

## A CONTRIBUTION TO THE KNOWLEDGE OF THE *HIPPOBOSCIDAE* (DIPTERA PUPIPARA).

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(With 20 Text-figures.)

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### INTRODUCTION.

THE approach to the study of the ectoparasitic flies of the pupiparous family *Hippoboscidae* has heretofore been almost entirely by way of the conventional methods of the Dipterists. In other words, descriptions have been based almost exclusively upon pinned specimens. Consequently these descriptions have, for the most part, considered only the conventional subjects of colour, wing venation, size, shape, form of the claws and a few of the more obvious chaetotactic characters. A few descriptions have been based upon alcoholic specimens and these descriptions are decidedly better than those based upon pinned specimens, although they still leave something to be desired.

It is probable that the greater part of the specimens of Hippoboscids in collections are of the pinned type and it is the belief of the present writers that however satisfactory such specimens may be in the case of representatives of the other families of Diptera they are not adequate for the proper study of the Pupipara. In nearly all the members of this group the abdomen is so soft that it becomes greatly shrivelled in pinned specimens and practically none

of its characters can definitely be determined. A review of the existing descriptions shows that in almost all cases this portion of the body has been passed over with little or no mention. Yet an examination of the material available to us has shown that the abdomen frequently presents characters that we believe to be of very great usefulness.

We are consequently presenting this paper more as a contribution to the methodology of the study of the *Hippoboscidae* than for any other reason, although in its inception it was intended merely for the description of a few new and little known species. We are taking advantage of the opportunity to figure and give notes upon all the species that are available to us for study.

#### TECHNIQUE.

In the course of its development the study of practically all the ectoparasitic groups of insects has passed through certain fairly well-defined stages. Beginning with pinned material, even in those groups the members of which are the most fragile, it has progressed through various types of inadequate preparations resulting finally in the development of a specialized technique for the production of microscopic preparations in the making of which a considerable degree of care and skill is necessary.

In the preparation of slide mounts of Hippoboscids we have utilized the following procedure. In the case of winged specimens the wings are detached and mounted directly. The body is boiled in a 10 per cent. solution of caustic potash until the contents are entirely liquefied. It is then transferred to water, judiciously placed slits are made in it and the contents carefully pressed out. In the case of these insects this is a bit difficult because of the highly developed network of tracheae within the body. The specimen is then transferred to 95 per cent. alcohol for a few minutes, then to carbol-xylene and then mounted in balsam. In most cases it is desirable to support the cover-glass on bits of broken glass in order to avoid distortion of the specimen.

There are certain very definite disadvantages in this method. It is rather difficult to avoid the accidental removal of more or less of the vestiture of setae and some distortion of the body is almost inevitable. The development of a certain amount of skill on the part of the preparator, however, will reduce these disadvantages to a minimum. We cannot consider that objections to the method based solely upon the necessity for acquiring this skill and the time consumed are valid. The histologist does not complain of the time spent in acquiring the skill in technique that is necessary for the accomplishment of his aims.

A further objection that the colours of the specimen are lost by this method of preparation is in part valid. However, what we have seen has not led us to accord any special respect to colour as a taxonomic criterion in this group and in any case colour notes can be taken before the specimen is prepared. The general colour, whether light or dark, can be determined well enough from the mounted specimens as can the colour of setae.

## FIGURES.

Very few illustrations have been employed in describing members of this family and such as have been given have usually been of but little value to the systematist. In fact the majority of the existing figures can only be described as crude. A most gratifying exception to this rule is that of the figures given by Massonat (1909) in an extended paper on the family. Yet even these figures, although they are probably the best that have been given by any author, are not as detailed and careful as is desirable, too little attention having been given, for instance, to the chaetotaxy, which in some genera is a matter of considerable importance.

The figures that we are presenting have for the most part been made from carefully corrected camera lucida sketches. We have endeavoured to put into them all the structures visible in the specimens, but this ideal cannot entirely be realized, it being impossible to show some of the pleural structures of the thorax. We have endeavoured also to attain a degree of accuracy that will at least come within the probable range of variation. All the figures have been checked over by both authors.

In the case of figures that are divided, the left half represents the dorsal aspect, the right half the ventral aspect. We believe that the many advantages of this type of figure far outweigh any possible disadvantages and are sufficient to overcome any possible objections on the ground that the figures are not artistic.

## ACKNOWLEDGMENTS.

The material upon which this paper is based has come from various sources. We are especially indebted to Mr E. P. Van Duzee, Curator of Entomology of the California Academy of Sciences, for placing at our disposal the *Hippoboscidae* in the collection of that institution. The Department of Entomology of the University of California, through Prof. S. B. Freeborn, has loaned material of the genus *Lipoptena*. Certain specimens were taken some years ago by the senior author from skins in the collections of the United States National Museum and the Field Columbian Museum and acknowledgments are due to the authorities of these institutions for this privilege. Finally, to Major E. E. Austen, of the British Museum, we are indebted for specimens of *Lipoptena cervi* and *Ornithomyia lagopodis*.

Genus **Lipoptena** Nitzsch.

The material of this genus that is before us represents five species, one of which is apparently new. In addition to notes on specific characters we are enabled to add also some information concerning the larvae.

