short setae, more or less in transverse rows. Abdomen: basal dorsal pleurite (I) large, squarish, with an apical row of 5 long setae and none on the



FIG. 16. *Echestypus binoculus* Speiser, female, Hoopstad District, Orange Free State, from above (right) and below (left).

disk; pleurites II to V well set off and somewhat sclerotized, with a few, uniformly spaced setae; five median tergal plates: first to fourth large, transversely elliptical; fifth much shorter and somewhat narrower than fourth; first to third with one long seta in each hind corner; fourth and fifth with a pair of long setae in each corner; remainder of dorsum membranous and extensible, showing traces of segmentation, bare. Basal ventral sclerite deeply but broadly emarginate at apex, the lateral lobes of the crescent unusually long and narrow, with relatively few heavy setae at and close to the hind margin and on the lobes; ventral portion of pleurites well set off, more or less sclerotized and uniformly covered with scattered setae; remainder of venter membranous and uniformly covered with spaced setae arising from thickened bases. Abdominal spiracles small, but distinct; spiracles VI and VII very close to, but not enclosed in the fourth and fifth tergal plates. Legs moderately heavy, rather sparsely setulose; apical spur of fore tibia long and thick; mid tibia with 2 apical spurs, one of them very small; claws very slender, slightly asymmetrical. Wing unknown.

Length (h. + th.): ♀, 2.1 mm.

*Male* not seen. It is described by Speiser.

**SPECIMEN EXAMINED.**—Orange Free State: Hoopstad District, one female, off *Raphicerus campestris*.

**Distribution.**—Known at present from the Kalahari, western Orange Free State and west-central Cape Province in South Africa.

**Host Relations.**—The few specimens known have been taken from two of the smaller antelopes: the steinbok, *Raphicerus campestris* (Thunberg), and the springbok, *Antidorcas marsupialis* (Zimmermann).

**Original Description of *Echestypus binoculus* Speiser** (translated): "Length, 3.5 to 4.5 mm.; from oral margin to hind margin of scutellum, 2 mm. Chestnut-brown, with some paler areas on head, basis of femora and humeral angles; membranous portions of abdomen pale umber-brown. Head rounded; eyes only slightly narrowed, about one and one-half times as high as wide. Orbits very wide, nearly as wide as the eye. Frontal vitta [mediovertex] somewhat longer than wide. Lunula without fovea. Clypeus [fronto-clypeus] paler than remainder of head, with a few brown cross-lines and a grooved, paler median line ending in a fovea medially between the antennae. Maxillary palpi, forming the sheath of the proboscis, short. Thorax dorsally and ventrally al-

most exactly like that of *Lipoptena* in shape and chaetotaxy. Scutellum with one pair of bristles. Knees somewhat darker brown than remainder of legs. See the generic description for wing-stumps and halteres. Abdomen shaped almost alike in ♂ and ♀, except that in the ♂ the limits of the segments are rather distinct on the venter also, while they are effaced ventrally in the ♀. Tergite I is only defined as two tough sclerotized plates in tergite II. This tergite II not as tough as in *Lipoptena*, with bow-shaped hind margin, which is, however, divided medially by a narrow notch to half-way its length from behind. Behind this lie four sclerotized plates, about alike in length and width, corresponding to the hind margins of tergites III to VI. The anterior margin of the first three plates is not straight, but produced anteriorly in the middle into a corner or tooth; they bear close to their hind margin on each side one seta. Fourth plate with straight anterior margin, sometimes with 2 setae on each side. Behind this a pair of almost square plates, bearing many setae at the hind margin corresponding together to tergite VII; behind this the soft anal segment. Ventrally there is no tough sclerotization outside the basal segment. Basal sternite narrow, consisting almost entirely (as in *E. sepiaceus*) of two narrow, tongue-shaped, diverging lobes, which widen medially where they fuse so much that it is in the ♀ about one and one-half times, in the ♂ almost twice as wide (correctly, long), as on the sides. The remaining sternites are indicated by somewhat darker sclerotization and the arrangement of the setae. In the ♂, on either side of the genital opening a small, scarcely raised knob, covered with thin setae." I have not seen the types and do not know their present location.

#### Genus *Melophagus* Latreille

*Melophagus* Latreille, 1802 (an X), Hist. Nat. Crust. Ins., III, p. 466 (monotypic for *Hippobosca ovina* Linnaeus, 1758); 1805 (an XIII), *op. cit.*, XIV, p. 402.

*Melophaga* v. Olfers, 1816, De Vegetativis et Animatis Corporibus in Corp. Anim. Reper., I, p. 99 (for *Melophaga hirtella* v. Olfers, 1816 = *Hippobosca ovina* Linnaeus, 1758; and *Melophaga trifasciata* v. Olfers, 1816 = *Pediculus cervi* Linnaeus, 1758. Type by present designation, *Melophaga hirtella*).

*Hippobosca* subgenus *Melophila* Nitzsch, 1818, in Germar's Mag. d. Entom., III, p. 311 (monotypic for *Hippobosca ovina* Linnaeus, 1758).

*Melophagus* Hoffmann, 1834, Verz. Ins. Latreille, p. 19 (misspelling of *Melophagus*).

*Mallophaga* Shuckard, 1840, On the History and Natural Arrangement of Insects, p. 379 (misspelling of *Melophagus*).

*Mallophagus* C. W. Stiles, 1901, Proc. Ent. Soc. Washington, IV, p. 491 (misspelling of *Melophagus*).

*Melaphagus* E. Pfeiffer, 1905, Zeitschr. Hyg. Infektionskrankh., L, p. 324 (misspelling of *Melophagus*).

*Malophagus* C. W. Johnson, 1925, Occas. Papers Boston Soc. Nat. Hist., VII, No. 15, p. 294 (misspelling of *Melophagus*).

Head broad, transversely elliptical; occipital margin strongly arched and inserted in the moderately concave anterior slope of the prothorax. Antennae short, subglobular, without dorsal prolongation, hidden in the antennal pits, which are completely surrounded by a rim; arista bifid at apex, each branch divided into comb-like processes. Eyes narrow, oblong, with relatively few and large ommatidia (in *M. ovinus* about 135, according to Jobling, 1926), mostly on the dorsal side of the head, the short anterior region ventral. No ocelli. Frontoclypeus semi-circular, with truncate anterior margin; postvertex over twice the length of the mediovertex, which is very narrow owing to the great extent of the inner orbital sclerites. Palpi well developed, either very long or short. Thorax: dorsally, pronotum faintly divided from mesonotum; median notal suture barely indicated; no intrascutal grooves; transverse mesonotal suture only weakly indicated at the sides; humeral callosities not limited behind, the humeral angles more produced forward than in *Lipoptena*, but broadly rounded off; scutellum small, convex, not extending toward the sides; all four thoracic spiracles unusually large; ventrally, lobes of prosternum very far apart, with only a narrow median connection; mesosternum and metasternum of about equal length. Wings rudimentary (Fig. 18C), reduced to small, elongate, sclerotized knobs, which bear a few short setae apically; these knobs were mistaken for rudimentary halteres by Pratt (1893), but Stange (1907) followed their development from the imaginal wing disks of the larva; they are inserted on either side of the dorsum above the upper corner of the metathoracic spiracle. Halteres wanting; imaginal disks of the halteres are present in the larva, but disappear during pupation, according to Stange (1907).<sup>44</sup> Legs

<sup>44</sup> The absence of halteres is not as exceptional in Diptera as was believed formerly. It is often observed in completely apterous species (Bezzi, 1916, *Natura*, Riv. Sci. Nat., VII, pp. 109-110).

short and thick, the femora much swollen; claws distinctly asymmetrical in each pair, one claw being longer, though not appreciably thicker than the other; fore tibia with one stout apical spur; mid tibia with two spurs, one longer than the other. Abdomen alike in both sexes; dorsally with a pair of transverse basal plates, narrowly separated medially (pleurites I); ventrally with a thick, crescent-shaped basal plate; remainder of abdominal integument membranous and extensible, without

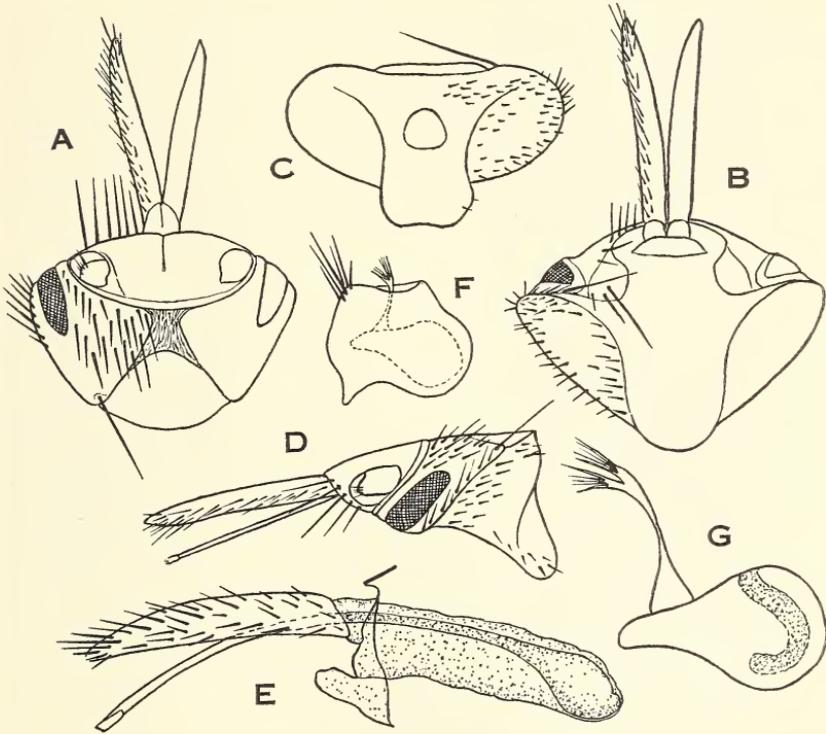


FIG. 17. *Melophagus ovinus* (Linnaeus): A-D, head of male from above (A), below (B), behind (C) and the side (D).—E, mouth parts from the side.—F, antenna.—G, third antennal segment.

differentiated or sclerotized areas in *M. ovinus*, except for the small genital and anal sclerites; in *M. rupicaprinus* with one or two median tergal plates near apex. Seven pairs of unusually large abdominal spiracles, the first in the sides of pleurites I.

*Classification.*—Although only two species of *Melophagus* are known at present, they differ so much, particularly in the structure

of the abdomen, that they should be placed at least in distinct subgenera.

1. Subgenus *Melophagus*, proper.—Monotypic for *Hippobosca ovina* Linnaeus, 1758. Abdomen dorsally without sclerotized plates, except for the two basal pleurites I. Palpi as long as the height of the head.