*Specific characters.*

It appears from our material that excellent specific characters are to be found in the genitalia of the males, which can be seen to advantage only in

cleared specimens; in the chaetotaxy of the head and thorax; in the form of the first abdominal sternite and in the form and arrangement of the tergal plates of the abdomen. There is evidently a certain amount of variation in the chaetotaxy but not enough to be especially disturbing. The presence or absence of an apical seta or setae on certain of the tibiae is evidently a valuable specific character in some instances.

The volant individuals, that is those taken before the wings have been dropped, differ so markedly from those that have dropped the wings and become distended by full feeding that at first difficulty was experienced in correlating the two forms. The abdomen in the volant individuals is so small and contracted that the distribution of the setae can not be determined with accuracy. The tergal plates are not entirely defined, the diverging dorsal lines seen in *L. depressa*, for instance, not appearing at all. Reference to the chaetotaxy of the head and thorax, however, has been sufficient to permit the definite placing of all examples of this sort that we have seen.

#### *Sexual dimorphism.*

In pinned specimens of the ordinary type it is very difficult to distinguish between the sexes, in fact most authors appear not to have attempted any such distinction. It seems to have been supposed by some that the males retain the wings. Massonat (1909, p. 59) has pointed out that this is a mistake and we are entirely in accord with his views, for, in our material of *L. depressa* and *L. subulata*, both sexes appear without the wings. It is probable that this mistake has arisen simply from a failure to distinguish the sexes. Correlated with this error, some authors appear to have thought that the slender-bodied volant individuals must be males. For example, one such individual received, through the kindness of Major Austen and by him labelled as a male, is in reality a female.

It is true that in the male the abdomen appears never to attain the size that it does in the female, but otherwise there is little but the presence of the genitalia by which to distinguish them, at least in all the species we have examined except *L. cervi*. We have not seen the male of this species, but according to Massonat there is a decided difference in the form and arrangement of the abdominal plates. The external genitalia of the males at the most consist of a pair of small, ventral processes, and in some of the species even these are lacking. The internal structures show very plainly in cleared specimens and permit no possibility of error as to the sex.

#### *Larvae.*

Larvae of two species, *L. depressa* and *L. mazamae*, were found within the bodies of females. The number of specimens (one of each species) is not sufficient to permit any extensive study. Nevertheless, certain interesting facts are revealed.

In both of these larvae the posterior portion of the body is heavily chitinized. There are no distinct spiracles, the place of these being taken by a large number of small, pore-like openings which communicate with tracheal branches, the arrangement being somewhat like that of the polypneustic lobes described by Newstead as occurring in the larva of *Glossina*. In the larva of *L. mazamae* (Fig. 2 A) these openings are very numerous, are arranged in two general series and appear to occur on both the dorsal and ventral sides of the body. In that of *L. depressa* they appear to be very few and confined to one side of the body, but our single specimen is in too poor condition for study to permit a definite determination of the condition.

*Lipoptena depressa* (Say).

Figs. 1, 2 B, 2 D, 2 F.

1823. *Melophagus depressus* Say, *Journ. Acad. Sci. Phil.* III. 104.

1907. *Lipoptena depressa* (Say), Coquillett, *Ent. News*, XVIII. 290.

PREVIOUS RECORDS. Originally described by Say from *Cervus virginianus*, without indication of locality. This is probably some sub-species of the deer now known as *Odocoileus americanus*, which ranges throughout a large part of North America east of the Rocky Mountains. Recorded by Coquillett from "black tailed deer" (*Odocoileus columbianus*) from Humboldt County, California.

Speiser has placed *L. mazamae* Rondani as a synonym of this, but, as will be pointed out below, we regard this as an error.

SPECIMENS EXAMINED. Numerous examples from sub-species of *O. columbianus* from the following localities in California: Humboldt County; Gualala and Laytonville, Mendocino County. Also from "deer" at Deer Park, British Columbia, Canada, and specimens taken in flight at Sobre Vista and on Mt Wilson and from unstated locality in California.

NOTES. The original description of Say contains little of value except the statements that there are "two impressed lines from the base to the margin beyond the middle" of the dorsum of the abdomen and that the venter of the abdomen has an "arquated series of spines near base." These characters will permit the positive separation of the species from *L. subulata* Coq. but not from more closely related forms such as *L. mazamae* Rondani. We present the following notes on the species, indicating the most salient characters.

The sexes are very similar except for the characters associated directly with the genitalia, and we are figuring the female only (Fig. 1).

*Head* above almost destitute of setae. There is some variation, some specimens showing but a single pair of large setae on the front, others showing two pairs and a few smaller setae, but in no case are these setae to be described as numerous. The front (as in most Hippoboscids) shows a median area or frontal vitta which presents a roughened appearance and the posterior margin of which bounds a semicircular area about the ocelli. The form and extent

of these areas appear to afford specific characters. In *L. depressa* the frontal vitta is rather short and broad and the ocellar area correspondingly larger. The ventral side of the head bears a few small setae.

*Thorax* with a row of large but slender pre-alar setae; with an irregular series of smaller setae across the mesonotum; with a group of three post-alars and a group of three or four pre-scutellars on each side; with a median pair of scutellars. On the ventral side both meso- and meta-sterna are thickly beset

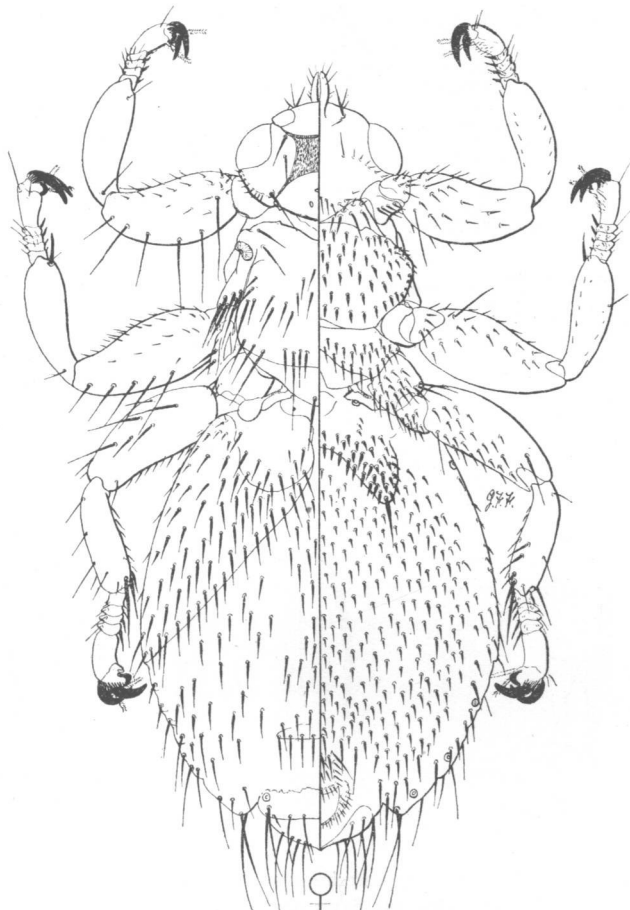


Fig. 1. *Lipoptena depressa* (Say), female.

with short, stout setae. The legs present no special characters except that the anterior tibiae are without an apical seta on the inner margin and that the claws are equal (Fig. 2 *D*).

*Wings* (Fig. 2 *B*) weakly veined as is characteristic of the genus, vein  $R_{4+5}$  (the third vein of Dipterists) with a stigma-like expansion at the margin.

*Abdomen* with a conspicuous pair of diverging lines on the dorsum, these lines forming an inverted **V** and attaining the lateral margins slightly behind

the middle. The spaces between these lines and the lateral margins tend to be more or less chitinized and these areas are beset with numerous setae. Behind these lines the dorsum is membranous except for two small, transverse, pre-apical sclerites, and bears but a few scattered setae.

On the ventral side the basal sternite is quite heavily chitinized and is divided by a deep posterior emargination into two pronounced lobes the tips

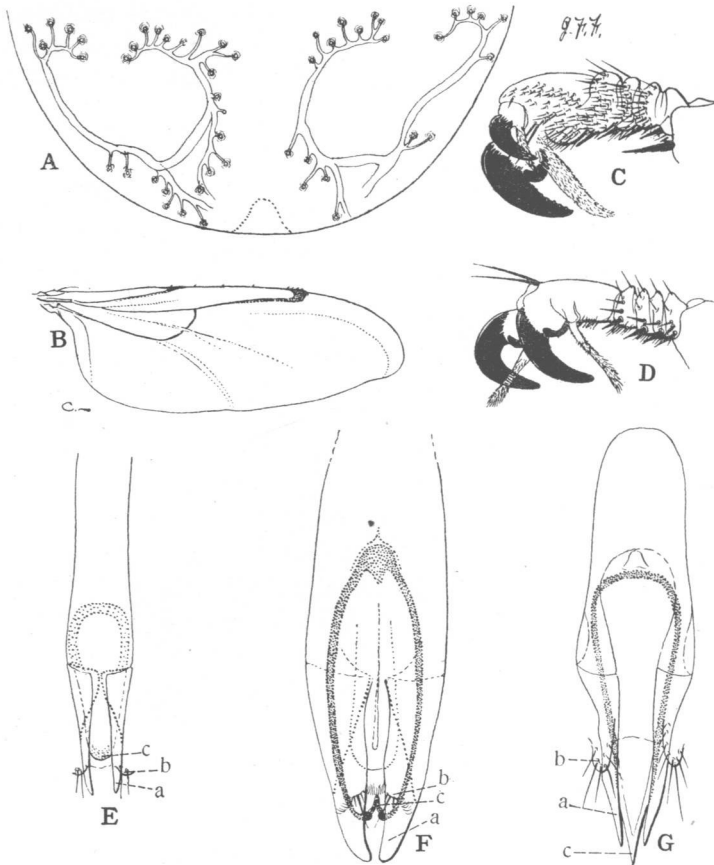


Fig. 2. *Lipoptena mazamae* Rondani: A, posterior extremity of larva showing spiracular openings; E, genitalia of male. *Lipoptena depressa* (Say): B, wing; D, anterior tarsus; F, genitalia of male. *Lipoptena subulata* Coq.: C, anterior tarsus. *Lipoptena traguli* n. sp.: G, genitalia of male.

of which are free. The entire sternite is beset with numerous stout setae. The remainder of the venter is quite thickly beset with small, slender setae.