2. Subgenus *Dorcadophagus*, new.—Monotypic for *Melophagus rupicaprinus* Rondani, 1879. Abdomen in both sexes dorsally with one or two median tergal plates, placed close to the apex, in addition to the usual pair of sclerotized basal pleurites I. Palpi less than half the height of the head. These characters indicate that *M. rupicaprinus* is somewhat more primitive than *M. ovinus*, and represents one of the stages connecting the wingless and winged Melophaginae. The structure of head and thorax is, however, essentially the same in the two species, while the somewhat reduced chaetotaxy of *M. rupicaprinus* is believed to be of specific value only.

KEY TO SPECIES OF MELOPHAGUS

1. Inner orbit mostly covered with many setae; usually one pair of vertical bristles. Palpi as long as the height of the head. Abdomen without median tergal plates

*M. ovinus*.

Inner orbit mostly bare, with only 3 to 5 setae over inner half; three pairs of vertical bristles. Palpi slightly shorter than fronto-clypeus. One or two median tergal plates toward the tip of the abdomen ..... *M. rupicaprinus*.

Subgenus *Melophagus*, proper

1. *Melophagus ovinus* (Linnaeus). Figs. 2, 3A-C, 17A-G and 18A-D.

[*Pediculus reduvius* Moufet, 1634, *Insectorum sive Minimorum Animalium Theatrum*, p. 272, fig. (adult; England). Charleton, 1668, *Exercitationes de Differentiis et Nominibus Animalium*, p. 49].

[*Pediculus ovinus* John Ray, 1710, *Historia Insectorum*, p. 9]. ["Schaf-Lauss" Frisch, 1724, *Beschreibung von Allerley Insecten in Teutschland*, V, p. 40, Pl. XVIII, figs. 1-2 (adult and puparium; Germany)].

[*Hippobosca aptera* Linnaeus, \*1747, *Wästgöta Resa Foerrättad* 1746, p. 59 (southwestern Sweden); 1748, *Syst. Nat.*, 6th Ed., p. 65; 1754, *Amoenit. Academic.*, IV, p. 166 (*Dissertatio Oves Adumbrans*, p. 22)].

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(To be concluded in number 4)

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## A MONOGRAPH OF THE MELOPHAGINAE, OR KED-FLIES, OF SHEEP, GOATS, DEER AND ANTELOPES (DIPTERA, HIPPOBOSCIDAE)

BY J. BEQUAERT

(Continued from number 3)

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Although the foregoing bibliography is extensive, it is as yet far from complete. With very few exceptions, marked with an asterisk, I have omitted references which I was unable to consult in the original.

*Female*.—Eye small and narrow, of relatively few facets, with an unusually large ventral portion; mediovertex very small, about as long as wide or somewhat narrower, much less than half the length of the fronto-clypeus; clypeus completely fused with frons, its extent only indicated by the very fine anterior median furrow which ends behind in a deep fovea; pretilinal area indistinct, without fovea; inner orbit very extensive, the postocular portion longer than the eye, its width between four and five times that of the eye, mostly covered with many (18 to 22) stiff, unequal, irregularly scattered setae; none of the setae are very long and they do not extend behind the eye; one very long vertical bristle; postvertex broadly and irregularly elliptical, less than twice as wide as long, the occipital margin bow-shaped, the fore margin broadly rounded; outer orbit nearly as wide as the eye, with a row of heavy setae, which continues below. Palpi very long, about as long as the height of the head. Pro-mesonotal suture distinct but weak; suture between pronotum and propleuron weak. Mesothorax: median notal suture barely indicated; no longitudinal intrascutal grooves; mesonotal and posthumeral sutures lacking; notopleuron incompletely limited behind by a very weak suture; mesothoracic spiracle unusually large, placed dorsally close to the side; notum mostly covered with many irregularly scattered unequal setae, in which the several groups cannot be distinguished; a bare lateral area behind the mesothoracic spiracle, extending somewhat medially; prominent longer bristles at hind margins of notopleuron and mesoscutum; usually 8 scutellars, rather irregularly placed in a transverse group near the hind margin of the scutellum; ventrally, lobes of prosternum,

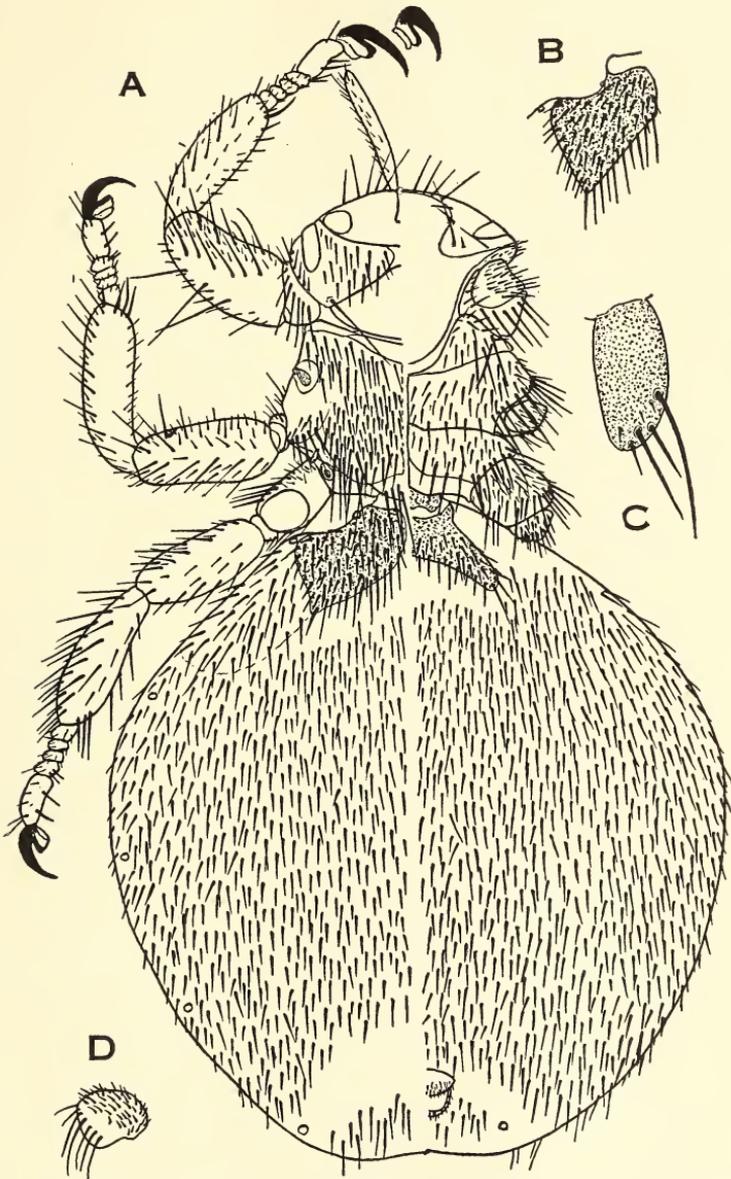


FIG. 18. *Melophagus ovinus* (Linnaeus): A, female, Midland Co., Michigan, from above (left) and below (right).—B, basal pleurite (I) of male, Bogotá, Colombia.—C, wing rudiment.—D, fore coxa from above.

mesosternum and basisternum covered fairly uniformly with short setae and a few longer bristles, the latter mostly at the sides of the mesosternum and the hind margin of the basisternum. Abdomen: only the basal dorsal pleurites (I) sclerotized, forming irregular, oblique, nearly rectangular plates, with rather blunt outer hind corners, covered with scattered short setae and a few longer ones along the hind margin. Pleurites II very weakly or not indicated; remainder of segmentation shown only by the arrangement of the abdominal spiracles. Basal ventral sclerite crescent-shaped, with very shallow apical inward curve, the lateral lobes long and straight, mostly covered with short stiff setae and with longer bristles along the hind margin; no other ventral sclerotized areas, except for the small anal and genital sclerites. Integument of abdomen densely covered, dorsally and ventrally, with stiff setae of medium length; the pre-anal dorsal and ventral areas partly bare. Legs very heavy, strongly setose; apical spur of fore tibia thick, flanked by two shorter heavy bristles; apex of mid tibia with a transverse row of four heavy bristles; claws heavy, slightly asymmetrical.

*Male*.—Scarcely different from the female. Usually 10 scutellar bristles. Setae of abdomen somewhat longer and usually appearing denser, because the abdomen does not distend as much as in the female. Basal dorsal pleurite (I) of abdomen with the outer hind corner drawn out into a sharper angle than in the female, but its shape varies even within a series taken from one host. Terminalia: parameres heavy, straight, gradually narrowed to a point; aedeagus narrowly conical, ending in a blunt, somewhat notched tip.

Length (h. + th.): ♀, 2 to 2.5 mm.; ♂, 2.2 to 2.4 mm.

SPECIMENS EXAMINED.—CROATIA: Zengg.—POLAND: Wienbica.—SARDINIA: Siliqua.—IRELAND.—THIBET: Yatung, off a cow.—BELGIAN CONGO: Dolo, off recently imported sheep (J. Rodhain).—ALASKA: East Fork, Mile 42, McKinley National Park, one female, off a wolf (F. W. Morand); Robertson River, an affluent of the Yukon, without host (O. J. Murie).—Alaska-Yukon Boundary, without more definite locality, off "mountain sheep" (cotypes of *M. o. montanus*).—DOMINION OF CANADA: ONTARIO: Guelph.—BRITISH COLUMBIA: Riske Creek, Chilcotin (G. J. Spencer); Fraser Valley, off coyote (G. J. Spencer); Vancouver (R. A. Cumming; G. J. Spencer).—UNITED STATES: MAINE: Orono; Mt. Desert.—NEW HAMPSHIRE: Durham.—MASSACHUSETTS: Athol (P. Doneilo); Bos-

ton; West Newbury; Amherst; Chester.—CONNECTICUT: Ashford; Storrs.—NEW YORK: New York stockyards, off imported Montana sheep (K. W. Cooper).—PENNSYLVANIA; Philadelphia; West Chester (Leidy).—OHIO: Marshalville (L. J. Lipovsky); Morral, Marion Co. (D. Washburn).—ILLINOIS: Urbana.—MICHIGAN: Detroit; Henderson (L. J. Lipovsky); Midland (R. R. Dreisbach).—MINNESOTA: St. Paul.—KANSAS: Douglas Co. (Kansas Univ.).—IOWA: Des Moines Co.; Henry Co.; Iowa Co.; Davis Co.; Kossuth Co.; Ringgold Co.; Monroe Co.; Van Buren Co.; Mt. Pleasant (all sent by H. E. Jaques).—TEXAS: Menard Co. (J. E. Gillaspay); Sonora, Sutton Co. (O. G. Babcock).—NEW MEXICO: Albuquerque.—UTAH: Grantsville (H. R. Hagan).—STATE OF WASHINGTON: Wawawai (R. D. Shenefelt); Pullman; Kiona.—NEVADA: Emigrant Sta., Eureka Co.; Las Vegas, Clark Co.; Reno; Pyramid Lake, Washoe Co.; Desert Ranch, Elko Co.; Fishlake Valley; Ely, Whitepine Co.; Elko; Mt. Ingalls, Pershing Co.; Lake Tahoe; Long Valley, Washoe Co. (all sent by I. La Rivers); Lander Co., off a domestic goat running with sheep (W. L. Jellison).—MONTANA: Bozeman; Gallatin Co.; Helena; French Basin, Ravalli Co.; Bitter Root Valley (H. Colfer).—CALIFORNIA: Stanford University.—MEXICO: without more definite locality (Dr. Valadez); Guanajuato, State of Guanajuato (Kansas Univ.).—PANAMA: Chitre (L. H. Dunn).—COLOMBIA: Bogotá (L. M. Murillo).—ECUADOR: Mt. Chimborazo.—CHILE: Puren, Malleco (Chas. Wilhelm).—BOLIVIA: Oruro (cotypes of *M. ovinus bolivianus*).—All of domestic sheep, unless stated otherwise.