*Genitalia* of the male (Fig. 2 F) without external processes, the position of these (b) indicated merely by two or three small setae. We are not prepared to discuss the homologies of the internal parts—to do so would necessitate a separate study for which we scarcely have the material—and must content ourselves with a general description. They consist of a pair of stout, chitinized

processes (*a*) attaching basally to a large apodeme or basal plate. Between these two processes is a ring-shaped piece (*c*) which extends forward on to the basal plate and terminates distally in a small point. Within this ring-like piece are some ill-defined structures that probably represent the true penis.

*Lipoptena mazamae* Rondani.

Figs. 2 *A*, 2 *E*.

1878. *Lipoptena mazamae* Rondani, *Ann. Mus. Civ. Genova*, p. 153.

1904. *Lipoptena depressa* (Say), Speiser, *Ibid.* p. 334.

1905. *Lipoptena depressa* (Say), Aldrich, *Catalogue of North American Diptera*, p. 653.

PREVIOUS RECORDS. Known only from the original records, from *Cervus mexicanus*, Central America.

SPECIMENS EXAMINED. Three males and two females from skin of a deer, *Mazama* sp., Yacuiba, Bolivia, in the collection of the Field Columbian Museum.

NOTES. Speiser (ref. cited) has placed this species as a synonym of *L. depressa*, but if our identification of the species be correct, this is decidedly in error, the genitalia of the males being so different that the two certainly cannot be the same species.

In general appearance *L. mazamae* is very similar to *L. depressa*, so much so, in fact, that the figure given for the female of the latter will apply almost equally well for the former. There are slight differences in the arrangement of the setae, but no more than might be included within the possible range of variation. The presence of a stout apical seta on the inner margin of the anterior tibia will permit the separation of *mazamae*, however. The genitalia of the latter (Fig. 2 *E*) are very different, being not only relatively but actually smaller than in *depressa* and having the inner ring-like piece (*c*) bluntly rounded at the tip.

*Lipoptena traguli* n. sp.

Figs. 2 *G*, 3.

SPECIMENS EXAMINED. Five individuals, the holotype, a female, and one female paratype from *Tragulus subrufus* Lingga Id., China Sea; the allotype and one male paratype from *T. russeus* Tuangku Id.; and one female paratype from *T. rubeus* Pulo Bintang, Rhio Archipelago. All the specimens are from skins in the National Museum and a paratype will be deposited in the collection of that institution.

The hosts are members of the family *Tragulidae*, the "mouse deer."

**Female** (Fig. 3). 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



Fig. 3. *Lipoptena traguli* n. sp., female.

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* (Fig. 2 G) with a pair of short external lobes (*b*) which are beset with small setae; internally with the inner ring-like piece (*c*) very sharply pointed at the apex.

NOTES. While in general this species quite closely approaches *L. depressa* it differs in numerous small details including the presence of a stout apical seta on the anterior tarsi and in the character of the genitalia.

*Lipoptena subulata* Coquillet.

Figs. 2 C, 4.

1907. *Lipoptena subulata* Coquillet, *Ent. News*, xviii. 290.

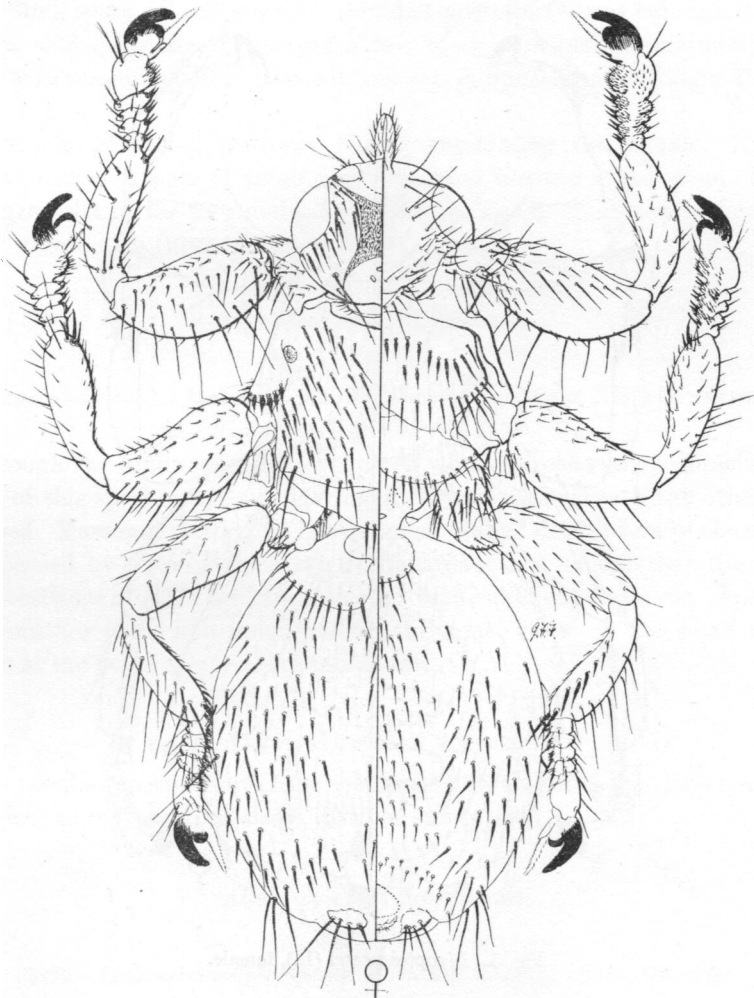


Fig. 4. *Lipoptena subulata* Coq., female.

PREVIOUS RECORDS. From "deer," Woodstock, New Hampshire, U.S.A.  
SPECIMENS EXAMINED. Males and females from *Odocoileus columbianus*, Humboldt and Mendocino Counties; from a locality not stated; and specimens taken in flight on Mt Wilson; all from California.

NOTES. The original description contains nothing of value in aiding to identify the species except the statement that there is "a stout black spine at the apex of the inner side of the front tibiae," which is sufficient to distinguish the species from *L. depressa*. We are simply assuming that our specimens represent this species.

The species presents a wealth of structural characters by which it is distinguished from any others that we have examined.

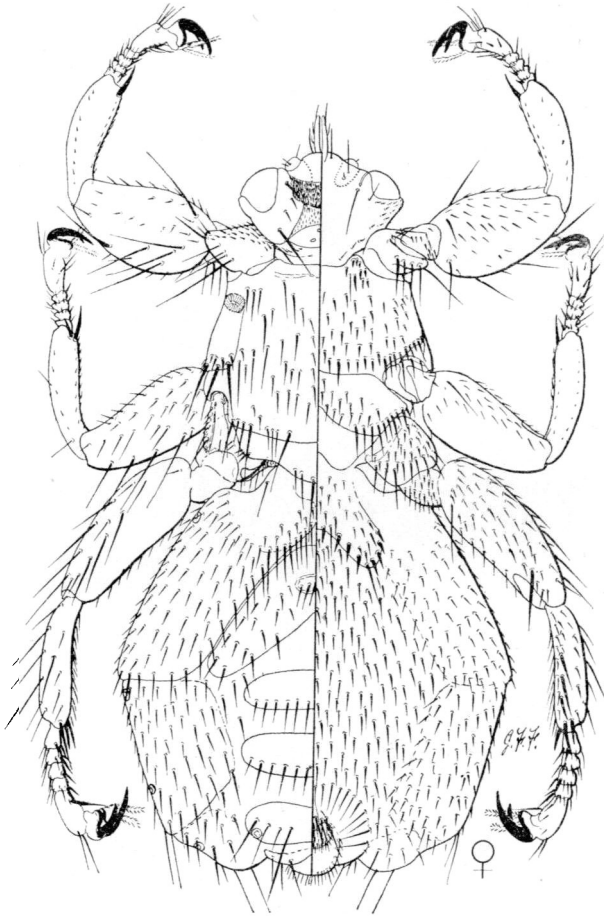


Fig 5. *Lipoptena cervi* (L.), female.

*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 pre-alar 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 (Fig. 2 C) 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 sub-marginal 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*.

*Lipoptena cervi* (Linnaeus).

Fig. 5.

1909. *Lipoptena cervi* L., Massonat, *Ann. de l'Université de Lyon*, N.S. (1), xxviii. 250-6; Pl. 2, figs. 13-19.

Through the kindness of Major Austen we have received specimens of the female of this species and are figuring it for comparison with the others here described. Massonat (ref. cited) has given a detailed description of the species, accompanied by figures which are quite satisfactory except that the details of the vestiture of setae are not indicated with sufficient clearness. According to this author there is a much greater difference between the sexes than is present in the other species here included.

Genus **Allobosca** Speiser.

The peculiar species that is the sole representative of this genus is regarded by Speiser as representing also a distinct sub-family.

*Allobosca crassipes* Speiser.

Figs. 6, 7.

1899. *Allobosca crassipes* Speiser, *Wien Ent. Zeitung*, xxviii. 199; Fig.

PREVIOUS RECORDS. From *Propithecus diadema* and *Lepilemur mustelinus*, Madagascar. The hosts are lemurs.

SPECIMENS EXAMINED. Five females and one male from skin of *Propithecus edwardsi*, Madagascar, in the United States National Museum.

NOTES. The original description of this species was accompanied only by a figure of the wing and we are taking advantage of the opportunity to

present figures and to add some notes. These are especially desirable as the species is one of considerable interest.

Speiser seems to have been in doubt as to the identity of the sexes, but as he suggested, the female (Fig. 6) has the apex of the abdomen quite deeply



bilobed, while in the male (Fig. 7 *B*) it is smoothly rounded. The abdomen of the male bears a large, oval genital plate which is almost destitute of setae. In other respects it is quite as in the female. The genitalia of the male are entirely internal and it has not been possible to make much out of them from the single specimen available.

The clypeal region (Fig. 7 *C*) has the median portion separated by a pair of deep incisions from the lateral parts. The front tarsi (Fig. 7 *D*) differ from the others in the presence of short, almost spatulate setae on the first four segments. The wing (Fig. 7 *A*) was figured by Speiser, but for the sake of completeness we are figuring it again.