*Distribution.*—It is commonly believed that *M. ovinus* is now cosmopolitan, under the assumption that it should occur wherever domestic sheep are kept; but this is far from being the case. So far as can be ascertained, the sheep-keed has not become established in the hot and moist tropical parts of the world on sheep kept there permanently. Sometimes it is seen there on animals recently imported from more temperate regions, but seemingly dies out soon after arrival. Within the tropical belt, however, it is a permanent parasite in the cooler highlands (high plateau of Kenya in East Africa; tierra templada of Mexico; Andes of South America), where it may be found at altitudes up to 3,700 meters.

From specimens seen and reliable published records, the breeding range of the sheep-keed appears to cover at present most of Europe, as far north as Lapland, with definite records from England, Scotland, Ireland, Iceland, the Faroës, Norway, Sweden, Lapland, Russia, Poland, Denmark, Germany, the Netherlands, Belgium, France, Spain, Switzerland, Austria, Czecho-Slovakia,

Bulgaria, Jugoslavia, Greece, Italy, Sardinia, and Sicily; northern Africa (Morocco; Tunis; Cyrenaica); Palestine (very rare, according to Theodor, 1928, and Aeschner, 1931); Cyprus; Central Asia (Turkestan; Mongolia; Thibet); Japan; northern India; eastern Africa (highlands of Kenya), the Union of South Africa (Cape Province; Orange Free State; Basutoland; Transvaal); Australia, Tasmania, and New Zealand; Hawaii; much of North America, with definite records from Alaska (Chitina River.—Dept. Agric. Ottawa; see also records listed above), British Columbia, Alberta, the State of Washington, Oregon, California, Nevada, Montana, Wyoming, Utah (common, according to a mimeographed list of Diptera by G. F. Knowlton, F. C. Harmston and G. S. Stains, 1939), Colorado, New Mexico, Oklahoma (records sent by D. E. Howell: Cordell, Washita Co.; Tomkawa, Kay Co.; Ponea City, Kay Co.; Dustin, Hughes Co.; El Reno, Canadian Co.; Chikasha, Grady Co.; Boise City, Cimarron Co.; Stillwater, Payne Co.; McAlester, Pittsburg Co.; Cache, Comanche Co.), Nebraska, Kansas (Riley Co.; state-wide but not a major pest, according to R. H. Painter), Iowa, Minnesota, Illinois (on 81% of the farm flocks examined in the southern counties, according to McCauley and Russell, 1940), Michigan (according to C. B. Dibble, throughout the state, but rather uncommon in the Upper Peninsula; in the Southern Peninsula, more abundant in the northern half, approximately north of a line drawn from Bay City to Muskegon), Ohio, Kentucky (relatively abundant throughout the state, according to information received from L. H. Townsend), Texas, southern Ontario (common in Grey Co. according to F. P. Ide; widely distributed as far east as Kingston, according to M. Fallis; reported from Ottawa and Essex Co., according to Dept. Agric. Ottawa), and southern Quebec (Oka near St. Eustache, according to Father Leopold; vicinity of Montreal, Hemmingford and Masson, according to Dept. Agric. Ottawa); Mexico (highlands only); Panama (perhaps on newly introduced animals only); the highlands of Colombia, Venezuela, Ecuador, Peru (according to S. H. Gaiger, 1917, *Jl. Comp. Path. Therap.*, XXX, p. 187, common in the Peruvian Andes at altitudes above 10,000 ft.) and Bolivia; Chile; southern Brazil (Sa Catharina); Uruguay; and Argentina (as far south as Patagonia). It has also been reported reliably in the eastern United States from Maine, Vermont, New Hampshire, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland (U. S. Bur. An. Ind.), Washington, D. C. (U. S. Bur. An. Ind.), Virginia (U. S. Bur. An. Ind.), West Virginia, and North Carolina. Just how much of this territory

should be included in the present-day breeding range is doubtful, as several of the records are clearly based on keds taken in stockyards or slaughter-houses; others may be from animals recently imported from farther west to strengthen existing flocks. In such cases the keds may perhaps pass temporarily to local sheep, only to die out eventually if no new insects are imported.

In the Pacific Islands, the sheep-ked has only been taken on two occasions in the island of Hawaii, but under conditions indicating clearly that the insect is well established there on the feral sheep derived from introduced domestic animals. Muir (1928) first mentioned it as taken on a bag of seed collected in the forest near a sheep run at Honohina, Hawaii, in December, 1926. Concerning this find, Mr. R. H. Van Zwaluwenburg writes me as follows: "The region in question is very inaccessible, and that there are no subsequent records of the species may merely be because no one has definitely searched further for the fly. The circumstances of the find are somewhat obscure, but the fact that the finding of *Melophagus* was so purely incidental suggests that it may be established on the wild sheep which are so numerous in the region (elevation: some 5,000 feet)." Swezey and Williams (1932) later found one sheep-ked at Keanakolu, Hawaii, "in the saddle-house." In reply to a request for further information, Dr. F. X. Williams writes: "Sheep found within the forest reserve may be shot by the rangers. The ked Mr. Swezey took in 1931 was found on a saddle in a saddle house. Our guide had shot a sheep or two and brought them down on his saddle."

Some published records from other parts of the world are either doubtful or based on temporary introductions. The specimens which I list from Dolo (in the Lower Belgian Congo), were taken by Dr. J. Rodhain on sheep recently imported from Europe. I have never seen keds on the sheep commonly kept by the natives in the Congo or in other parts of tropical Africa I visited. Le Roux (1939) also states definitely that, in Northern Rhodesia, keds are found only on imported sheep. Anderson (1924) reports finding them in the highlands of Naivasha (Kenya), but does not state whether on imported sheep or on animals kept by natives. Wolcott's catalogue of Puerto Rican insects (1936) lists *M. ovinus*; but from information received, it was included from a manuscript record which could not be traced to an actual specimen. Van Volkenberg (1939) expressly mentions that he was unable to find it in Puerto Rico and there is no other record from the Antilles. Dr. J. Pérez Viguera in a recent letter (1941) definitely states that it has never been found in Cuba.

The foregoing discussion is intended to stress the fact that the true world breeding range of the sheep-ked calls for further investigation, although it seems certain that this parasite does not exist or is only accidental in many countries where domestic sheep are nevertheless kept. We are as yet in the dark as to why this should be. The most obvious possible cause is, of course, the influence of climatic conditions, particularly of temperature and moisture. While these may be at least partly responsible for the absence of keds in moist tropical areas and in many oceanic islands, it would seem that in the deeper layer of the fleece, where they usually keep, these insects are effectively protected against unfavorable atmospheric conditions. For this reason I suspect that the many and wide differences in the texture, length, denseness and moisture of the fleece among different breeds of sheep may play a more important rôle. I have found in the literature a few statements that certain breeds of sheep are relatively free of keds. Imes (1917, p. 8) writes: "Open-fleece sheep, such as the coarse-wool and medium-wool breeds, are subject to the ravages by the tick [meaning "ked"]. The fine-wool sheep usually are not affected to any great extent as the parasites do not seem to be adapted to existence in the greasy tight fleeces of such breeds." It should also be kept in mind that the absence or scarcity of keds in a district may be artificial and due to efficient dipping, steadily carried out for many years, particularly where no reinfestation is possible by sheep imported from infested areas. It has been claimed that, in the same district, keds increase faster in certain years than usual.

*Host Relations.*—Nowadays the normal breeding host of *M. ovinus* is the domestic sheep, *Ovis aries* Linnaeus, either kept or gone feral; but I have pointed out that, contrary to general belief, it is by no means universal on this host. Moreover, domestic sheep are thus far the only breeding host known with certainty. No doubt the parasite originally came from some wild ancestor of the domestic breeds of sheep. Hase (1940) writes: "*Melophagus* lives of course also on wild sheep;" but, while this statement is theoretically correct, actual information in the matter is extremely scant. In fact, I am acquainted with only two records of sheep-keds possibly taken from wild sheep, and both are inadequate. I have seen two specimens, which I refer unquestionably to *M. ovinus*, labeled as taken from a museum skin of Marco Polo sheep, *Ovis ammon poli* Blyth; but the locality or origin of the skin are not given and it may have come from an animal kept in a zoological park, where it acquired the keds from domestic sheep. The second record concerns the re-

ported occurrence of *M. ovinus* on native American wild sheep. This I shall discuss in some detail later; but I may point out that the American wild sheep could scarcely be included among the ancestors of domestic sheep, and are therefore ruled out as the possible original breeding hosts from which the domestic animals acquired their keds. Speiser's (1908) incidental mention of the "Steinbock" of the Caucasus as the host of his *M. ovinus* var. *fera*, would, if correctly labeled, refer to a species of wild goat. Speiser suggested that these parasites were possibly the ancestral stock of *M. ovinus*; but it is highly improbable that domestic sheep would have acquired their keds from a species of wild goat.

*M. ovinus* has been found under natural conditions on a variety of stray hosts: domestic goat, on which it was first recorded by Macquart (1847); domestic cattle; aurochs, *Bos bonasus* Linnaeus (Wrublewski, 1912); camel (Olenev, 1931); domestic horse (Charbonnier, 1912); domestic dog; Alaskan wolf, *Canis lupus*, subsp.; North American coyote, *Canis latrans* Say; and man.<sup>45</sup> On some of these hosts keds are taken more often than on others. They are not very rare on domestic goats, which often live closely associated with sheep; but it is not known whether sheep-keds survive for any length of time or are able to breed on goats. Pullar (1937) reports a case of a calf, in Australia, infested with 50 to 60 adult sheep-keds and 20 to 30 puparia attached to the under side of the neck. This animal had been kept in close association with infested sheep.