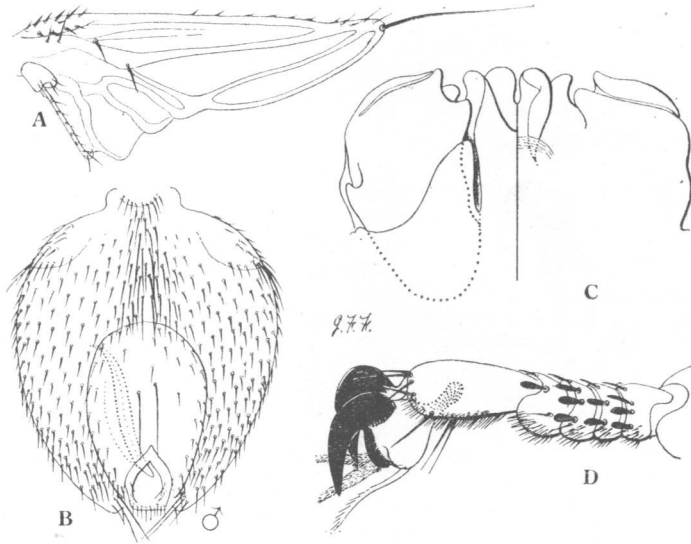


Fig. 7. *Allobosca crassipes* Speiser: A, wing; B, ventral aspect of abdomen of male; C, anterior portion of head; D, anterior tarsus.

#### Genus **Melophagus** Linnaeus.

An apology may be deemed advisable for discussing this well-known genus but our attention has been attracted to it by the discovery of an apparently new form, and in connection with the description of this some general notes may not be out of place. Furthermore, as far as we have been able to determine, there exists no illustration of any species of the genus that is of any particular value from a systematic standpoint. The crude figures that adorn the pages of most of our textbooks of parasitology, at least, can scarcely be regarded as pre-occupying the field, for at the best they show little more than the general characters of the genus.

Massonat (1909) has discussed at some length the question of the homology of the small projection at each posterior angle of the thorax which some authors seem to have regarded as a haltere. He arrives at the conclusion that these structures are in reality vestigial wings and with this conclusion we are entirely in accord. In fact their position is such that they cannot be halteres unless a most remarkable shifting of the position of these organs has taken place. They are to be regarded as almost the irreducible minimum of wing vestiges. No trace of the halteres can be found.

*Melophagus ovinus ovinus* Linnaeus.

Figs. 8, 9 A-D.

PREVIOUS RECORDS. A cosmopolitan species on domestic sheep. Speiser has described a "variety," *M. ovinus ferus*, from "Steinbok" in the Caucasus.

SPECIMENS EXAMINED. From domestic sheep in various parts of the United States.

NOTES. The accompanying figures will form a basis for the comparison of this species with other closely related forms such as that which we are describing below. The differences will be pointed out in connection with the description of this form.

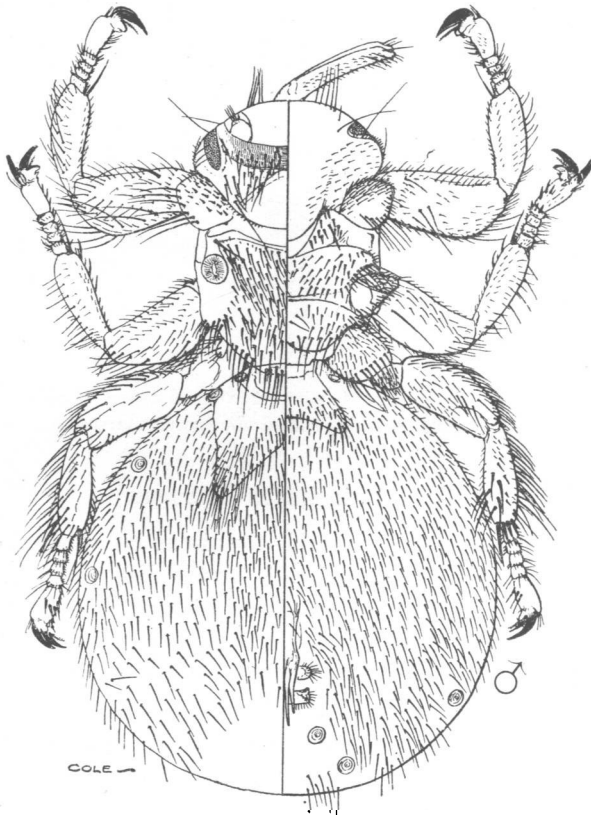


Fig. 8. *Melophagus ovinus ovinus* L., male.

*Melophagus ovinus montanus* new sub-species.

Figs. 9 E, 10.

SPECIMENS EXAMINED. Males only, from "mountain sheep," probably either *Ovis dalli* or *O. canadensis*, on the Alaska-Yukon boundary. The specimens, which have been in the Stanford Collection for some years, were received from the late Dr C. Gordon Hewitt.