The reported occurrence of *M. ovinus* on native North American wild sheep calls for some further discussion. Ferris and Cole (1922) described a special race of sheep-ked (*M. o. montanus*) from specimens taken by the late C. G. Hewitt on "mountain sheep" of the Alaska-Yukon Boundary, which the authors assumed were native wild sheep. Recent authorities recognize two species of native American sheep: the true bighorn, *Ovis canadensis* Shaw, occurring in several races from British Columbia to Lower California; and the Alaskan or thin-horned sheep, *Ovis dalli* Allen. It is difficult to ascertain how frequent keds are nowadays on these American wild sheep. Mr. W. L. Jellison informs me that he examined three of them in Montana (Lincoln Co. and the U. S. Bison Range at Moiese) without finding keds, and that Dr. C. B. Philip

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<sup>45</sup> Velu and Barotte (1924) also include the South American alpaca among the hosts, but I am unable to find on what evidence. Massonat's (1909) and Bornand's (1936 and 1939) records from chamois were based on *M. rupicaprinus*.

also failed to find them on one he examined in Alaska. Mr. I. McT. Cowan writes me that he never saw a sheep-ked on the few freshly killed *Ovis canadensis* he examined. As shown in the discussion following the copy of the original description, I am unable to recognize *montanus* as a distinct race of *M. ovinus*. I suspect that the few keds occasionally found on native American sheep were acquired from domestic sheep and that *Melophagus ovinus* is a recent importation from the Old World within historic times and not an indigenous insect. It should be remembered that native wild sheep were formerly abundant in the Rocky Mountains, from northern Mexico to Alaska, extending even into northeastern Siberia. There seems to have been plenty of opportunity of their acquiring ectoparasites by mingling with straying domestic sheep. Some breeds of sheep tend to roam away from domestication and easily turn feral. Moreover, it is generally believed that the bighorn acquired from domestic sheep another ectoparasite, the sheep-scab mite, *Psoroptes ovis* (Hering), which has played great havoc among them.

Sheep-keds often bite shepherds, sheep-shearers and other people who handle fresh wool or fleece. Zetterstedt (1848) states that the bite causes in man a swelling similar to that following tick bite. People who are bitten frequently become immunized against the bite, the skin no longer showing a reaction. Curtice (1890), Fantham and Porter (1913), Brumpt (1913), Galli-Valerio (1921), Jobling (1926), and Freund and Stolz (1928) found that *M. ovinus* can readily be made to bite man in captivity; while Brumpt fed it also on monkeys, domestic fowl and domestic pigeon, and Cauchemez (1912) on guinea pig. Although Curtice kept keds alive for nearly two weeks, feeding them on the back of his hand, they die as a rule in a few days and very rarely breed when fed on abnormal hosts. Jobling observed the method of feeding on man under the dissecting microscope: "Before the ked starts feeding it must attach itself to the host. As the human skin is very poor in hair much time is required before the ked becomes fixed. The ked then protrudes the haustellum between the maxillary palps, applying the end of the labellum to different points of the skin, apparently in search of a suitable spot for piercing. When such a spot is selected the insect pushes its proboscis against the skin with such force that the middle part of the haustellum bends into a bow. Sometimes in piercing the ked twists the haustellum as one twists an awl. Immediately afterwards there can be observed forward and backward movements in the labellum, the distal part of the proboscis

rapidly penetrating into the skin. The haustellum penetrates into the skin as far as two-thirds of its length. The appearance of a red spot under the vertex indicates the blood being sucked through the pharynx into the oesophagus. All the keds fed under observation were gorged in about 10 minutes after the appearance of the red spot in the region of the oesophagus. It has also been observed that forcible removal of the feeding ked involves the risk of tearing off the haustellum, as it is fixed by the everted prestomal teeth to the bottom of the hole formed in the skin. I felt no irritation during the feeding of the sheep-keds but four or five days later small yellowish papules made their appearance. Each had a very minute opening through which serum exuded. The irritation caused by these papules is not very severe but they heal very slowly, disappearing three or four weeks after the feeding of the insects."

*Life-History.*—As may be seen from the extensive bibliography, there are many accounts of the sheep-ked in textbooks and Agricultural Reports or Bulletins; but most of these are second-hand. Apart from the meagre information given by the early writers, the only original investigations I am acquainted with are by Curtice (1890), Swingle (1913), Mote (1914 and 1922), Sweet and Seddon (1917), Imes (1917), Miller (1918), Hoare (1923), Freund and Stolz (1928), and Seddon and Blumer (1932).

*M. ovinus* is a permanent ectoparasite, the entire life time being normally spent on the same individual host; but adult keds may pass onto other sheep when these animals come in close contact. In this way they spread from the ewes to the lambs. In cold weather they keep close to the skin, but on warm days they often crawl over the surface of the wool, when many are eaten by the sheep and some are brushed off. There is, however, no evidence that keds ever wander away deliberately some distance from one host in search of another, even after the host dies; or that they are able to direct themselves to a host if they happen to drop to the ground. Shepherds often believe that keds migrate after shearing time from the bare adult sheep to the unshorn lambs, but there is no proof of this actually happening, unless the lambs come in direct contact with the adult sheep. Keds may occur on all parts of the body, but seem to favor the neck and belly, where most of the puparia are also found. The fleece in which the keds hide differs in several respects from the usual hair-coat of other Pecora, and is no doubt in large part responsible for the apterous condition of the adult and its unique habit of gluing the puparium to the fur. In wild sheep, the original hosts of *M. ovinus*, the fleece consists of two types of hair.

The longer and coarser hairs are loose and differ little from those of other Pecora. But, close to the skin, there is a deeper layer of soft, short hairs, or wool, impregnated with so-called yolk, suint or wool-oil, a peculiar fatty secretion of the sebaceous glands.<sup>46</sup> The keds live in this moist under-fur and need the unusually long haustellum in order to reach the skin through the twisted and glued mass of soft hairs. If wings were present at any time, the sheep-ked could obviously not move about without getting them stuck to the oily under-fur. Complete apterism in turn called for a puparium adhering to the host, as otherwise newly hatched keds could scarcely ever reach a host. As compared with ticks, keds are at a great disadvantage in this respect, because the female produces very few young and because the adult has to feed soon after hatching and dies within a few days away from the host. The peculiarities of the fleece produce conditions of body temperature and humidity to which the sheep-ked is now completely adapted and without which it cannot thrive.

In domestic breeds of sheep the fleece has been altered in various ways by selection. In many tropical breeds the coat differs little from that of wild sheep. In other breeds, however, particularly those of temperate and cold climates, the adult coat consists mostly or entirely of wool, the soft hairs of the under-fur having grown longer, with a more copious secretion of yolk, while the coarse hairs have disappeared. These changes are more or less complete in different breeds, and, as I have suggested before, may have much to do with the presence, absence or scarcity of keds in different parts of the world.<sup>47</sup>

Curtice and Swingle, in North America, concluded that keds, when removed from sheep and exposed to normal atmospheric conditions, die within 3 or 4 days. In carefully controlled experiments, in Australia, Sweet and Seddon found that, away from the host, keds lived 2 to 11 days. They appear to stand dryness and lack of food best when the temperature is moderately cool and uniform. Moisture is required if extremes of temperature are to be withstood. In shorn or shed wool, life is always short and seems to

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<sup>46</sup> When extracted from the wool and purified this substance is known as lanolin.

<sup>47</sup> A great deal has been written on the fleece and wool of sheep. A fairly up-to-date résumé may be found in the following paper: J. E. Duerden. 1929. The zoology of the fleece of sheep. South African J. Sci., XXVI, pp. 459-469, Pl. III.

be little influenced by the state of nutrition. Hill, in Australia, experimented with large numbers of adults, unfed and fed, as well as of different ages, and under a variety of conditions. He concluded that they may survive away from the host longer than had been generally believed. One ked, kept in a cellar, lived for 18 days; two for 14 days under similar conditions; a few others, under more natural conditions, for 11 to 13 days. These were, however, exceptional individuals, for his tables show that 75% to 80% of the keds died within 1 to 6 days.

The keds are also well protected against potential enemies by the fleece. When the hairs or wool are long, the keds spread over the entire body; but when they are short, they move toward the neck where the sheep cannot reach them with the teeth. After shearing, the few keds not removed with the wool, are killed either by exposure to the direct rays of the sun or by starvation, being unable to get a firm hold on the bare skin before feeding. Those that drop off in most cases soon die. At this time too they may be eaten by certain birds. In Europe, Modeer (1785) stated that crows will eat them; while, according to Girard (1885) and others, starlings (*Sturnus*) follow the flock of sheep in order to feed on the keds; and Neumann (1888) includes the wagtail (*Motacilla*) among their enemies. As is often the case with ectoparasites, their chief enemy, however, is the host itself, which bites or licks many of them out of the fleece. *M. ovinus* is not known to have an arthropod parasite either in the adult or pupal stage. Its several unicellular endoparasites, fully discussed in the sequel, seem to do little if any harm to their host.

As most of the sutures between the thoracic sclerites have disappeared and the exoskeleton is very strongly sclerotized, sheep-keds are even more secure against mechanical injury than other Hippoboscidae. This is well illustrated by Haimbach's account of the "Vitality and power of resistance of the sheep tick, *Melophagus ovinus*" (1907): "Being interested in a woolpulling establishment, I have had the opportunity of observing the terrible punishment inflicted upon the sheep ticks [keds], after the sheepskins are brought into the shop,<sup>48</sup> and how they come out whole and very much alive after said punishment. The skins are brought in all day up to six o'clock P.M., and are put into large cement vats with running water, in which the skins are totally submerged; they re-

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<sup>48</sup> The skins were obviously brought in to the shop when still fresh, shortly after being removed from the animals. [J. B.]

main in these vats over night, and the following morning are run through a scrub machine, a machine for cleaning the wool, with steel blades on a cylinder, revolving nine hundred times per minute; these blades and the force of water make the wool as white as the driven snow, taking out burs and dirt. The skins are then put into a hydro-extractor revolving twelve hundred times a minute, from which the skins come out very nearly dry; they are then painted on the pelt side with a very strong solution of sulphide of sodium, folded wool out, and laid in piles twelve high; in this position they remain for at least twenty-four hours, when they go to the pullers' beams, and it is here that the pullers have their troubles, for unless they see the ticks first, the latter will get under their clothing wherever there is a chance, and try to make up the time lost in the two or three days' fast. They finally succumb, however, after the wool is pulled and goes into the drying machine, where the temperature is two hundred and fifty degrees Fahrenheit."

The puparium is described in the section dealing with the development of *Melophaginae*. It is attached to the wool by means of a glue-like substance, which dissolves readily in water, yet hardens upon drying and is often encrusted with dirt. Most puparia are placed from half an inch to an inch from the skin, so that they are usually removed by shearing. The length of the incubation period depends upon the temperature. In Swingle's experiments, carried out in Wyoming where summers are cool and winters severe, puparia kept on sheep under as natural conditions as possible, hatched in from 19 to 23 days in summer and in from 20 to 36 days in winter. Raising the temperature did not appreciably shorten the incubation period, but at lowered temperatures, away from the host, puparia did not hatch in less than 39 to 46 days. Mote, in Ohio, found that his puparia hatched in from 10 to 14 days, the shorter incubation period being no doubt due to the warmer summer of that part of the country. In Victoria (Australia), where the winter is mild and the summer hot, Hill found that incubation lasted 22 to 24 days in winter and 19 to 21 days in spring. This investigator also carried out some experiments to determine the viability of the pupa when removed from the host. When sheltered and incubated at 64.4° F. to 82.4° F., all hatched between the 10th and 26th day. Under less favorable conditions, particularly of temperature, a large proportion died. Placed on sand out-of-doors or on earth in a cellar, very few or none survived.

Soon after hatching, the ked starts feeding and its diet consists of blood only. It has been claimed that it feeds also upon the yolk

of the fleece, but there is no evidence to support this and it seems improbable that the greasy yolk could be taken up from among the wool by the needle-like haustellum. There is also no way in which keds could directly injure the fibers of the fleece. Freund and Stolz (1928) found that from 0.008 to 0.0142 gram of blood is imbibed in one meal. At first the ked is only 2.5 to 4 mm. long, but may eventually reach 6 to 7 mm. when fully engorged or gravid.

Mating may occur within 3 or 4 days after hatching or much later, and is often repeated. It is a matter-of-fact procedure, without any display of nervous excitement. The male sits on the back of the female's abdomen, clasping his legs around her sides. He then backs up, so that the tip of his abdomen extends behind that of the female and, curving it upward beneath her, inserts the terminalia in the vulvar opening. The exact proportion of the sexes upon hatching and later upon the sheep has not been determined, although it is claimed that the females outnumber the males by about 2 to 1 (W. C. Miller, 1925). The span of life of the male is unknown.

In a series of controlled experiments carried out in Wyoming with newly hatched keds placed on clean lambs, Swingle (1913) found that a female voids her first larva when she is from 14 to 30 days old. A total of 105 keds of both sexes were used in four experiments, producing 30 puparia in all. Pairs were found mating the fourth day after being released on the host. In these experiments females lived from 28 to at least 165 days, or 4 months on the average. During this period puparia were voided at average intervals of about 8 days. A ked living 4 months might therefore produce from 10 to 12 puparia; but the few females that reach 6 months might lay 15 to 20 each. In warmer countries breeding is probably continuous throughout the year; but in colder climates it may stop or be slowed up in winter, as puparia are readily killed by frost. Hill's experiments, in Australia, were on a much smaller scale, but gave similar results. Females extruded their first puparium when 13 to 23 days old, after which they repeated the performance at intervals of about 9 days.

The ked walks very slowly and clumsily, yet seems to move about rather frequently on its host. At any rate, it is difficult to confine keds in a small space in the fleece for experimental purposes. Swingle placed his keds in a ring-shaped cup of muslin glued to the sheared skin, the wool being left in the center of the ring and the top of the cup closed by sewing on cheese cloth. He found that many escaped nevertheless and that the others died very soon, due chiefly to confinement, it would seem. He finally allowed his experi-

mental keds to go free on a lamb from which all other parasites had been removed, or marked individual keds by tying a colored silk thread about the thoraco-abdominal constriction. Tetley (1930), in New Zealand, devised a modification of the Swingle cage, the edge at one end of a cylindrical sleeve of muslin being sewn to the skin of the sheep with sterilized horse-tail hair, while the free edge is drawn together and tied with tape.

*Parasites.*—Hindle (1921) mentions incidentally that he found a parasitic nematode worm in the alimentary canal of a British specimen of *M. ovinus*; but nothing further is known of this parasite.

The sheep-ked harbors a variety of unicellular organisms, which have attracted the attention of many investigators owing to their possible relations with similar organisms of other blood-sucking insects or of other Invertebrates and Vertebrates.

The earliest known is the flagellate now called *Trypanosoma melophagium* (Flu), which was first seen and described by E. Pfeiffer (1905) in the lumen of the mid-gut of sheep-keds in Germany. Flu (1908) originally called it *Crithidia melophagia* and regarded it as a specific parasite of the ked, a view also adopted by some later investigators, but now abandoned. According to recent work by Nöller (1919), Kleine (1919), Hoare (1923), and Turner and Murnane (1930), these flagellates are developmental stages of a trypanosome found in the blood of most domestic sheep. Laboratory-bred keds become infected by feeding on the blood of sheep harboring trypanosomes. The insect does not transmit the flagellate to the offspring, as was believed at first (Porter, 1910). The sheep acquire the trypanosomes, not through inoculation by the bite (proboscis) of infected keds, but, according to Hoare (1923) and Turner and Murnane (1930), by the so-called contaminative method. In all experiments in which emulsions of infected keds were fed by mouth to clean sheep, the latter acquired the trypanosome; while control experiments to infect clean sheep either through the abraded skin or by the bite of infected keds, invariably failed. In nature sheep therefore must become infected by biting keds off the body and crushing them in the mouth. Presumably the flagellates enter the blood stream through the mucous membrane of the mouth. In newly hatched keds fed on infected sheep, the trypanosomes taken up with the blood undergo a definite cycle of development in the alimentary tract. A crithidial stage is produced in the mid-gut, followed by infective forms (metacyclic trypanosomes) in the hind-gut, where they line the walls. In sheep the trypanosomes are always scarce and apparently non-pathogenic to the host, unless they may do some

harm to animals debilitated from other causes.<sup>49</sup> Under natural conditions nearly every sheep-ked examined has been found infected in Europe, North Africa, North America and Australia. *T. melophagium* has been investigated repeatedly and from many different aspects by E. Pfeiffer (1905), Flu (1908), Swingle (1909; 1911), Georgewitch (1910), Annie Porter (1910), C. F. Bishop (1912), Cauchemez (1912), Chatton and Delanoë (1912), Laveran and Franchini (1914; 1919), Nöller (1917; 1919), Kleine (1919), Böning (1920), Hoare (1921; 1922; 1923), Witzky (1922), Sprehn (1922), Buchner (1922), E. R. Becker (1923), Nöller and Kuchling (1923), Kuchling (1924), Bozhenko and Tzeiss (1928), Turner and Murnane (1930), and Colas-Belcour (1931).

*Rickettsia melophagi* Nöller (1917) is a unicellular, spherical or rod-like microorganism occurring in most sheep-keds of Europe and North America. It is found in large numbers in the lumen of the mid-gut, where it forms a layer over the cuticula of the epithelium. As it is strictly extracellular, it should perhaps not be included in the genus *Rickettsia*, which properly speaking contains intracellular organisms only. Although it occurs in newly hatched, unfed keds, infection is not through the egg, but by way of the intra-uterine larva, which absorbs the *Rickettsia* while feeding on the secretion from the milk-glands of the female.<sup>50</sup> *R. melophagi* does not seem to affect the sheep-ked adversely; on the other hand, there is as yet no direct proof that it is a beneficial symbiont. The organism can be cultivated outside the body of the insect on an agar-blood

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<sup>49</sup> The presence of trypanosomes in the blood of sheep attacked by a disease known as "loup-ill" in England, to which C. F. Bishop (1912) called attention, is purely incidental, as this disease is transmitted by a true tick, *Ixodes reduvius* (= *I. ricinus*). Rodhain and Brutsaert (1935) succeeded in infecting experimentally *M. ovinus* with two trypanosomes which normally do not occur either in keds or in sheep (*Trypanosoma lewisi* and *T. cruzi*), by feeding them on guinea pigs infected with these flagellates. Laveran and Franchini claimed to have inoculated mice with *T. melophagium*, but their experiments could not be repeated successfully by others.

<sup>50</sup> Jungmann (1918) states that he found the "ova" of *M. ovinus* infected with *R. melophagi*. He used the term "ova" not for the true egg, but for the young larva developing in the uterus of the fly. The mechanism of transmission from adult to offspring was elucidated by Zacharias (1928).

medium. Experiments have shown that it is not pathogenic to sheep, other animals or man, and that it is not a degenerated form of *Trypanosoma melophagium*, as was claimed at one time. Nöller and Kuchling (1923) believed that they cultivated *R. melophagi* from the blood of sheep, but it seems rather doubtful that the organism they obtained was the same as that found in *Melophagus*. *R. melophagi* was studied by Nöller (1917), Jungmann (1918), Sikora (1918), Hindle (1921), Arkwright and Bacot (1922), Arkwright (1923), Nöller and Kuchling (1923), Kuchling (1924), Hertig and Wolbach (1924), van Thiel (1925; 1926), Anigstein (1927), Zacharias (1928), Glaser (1930), and Kligler and Aschner (1931).

*Melophagus ovinus* is also infected with peculiar intracellular microorganisms (bacteroids), usually referred to as symbionts. Sikora (1918) first noted them briefly, and they were studied or seen by Jungmann (1918), Hertig and Wolbach (1924), Anigstein (1927), Zacharias (1928), and Aschner (1931). Some of the early authors regarded them as developmental stages of the intestinal *Rickettsia*, but they are now generally accepted as distinct organisms. The bacteroids appear to be of two types. One type, found in all flies of both sexes examined, in Europe as well as in North America, fills the protoplasm of enlarged epithelial cells (mycetocytes) in the posterior portion of the mid-gut. Here the infected cells are grouped into a peculiar, ring-like "mycetome," always located at the same bend of the gut. The bacteroids pass from the mother fly to the developing larva with the secretion from the milk-glands, being later retained by the puparium and eventually reaching the adult. Although transmitted from the female to the offspring in this fashion, they are not "inherited" by the egg itself. The definite location of the infected cells in a special mycetome, their presence in all individuals, as well as the elaborate arrangement assuring the orderly transmission to the young, point to some intimate relation between the fly and the bacteroids. The exact nature of this relation is, however, disputed. The organisms can scarcely be parasites in the generally accepted meaning of the term, as obviously they do not impair the normal life activities of the host. They are either harmless, tolerated guests or live in a state of mutualism, beneficial to themselves as well as to the insect host. It is noteworthy in this connection that the only blood-feeding arthropods known at present to harbor intracellular bacteroids are species that take no other food but blood throughout the whole of the life-cycle. Various suggestions have been put forward as to the possible benefit

derived by the fly from the bacteroids. Roubaud (1919) claimed that they play an essential part in the digestion of blood. Other authors suppose that they furnish their host with some accessory food substance comparable or possibly even identical with vitamins. It must be admitted, however, that no experimental evidence has as yet been adduced in support of these views.<sup>51</sup> A second type of bacteroid, of a different shape, was found by Zacharias (1928) in some specimens only of *M. ovinus*, occasionally filling ordinary, flat epithelial cells usually of the mid-gut, more rarely of the hind-gut or of the Malpighian vessels. They are also carried over from the female to the offspring by way of the milk-glands.