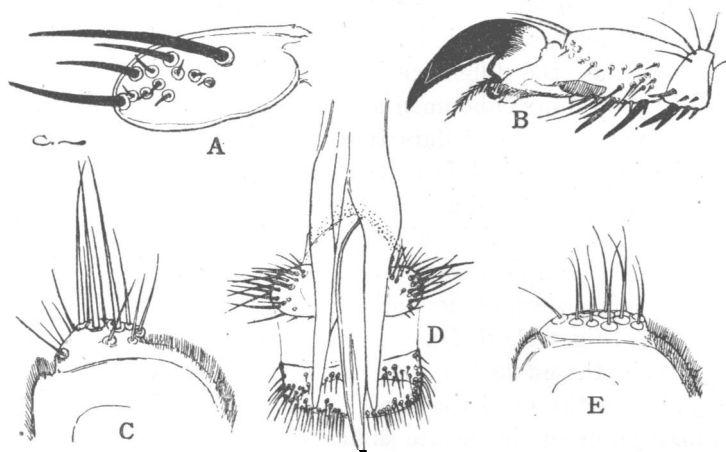


Fig. 9. *Melophagus ovinus ovinus* L.: A, wing vestige; B, portion of anterior tarsus; C, tip of antenna; D, genitalia of male. *Melophagus ovinus montanus* n. ssp.: E, tip of antenna.

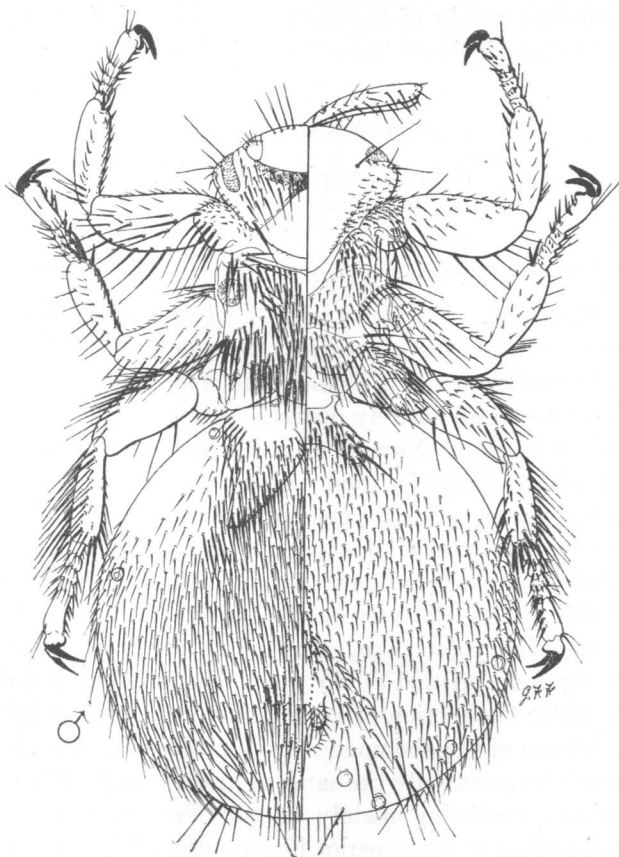


Fig. 10. *Melophagus ovinus montanus* n. ssp, male.



**Male** (Fig. 10). Differing from the male of *M. ovinus ovinus* (Fig. 8) 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 (Fig. 9 *C*) having the apical setae much longer than they are in *montanus* (Fig. 9 *E*). The wing vestiges, genitalia and claws seem to be the same as in the typical form (Fig. 9 *A, B, D*).

**NOTES.** While these two forms are certainly closely related we cannot but regard them as worthy of distinction. The differences are small, but upon a direct comparison of specimens are sufficiently evident. A sufficient amount of material of the typical form has been examined without evidence of variation to reduce the chance that *montanus* is simply a variant.

A comparison with *M. ovinus fera* Speiser is not possible, for the description of this form consists merely of the statement that "sie ist etwas schlanker, etwas heller und etwas kleiner" than the typical form.

#### Genus *Olfersia* Wiedemann.

##### *Olfersia americana* (Leach).

Figs. 11, 12.

1905. *Olfersia americana* (Leach), Aldrich, *Catalogue of North American Diptera*, p. 655.

**PREVIOUS RECORDS.** A widely distributed and often recorded species, infesting chiefly owls, in North America. Massonat (1909) has recorded the species from *Platalea leucorodia* in France, but, if we may rely upon his figures, his specimens represent an entirely distinct species.

**SPECIMENS EXAMINED.** Numerous examples from California and from Washington, District Columbia, from various species of owls.

Major Austen has very kindly compared one of our specimens with the type of this species in the British Museum and has confirmed this determination.