Annie Porter (1910), reported finding, in addition, a *Spirochaete melophagi* Porter, in the gut, ovaries and puparia of some British sheep-keds. She also described a peculiar fungus, apparently "more nearly related to the Peronosporae," present in many of the keds from Scotland, chiefly in the Malpighian tubules and to a lesser extent in the intestine. These organisms have not been mentioned by more recent investigators. Fantham and Porter (1913) claim to have infected *M. ovinus* through the proboscis with *Nosema apis* Zander, one of the Microsporidia and the causal agent of an epidemic disease in domesticated hive-bees.

*Economic Importance and Control.*—It has sometimes been claimed that keds cause little annoyance to sheep and no appreciable economic loss. On the other hand, most veterinarians and sheep owners are emphatic that they do considerable damage. The case against the keds is summarized by Imes (1917) as follows: "The sheep-ked obtains its food by puncturing the skin of the sheep with its lance-like proboscis or sucking tube and feeding on the blood and lymph. The irritation thus caused is very great, especially in the case of lambs that are infested heavily, and while the quantity of blood drawn by one ked in 24 hours is small, the total amount taken by a large number of keds is considerable and the drain constant. The irritation caused by the keds makes the sheep restless so that they do not feed well, and in consequence, they do not grow and fatten as rapidly as when free from keds. Thus a loss is caused by shrinkage in weight and a general unthrifty condition of infested flocks, with a consequent lowering of the vitality and a reduction in the resisting powers of the animals. These conditions not only help

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<sup>51</sup> See V. B. Wigglesworth, 1929, *Parasitology*, XXI, pp. 288-321; R. W. Glaser, 1930, *Archives of Pathology*, IX, pp. 71-96 and 557-576; and P. Buchner, 1930, *Tier und Pflanze in Symbiose*, Berlin, 2d Ed., xx + 900 pp.

to reduce the market value of the sheep but also tend to reduce wool growth."<sup>52</sup> Imes also quotes estimates by sheep owners in Utah, where keds are very prevalent, of annual average losses of 25 cents per head for lambs and 20 cents per head for ewes in infested flocks. The only experimental data bearing on this subject are contained in a paper by Mote (1922). He compared in Ohio seven lambs, five of which became heavily infested with keds and lice as winter progressed, while two remained free of keds and had only a few lice. The lambs were weighed individually every week, the results being given in a table. He concluded that the lambs heavily infested were the ones that did not gain weight; but the differences, as shown in the table, are not very striking. It is also often stated that the faeces of the keds stain or soil the wool, thus impairing its market value; but Freund and Stolz (1928) found that the freshly voided faeces are solid and dry and could hardly affect the color of the fleece.

Sheep-keds are not known at present to carry any infectious disease to sheep, although they have often been suspected. *Trypanosoma melophagium*, which they transmit from sheep to sheep is, so far as known, a harmless organism. It was discussed at length before. McMurrich (1884), Flattely (1922) and Jenkins (1924) have considered the possibility of *M. ovinus* being the intermediate host of the sheep tape-worm, *Moniezia expansa* (Rudolphi); but no experimental proof could be obtained and, in recent years, Stunkard and Knull have shown that certain oribatid mites act as intermediate hosts of this worm. Neitz (1937), in South Africa, made unsuccessful attempts to transmit *Eperythrozoon ovis* to sheep by means of sheep-keds. Zumpt (1939) quotes an apparently unpublished report of experiments by Bongert, in which this investigator transmitted anthrax from infected to healthy sheep by the bite of *M. ovinus*; the anthrax bacilli were found in the gut of some of the keds taken from sheep that died from anthrax. It seems doubtful that the sheep-ked is an important means of transmission of this disease. De Paolis (1935) also discussed the possibility of *M. ovinus* being a carrier of visceral leishmaniasis of sheep, but presented no experimental or other evidence. Boné (1939) carried out some unsuccessful transmission experiments with sheep-keds and *Spirochaete duttoni*, the causal agent of African relapsing fever in man.<sup>53</sup>

<sup>52</sup> Throughout this citation I have replaced the word "tick" by "ked."

<sup>53</sup> A curious erroneous belief, current particularly in South Africa, is that sheep-keds are beneficial to sheep, being in some way

Of the several methods of controlling keds, the most commonly recommended is dipping in some liquid insecticide, and in some countries this has been made compulsory by law. For the methods and required equipment, the reader be referred to various Government publications, particularly those by Swingle (1915), Imes (1917), Seddon and Blumer (1932), and McCauley and Russell (1940). According to Kollar (1837), the use of arsenical dips against keds was first suggested by a Suffolk farmer in the English "Farmers Magazine" for November, 1828. The dips most commonly used nowadays are coal-tar-creosote, cresol, nicotin and lime-sulphur-arsenic. It is stated that they cannot be depended upon to kill all adults and puparia with one dipping, but the operation must be repeated after an interval of 24 to 28 days. In Peru, successful dipping against *M. ovinus* has been carried out with an extract from the root of "cubé," *Lonchocarpus nicou* de Candolle, containing the insecticide rotenone (Wille, Ocampo, Wederbauer and Schofield, 1937, Bol. Estac. Expt. Agric. Minist. Fomento Peru, No. 11).

While dipping with the proper chemicals is the only practical method of eradication, experiments have also been made with dry insecticides dusted in the fleece. Mote (1922) used pyrethrum powder as well as a proprietary insecticide, "Cornell (Lowry) powder," applied by means of a shaker in the wool. Of 10 sheep thus treated, each carrying 1 to 6 dozen keds, 6 were free of adults and puparia 7 days later, 4 still had a few (1 to 6) adults and 1 had two puparia.

Many empirical methods of control have been used by herdsmen. Bock (1785) recommended an infusion in hot water of a powder made from the crushed roots of European maple ("Ahornbaum," *Acer campestre* Linnaeus). D. Humphreys (1816) suggested dipping in a decoction of American white hellebore (*Veratrum viride* Aiton).<sup>54</sup>

*Historical Note.*—None of the ancient Greek and Latin writers on Natural History appear to have distinguished between the sheep-ked and other types of vermin (ticks and lice) found in the fleece of sheep. The earliest fairly accurate description of *Melophagus*, accompanied by a recognizable figure, is by Thomas Moufet (or

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antagonistic to sheep-scab. Some farmers even claim that the keds feed on the scab-mite, which is a physical impossibility. (See Davison, 1910).

<sup>54</sup> According to Reichert (1939) *M. ovinus* was formerly eaten by people in Germany, in the belief that it cured fever.

Mouffet) (1634). The difference from the tick ("*Ricinus*") is particularly emphasized by him: "ovibus etiam et capris molestos esse Ricinus testatur Cato, similitudine corporis deceptus. Nam ovium ille Pediculus Reduvius dici debet (nostri Sheep-lowse appellant) inter quem et Ricinum variae et differentes notae. Nam Reduvio rostellum longius, corpus vero etiam a maxima repletione nunquam ita distentum, quin semper compressum nunquam globosum videatur: hujus item pedes obscure rubent; dorsum cineritio est colore, tribus minutissimis punctis nigricantibus distinctum, et ad cordis figuram effigiatum. Caput non semper, imo rarius cuti infigitur, nam non nisi per vices sanguinem exsugit et excrementa inde genita per anum exprimit; quae lanam viridi ita tingunt colore, ut vix calido lixivio, ne dum frigidae cedat tinctura. In vellere detonso annum integrum vivunt Reduvii."<sup>55</sup> John Ray (1710) merely copied Mouffet's account almost *verbatim*, and this is true also of several contemporary and later compilers (Jonston, 1653; Charleton, 1668; Hill, 1752). The figures given by Frisch (1724), Panzer (1798) and Donovan (1799) are much better than that of Mouffet. Frisch also shows the puparium for the first time. In 1746, Linnaeus recognized the correct affinities of the sheep-keed with the winged *Hippobosca* of horse. Sometime before 1760, Lyonet wrote an illustrated description of the external morphology and some of the internal anatomy of *M. ovinus*; but this work was not published until 1826. Some of the early authors were perfectly acquainted with the "pupiparous" method of reproduction of the keed, as may be seen from the accounts by Bock (1785), Modeer (1785) and others. Modeer, for instance, states that the insect deposits the puparium ("dockor") in the sheep's wool to which it adheres by means of a sticky substance covering it at the time of birth. Bock noted the change of color as the newly laid larva changes into the puparium.

<sup>55</sup> Mouffet's book, published several years after his death, was a compendium of observations by himself and some of his contemporaries. (See F. S. Bodenheimer, 1928, *Materialien zur Geschichte der Entomologie*, I, p. 276). The account of *Melophagus* was based on English specimens, as shown by the quotation of the vernacular name, and on observations either by Mouffet (1550-1599 or 1604) or by the older naturalist Edward Wotton (1492-1555). I do not understand why Bodenheimer (*op cit.*, p. 287) seems to question the identity of Mouffet's "*Pediculus Reduvius*" of sheep. In vol. II, p. 352, however, he definitely identifies Mouffet's figure as *M. ovinus*.

It is probable that breeders and shepherds recognized sheep-keds and true ticks as distinct parasites from very early times, although the fact was not recorded by the ancient writers, at least not by those whose works we are acquainted with. This might explain how there is a distinctive vernacular English name for *Melophagus ovinus*. The word "ked" or "sheep-ked" occurs in printed form as early as 1570 (P. Levins, *Manipulus Vocabulorum*, col. 8 of 1867 reprint: "A Cade, sheepe louse, *pediculus ovis*") to designate specifically this insect. Also variously spelled kade, cade, kaid, kead, or kidd, its origin is obscure.<sup>56</sup> *M. ovinus* has also been called sometimes the sheep-fag. So appropriate a name as ked being available, there seems to be no justification for continuing to call this insect the "sheep-tick," as is commonly done in American and other economic writings.<sup>57</sup> This is particularly misleading as several species of true ticks attack sheep in many countries and are often of much greater economic importance than the ked, since they transmit specific infectious diseases. The puparium has sometimes been called improperly "egg" or "nit," even by some recent authors, causing unnecessary confusion and misunderstanding.

L. G. Neumann (1901) claimed that Linnaeus' *Acarus reduvius* (1758, *Syst. Nat.*, 10th Ed., I, p. 615) was based on *Melophagus ovinus*. As pointed out by A. C. Oudemans (1906, 1926, 1929 and 1936), this is certainly erroneous. Linnaeus' description reads: "*Acarus obovatus planus macula baseos obovata.*" It was based on actual specimens and can only be applied to a tick, not to the sheep-ked. It is true that some of his citations refer to the tick and others to the ked; but this does not impair the status of his specific name, which was based in the first place on a description drawn from actual specimens. Moreover, Linnaeus' more detailed account of 1761 (*Fauna Suecica*, 2d Ed., p. 479), based on specimens which he had found on sheep in Oeland, fits the tick only. It is also difficult to conceive how Linnaeus would have mentioned the sheep-ked twice in the same work, first correctly as a "*Hippobosca*," and again erroneously as an "*Acarus*."

*Original Descriptions and Synonymy.*—Linnaeus in 1758 defined "*Hippobosca ovina*" by the habitat and references, rather than by the description: "H. alis nullis. It. wgoth. 59. Frisch. ins.

<sup>56</sup> It may have been derived, perhaps, from "cade," a pet animal, sometimes used in "cade-lamb."

<sup>57</sup> It is often impossible to tell from the title of a paper whether it deals with keds or ticks.

5. t. 18. Habitat inter ovium lanam." The citations unmistakably refer to the sheep-keg, and, although no type is in existence, the identity of the specific name is beyond dispute.

Pallas' "*Hippobosca ovilla*" (1777) was probably a lapsus for *ovina* rather than an intentional emendation. The name was, however, accompanied by a brief description: "Notandum: ovillae rostrum bivalve esse majus, quam in reliquis, colorem in capite, thorace, pedibus abdominisque basi luteo testaceum, in abdomine gryseum, pilis ubique crebris fuscis, et thoracem maxime postice pilosissimum."

v. Olfers (1816) gave the following description of *Melophaga hirtella*: "Rufo fusca undique pilis adspersa, femoribus tumidulis.—Caput brevius, oculi angusti, fere superi. Abdomen, in feminis valde tumidum, hirsutum, albidum, poris respiratoriis verruciformibus aurantiacis; in anteriore abdominis parte utrinque macula aurantiaca, alaeformis. Pedes setis longis quadrifariam instructi. Processus sternalis bifurcatus, pilis rigidis ornatus." There are also references to "*Hippobosca ovina* auctor. *Melophagus ovinus* Latr.," so that the identity with the sheep-keg is certain. Possibly the type may yet be at the Berlin Museum, where some of v. Olfers' other specimens are kept.

The specific names "*vulgaris*" and "*ovis*" are errors or emendations, published without descriptions, and call for no discussion.

*M. ovinus* var. *fera* Speiser (1908) was merely described as "somewhat more slender, somewhat paler in color and somewhat smaller" than typical *M. ovinus*, being otherwise indistinguishable. To judge from the locality, the host meant by the German vernacular "Steinbock" may have been *Capra caucasica* Gldenstdt, the tur or wild goat of the Caucasus, although I am somewhat doubtful about this.

*Melophagus ovinus bolivianus* Bau (1930), was described as a "new form" (*nova forma*) as follows (translated): "The new form is smaller than *M. ovinus*, the elongate oval abdomen being particularly striking in the gravid female. ♀. Length of body, 5 to 5.2 mm.; of abdomen, 3.3 to 3.5 mm.; width of abdomen, 2.4 to 2.6 mm. According to Massonat, the corresponding measurements of *M. ovinus* are: 5.8 to 6.3; 3.6 to 4.3; 3.1 to 3.7 mm. ♂. Length of body, 4 to 5 mm.; of abdomen, 2.4 to 3 mm.; width of abdomen, 2.3 to 2.8 mm. According to Massonat, for *M. ovinus*: 5.2 to 5.4; 3 to 3.2; 2.7 to 2.8 mm. Color a saturated red-brown (in *ovinus* usually yellowish-brown). Vertical triangle with a deep transverse impression (smooth in *ovinus*). Otherwise like *ovinus*. Puparium red-brown

(yellowish-brown in *ovinus*).'' The types are at the Hamburg Museum. I have seen two females, sent by Bau to Prof. Ferris as "*bolivianus*," presumably paratypes, and now at Stanford University Museum. As no host is given, one can only surmise that the specimens came from domestic sheep, since there are no native Caprinae nor Rupicaprinae in South America. Bau's description is scarcely diagnostic. The only structure mentioned (the transverse impression of the postvertex) is also occasionally seen in keds from domestic sheep. No reliable difference could be found between the two supposed paratypes mentioned above and ordinary sheep-keds. Moreover, these paratypes do not show the transverse impression of the postvertex.

Original description of *M. o. montanus* Ferris and Cole (1922): "*Male*. Differing from the male of *M. ovinus ovinus* in the following particulars especially. Setae everywhere tending to be larger and more numerous, the difference in size being especially conspicuous on the dorsum of the thorax; abdomen above without a bare apical space as in the male of *ovinus ovinus*; scutellum apparently lacking and no scutellar setae present, while in the typical form the scutellum, although very small, is distinct and bears a cluster of apical setae. There appears to be a slight difference in the antennae, the typical form having the apical setae much longer than they are in *montanus*. The wing vestiges, genitalia and claws seem to be the same as in the typical form." Through the courtesy of Prof. Ferris I was able to study the three slides on which this race was based. After comparing them repeatedly with many specimens from domestic sheep, I am unable to recognize *montanus* as a distinct race. Of the differences given in the description, the supposed lack of scutellum and scutellar setae is untenable, as both are present in the types. The scutellar setae are even shown in the authors' drawing, while the noto-scutellar suture was merely obliterated by the process of mounting on slides. The vestiture varies in length and density, that of the thorax of the types of *montanus* differing scarcely from my own drawing (Fig. 18) made after a specimen off domestic sheep in Michigan. The relative length and density of the abdominal setae depend a great deal on the age of the adult fly; they always seem to be longer when the abdomen is only partly distended. The apical dorsal area of the abdomen is not always as bare in the male of ordinary sheep-keds as shown in Ferris' and Cole's Fig. 8; usually there are patches of long setae near the middle line and these are more or less removed from the remainder of the pilosity with the gradual distension of the abdomen. I confess that I am unable to

appreciate the difference in length of the apical setae of the second antennal segment.

Subgenus *Dorcadophagus* new subgenus

2. *Melophagus rupicaprinus* Rondani. Figs. 19A-C.

*Melophagus rupicaprinus* Rondani, 1879, Bull. Soc. Ent. Italiana, XI, p. 12 (no sex; off "*Antilope rupicapra*" = *Rupicapra rupicapra*; without definite locality, but from somewhere in Italy). Speiser, 1899, Insektenbörse, XVI, p. 122. Bezzi, 1905, Kat. Paläarkt. Dipt., IV, p. 284. Massonat, 1909, Ann. Univ. Lyon, (N.S.) CXXVIII, p. 258. Bezzi, 1916, Natura, Riv. Sci. Nat., VII, p. 178. Séguy, 1924, Insectes Parasites Homme Anim. Domest., p. 306. Falcoz, 1926, Faune de France, XIV, p. 39, fig. 51 (♀; La Pelouse, Fréjus, Dept. Var, France, off *Rupicapra rupicapra*; also Alps, without more definite locality). Enderlein, 1936, Die Tierwelt Mitteleuropas, VI, Ins., pt. 3, Abt. XVI, p. 249. Eichler, 1933, Zeitschr. Hyg. Zool., XXXI, p. 213 (common on chamois in southern Germany).

*Melophagus ovinus* Massonat, 1909, Ann. Univ. Lyon, (N. S.) CXXVIII, p. 263 (in part: specimens from chamois, La Pelouse, Fréjus, France). Bornand, 1936, Bull. Soc. Vaudoise Sci. Nat., LIX, p. 30 (Plans sur Bex, Valais, Switzerland; off *Rupicapra rupicapra*); 1939, Schweizer. Arch. Tierheilk., LXXXI, p. 67. Not of Linnaeus, 1758.

*Melophagus rupicaprarius* [Anonymous], 1911, Societas Entomologica, XXVI, p. 31 (error for *rupicaprinus*).

*Female*.—Head shaped as in *M. ovinus*; eye small and narrow, of relatively few facets, with an unusually large ventral portion; mediovertex much larger than in *M. ovinus*, over twice as wide as long, less than half the length of the fronto-clypeus; clypeus completely fused with frons, its extent only indicated by the very fine anterior median furrow which ends behind in a deep fovea; pretilinal area indistinct, without fovea; inner orbit between four and five times as wide as the eye, mostly bare, with only 3 to 5 fairly long setae widely spaced over the inner half; three long vertical bristles; postvertex broadly and irregularly elliptical, a little less than twice as wide as long, the occipital margin bow-shaped, the anterior margin broadly rounded off; outer orbit very broad, about as wide as the eye. Palpi of moderate length, slightly shorter than fronto-clypeus. Pro-mesonotal suture distinct but weak; suture between pro-



FIG. 19. *Melophagus rupicaprinus* Rondani: A, female, Styrian Alps, from above (left) and below (right).—B, basal pleurite (I) of male, same locality.—C, apex of abdomen of male, from above (left) and below (right).

notum and propleuron weak. Mesothorax: median notal suture very weak; no longitudinal intrascutal grooves; mesonotal and posthumeral sutures lacking; notopleuron incompletely limited behind by a very weak suture; mesothoracic spiracle smaller than in *M. ovinus*, at the lateral edge of the thorax; mesonotum with many stiff, unequal setae, irregularly scattered, but fewer

in number than in *M. ovinus*, with the same bare area on the notopleuron and the same very long and heavy bristles at the hind margin of notopleuron and mesonotum; 7 or 8 scutellars, rather irregularly placed; ventrally, lobes of prosternum, mesosternum and basisternum covered fairly uniformly with setae, most of them short; a few at the hind margins very heavy, spine-like, and some much longer at the sides of mesosternum and basisternum. Abdomen: sclerotized basal dorsal pleurites (I) shaped almost exactly as in *M. ovinus* and with similar setae; pleurites II very weakly indicated; two transverse median tergal plates near the tip of the dorsum, each including a pair of abdominal spiracles (VI and VII) and therefore homologous with the fourth and fifth tergal plates of *Lipoptena*; fourth plate over twice as wide as long, with a cross-row of 5 setae on each side; fifth plate one and one-half times as wide as long, apparently bare; remainder of dorsum without visible segmentation, uniformly covered with medium-sized setae, but much more loosely than in *M. ovinus* and with a fairly extensive median bare area before the fourth tergal plate. Venter with the basal sclerite, the anal and genital plates and the setae as in *M. ovinus*. Legs much stouter and relatively shorter than in *M. ovinus*, but also densely setose, with a similar arrangement of spurs and heavy bristles at the apices of the tibiae; claws long and relatively slender, nearly symmetrical.

*Male*.—Similar in structure and chaetotaxy to the female. Dorsum of abdomen with only one median tergal plate near the tip, corresponding to the first of the female and enclosing spiracles VI (the fourth of *Lipoptena*). Basal dorsal pleurite (I) somewhat more angular behind than in the female. Terminalia as in *M. ovinus*.

Length (h. + th.): ♀, 1.8 mm.; ♂, 1.7 mm.

SPECIMENS EXAMINED.—AUSTRIA: Styrian Alps, 12 specimens of both sexes, without host (G. Strobl.—Deutsch. Ent. Mus., Berlin-Dahlem).

*Distribution*.—*M. rupicaprinus* is known at present from southern Germany, Switzerland, the French Alps, Italy (exact locality unknown) and the Alps of southern Austria. No doubt it will eventually be found in most of the areas as yet inhabited by chamois.

*Host Relations*.—*M. rupicaprinus* is a specific parasite of the chamois, *Rupicapra rupicapra* (Linnaeus), the distribution of which has been discussed under *Lipoptena couturieri*.

*Affinities*.—While *M. rupicaprinus* agrees with *M. ovinus* in most

structural characters (head and thorax, lack of ocelli, reduced compound eyes, and rudimentary wing knobs), it is rather aberrant in the abdomen, palpi and chaetotaxy. I have therefore segregated it in a distinct subgenus.

*Original Description of Melophagus rupicaprinus*: "Fere duplo minor *M. ovino*, et colore distincte pallidiore, corpore toto etiam in abdomine lutescente testaceo: sed praecipue distinguendus exilitate et brevitate maxima proboscidis, et forma abdominis in nostra sp. ad apicem profunde excavati, non leniter tantum concavi. Proboscidis characteribus proxima videtur *Lipoptenis*, sed non solum ab istis difert absentia completa alarum, sed etiam oculorum forma et positione, qui anteriores sunt, lineares et parum observandi, non ovati, superi et satis distincti." The type, collected by V. Ghiliani, is at the Genoa Museum of Natural History. I have not seen it.

#### UNRECOGNIZED SPECIES

*Lipoptena* (?) *antilopes* (Pallas).

*Hippobosca antilopes* Pallas, 1777, Spicilegia Zoologica, XII, p. 50, footnote; Pl. III, fig. 12C (no sex; off "*Antilope gutturosa*"; Mongolia); 1818, in Wiedemann, Zool. Magazin, I, pt. 2, p. 3.

*Melophaga antilopes* Wiedemann, 1830, Aussereurop. Zweifl. Ins., II, p. 614 ("South Russia"; erroneous locality).

*Melophagus antilopes* Speiser, 1899, Insektenbörse, XVI, p. 122. Bezzi, 1905, Kat. Paläarkt. Dipt., IV, p. 283. Massonat, 1909, Ann. Univ. Lyon, (N. S.) CXXXVIII, p. 258. Bezzi, 1916, Natura, Riv. Sci. Nat., VII, p. 178. Séguy, 1924, Insectes Parasites Homme Anim. Domest., p. 306.

Pallas' brief description reads: "Pedes fere ut in *ovilla* [= *Melophagus ovinus*], thorax glabriusculus, planior, pectore inter articulos pedum plano, scabro; abdomen proportione minus, cum pedibus pilosum; color totius fuscus, in pedibus subtetaceus, fossa sub capite (pro rostro reponendo) triangularis alba."

Wiedemann obtained Pallas' specimens, but his description (here translated) adds little information: "Ferruginosa; abdomine fusco. Russet-brown, with blackish-brown abdomen.  $1\frac{1}{2}$  lines [= about 3.3 mm.]. Appears to differ from the preceding [*Lipoptena moschi* and *L. depressa*] in having only the two shiny plates or divisions close to the base of the abdomen, and not those laying behind them and stretching farther to the tip."

Although Speiser concluded that this belonged in *Melophagus*, it was more probably a *Lipoptena*, from the nature of the host. Pal-

las' statement "thorax glabriusculus" and Wiedemann's comparison with two recognizable species of *Lipoptena*, also seem to point to *Lipoptena* rather than to *Melophagus*. Pallas' types may yet be found in Wiedemann's collection at the Vienna Museum.

Since Pallas collected the specimens himself, there is no reason to doubt the correctness of the host record, an antelope first described in the same work and now placed in the genus *Gazella*. *Gazella gutturosa* (Pallas), the zeren or seren, is restricted to Mongolia.

*Lipoptena moschi* (Pallas).

*Hippobosca moschi* Pallas, 1777, Spicilegia Zoologica, XII, p. 50, footnote; Pl. III, figs. 12B and 12b (no sex; off "*Moschus sibiricus*" = *Moschus moschiferus* Linnaeus; eastern Siberia); 1818, in Wiedemann, Zool. Magazin, I, pt. 2, p. 3.

*Melophaga moschi* Wiedemann, 1830, Aussereurop. Zweifl. Ins., II, p. 613 (Asiatic Russia).

*Melophagus moschi* Bezzi, 1905, Kat. Paläarkt. Dipt., IV, p. 283. Séguy, 1924, Insectes Parasites Homme Anim. Domest., p. 306.

*Lipoptena moschi* Speiser, 1899, Insektenbörse, XVI, p. 122. Bezzi, 1916, Natura, Riv. Sci. Nat., VII, p. 178. Russell, 1922, Jl. Bombay Nat. Hist. Soc., XXVIII, p. 960.

Pallas' original description: "Caput et thorax glaber minora, pedes graciliores, abdomen scutis singularibus loricatum subpilosum; color capiti thoracique testaceo-fuscus, pedibus gryseo-testaceus, abdominis scutis testaceo-luteus, sed intergerinae cuti gryseus."

Wiedemann's description of 1830 (here translated) was based on Pallas' specimens and adds much valuable information: "Ferruginoso brunneus; abdomine silaceo laminis tribus transversis corneis. Russet-yellowish brown, with ochre-yellow abdomen and three transversely elongate horny plates. Length  $2\frac{1}{2}$  lines [= about 5 mm.]. Head short and broad, but not broader than the thorax. Eyes distinctly prominent on the sides, not linear. Frons horny and shiny at all four margins, the horny portion of the occipital margin somewhat convex anteriorly and with three depressions, which look like ocelli and like these are placed in a triangle. Clypeus with a weak, flattened emargination in the middle. Sheath of proboscis [palpi] short. Under side of head yellowish-white, ending in a point. Thorax quadrangular, behind with a membranous lobe on each side, which almost looks like a wing rudiment. Sternum

shagreened. Scutellum very short and broad. Abdomen on each side at the base with a brownish-yellow, almost horny plate, rounded behind, touching its fellow anteriorly, somewhat raised above the remaining middle surface; behind this a similar, larger, longer, oblique, much less horny plate, which almost looks like the diverging elytron of a *Meloë* and is covered with very short, thick setae. On the median area of the abdomen three transversely elongate, shiny, horny plates, provided with short setae at the hind margin. No such plates are to be seen on the ochre-yellow venter; but one finds here also, at least indicated by a kind of suture, the outline of the parts which dorsally were described as resembling elytra of *Meloë*, and behind these another similar suture or fold on each side. Presumably these parts assume another shape when the abdomen is engorged. Legs colored like the thorax. One specimen has the haustellum protruding from between the diverging valves of the sheath [palpi], exposing its yellowish-white, pointed oval base.' These types should also be looked for in Wiedemann's collection at the Vienna Museum.<sup>58</sup>

From these two accounts and the figure there can be no doubt whatsoever that this parasite is a *Lipoptena*. Indeed, it must be very close to, if not identical with *L. cervi*. It is surprising that it was never collected again, as Pallas stated in 1779 (*Spicilegia Zoologica*, XIII, p. 18) that the fawns of the musk-deer are very heavily infested with this ked.

I have seen the specimen in the v. Röder Collection referred by Bau (1929, *Zoolog. Anzeiger*, LXXXV, p. 11) to *L. moschi*; but it is no more than a typical winged male of *L. cervi*. It bears no name of a host, but merely the locality label "Amur."

*Lipoptena pteropi* Denny.

*Lipoptena pteropi* Denny, 1843, *Ann. Mag. Nat. Hist.*, XII, p. 314, Pl. XVII, figs. 5 and 5a-g (no sex; off "*Pteropus edulis*," a bat; East Indies). Bezzi, 1916, *Natura*, Riv. Sci. Nat., VII, p. 178.

Original description: "Ochraceus, nitidus, pubescens; oculis maximis, cinereo-caesus; thorace cum angulis lateralibus posterioribus et linea centrali castaneis; pedibus longis, crassis; unguibus nigris. Long. 1 lin. [= 2.23 mm.].—Dull ochraceous, shining and

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<sup>58</sup> Wiedemann does not seem to have known Pallas' descriptions of 1777 of *M. moschi* and *M. antilopes*. He quotes only a brief diagnosis from Pallas' MS for *M. moschi*: "aptera dorso abdominis tripectinato pedibus biunguiculatis."

pubescent. Head flat, transverse, as wide as the thorax. Eyes very large, ash-gray. Thorax transverse, with a line in the centre, and the posterior portion chestnut; the base with four large punctures and a series of bristles. Scutellum prominent and semicircular. Wings very small, rudimentary, apparently with only three simple costae? Abdomen subovate, somewhat pedunculate, flat and coriaceous, with faint indications of five segments? Legs long, thick, pale ochraceous; the apex of the femora with a fuscous spot; posterior pair slightly notched near the extremity. Claws divaricate, black, finely serrated beneath. Pulvilli membranous, ciliated, with a feathered bristle beneath."

Denny's collection of parasites was bought by the British Museum about 1853; but his *L. pteropi* has not been traced there. The figure and description, based on a single deälated specimen, clearly refer to a species of *Lipoptena*. The author writes: "I obtained my example from beneath the wing of *Pteropus edulis* (Black Roussette), commonly called, though inaccurately, the Vampire." Either some confusion of labels is responsible for this statement or the bat was an accidental or stray host. No species of Melophaginae or of any other Hippoboscidae has since been reported reliably from a bat.<sup>59</sup>

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<sup>59</sup> *Lipoptena dubia* Rudow and *L. phyllostomatis* Perty were Streblidae. *Lipoptena tolisina* "Speiser" Muir was based on an error, as shown before.

## ENTOMOLOGICA AMERICANA

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New names in **bold face**; valid genera and species in Roman; synonyms in *Italics*;  $\phi$  indicates animals, not insects; \* plants.

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