**NOTES.** The accompanying figure of the female (Fig. 11) should make the recognition of this species relatively easy. It is usually a reddish-brown species, some specimens being paler than others. The antennae are comparatively small and are strongly bristled at the apex. The frontalia is quite large and the orbits are wide. The section of horizontally striated membrane down the centre of the dorsum of the abdomen is quite noticeable. The chaetotaxy and form of the male are essentially the same as in the female. The male genitalia are characteristic, consisting mainly of two slender, pointed side pieces, possibly corresponding to the superior forceps, and a long central piece which is curved at the base, rather heavily chitinized and pointed. This may be

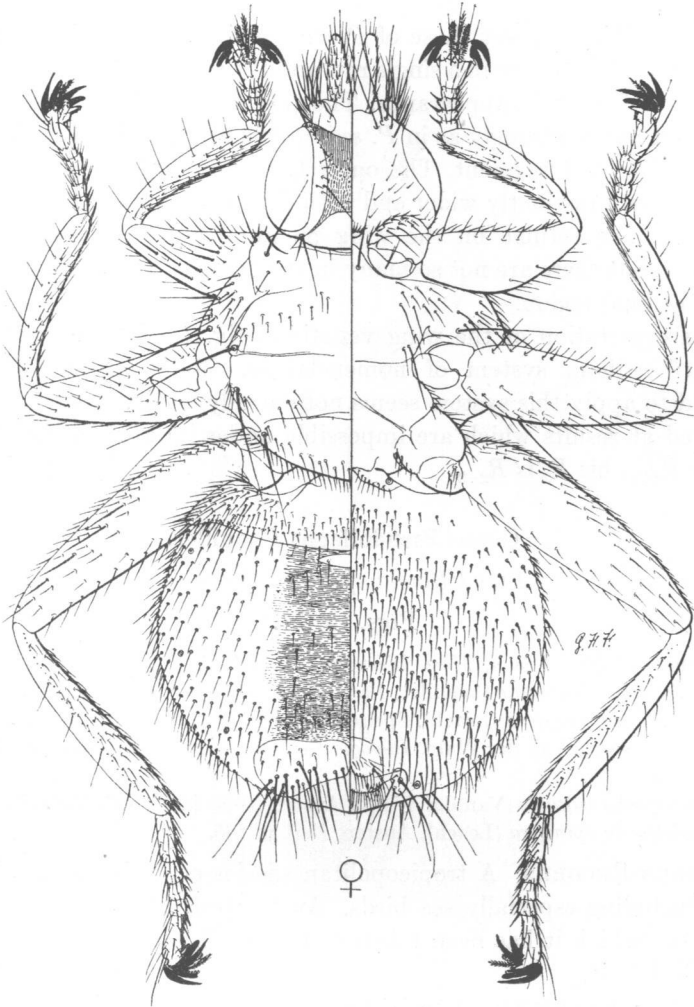


Fig. 11. *Olfersia americana* (Leach), female, from "barn owl,"  
*Aluco pratincola*, San Bernardino, California.

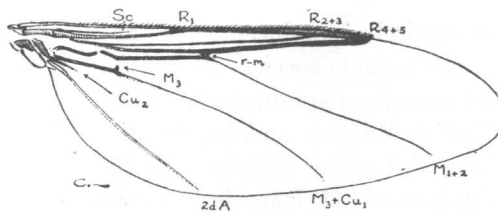


Fig. 12. *Olfersia americana* (Leach), wing. Lettering of venation according  
to Comstock-Needham system.

the aedeagus as there is a chitinized piece at the base, evidently the apodeme of the penis.

The hind tibiae suggest those of *Pseudolfersia spinifera*, described below, but the small tubercles are in a single row and the circular structures near them are slightly different in appearance. The posterior tarsi are toothed on the margins, but not so strongly as in *P. spinifera* and the teeth do not extend to the apex of the last segment. The outer tooth of the claws is very slender, the middle tooth distinctly wider and with a blunt, rounded tip. The arrangement of the fine setulae on the wing membranes is like that figured for *P. spinifera*, but there are not so many in the basal part of the wing and none at all in the anal region.

Our interpretation of the wing venation (Fig. 12) is in accord with the Comstock-Needham system of nomenclature. Massonat (1909) who has attempted to apply this system seems not entirely to have understood it and has arrived at results which are impossible under its application. His  $R_3$  is in reality  $R_{4+5}$ , his  $R_2$  is  $R_{2+3}$ .

#### Genus *Pseudolfersia* Coquillet.

##### *Pseudolfersia spinifera* (Leach).

Figs. 13, 14.

1818. *Feronia spinifera* Leach, *Mem. Wernerian Nat. Hist. Soc.* II. 557; Pl. 26, figs. 1-3.

1901. *Pseudolfersia diomedae* Coquillet, *Proc. Washington Acad. Sci.* III. 379.

1902. *Pseudolfersia spinifera* (Leach), Speiser, *Zeitschr. f. syst. Hym. und Dipt.* II. 146-149.

1903. *Olfersia vulturis* Van der Wulp, *Biologia Centrali Americana, Diptera*, II. 429; Pl. 13, figs. 1-1 a.

1903. *Pseudolfersia vulturis* (Van der Wulp), Austen, *Ann. Mag. Nat. Hist.* (7), XII. 261.

1903. *Pseudolfersia spinifera* (Leach), Austen, *Ibid.* p. 265.

**PREVIOUS RECORDS.** A tropicopolitan species occurring on a wide range of hosts including especially sea birds. Austen (ref. cited) gives a list of the species from which it has been taken and also a list of the names that have been applied to it.

**SPECIMENS EXAMINED.** A paratype male of *Pseudolfersia diomedae* Coq., from *Diomedea irrorata*, Galapagos Ids.; a single male from *Fregata aquila*, Cape San Lucas, Lower California; three males from "king vulture," Belize, British Honduras. All of these specimens from the Stanford University collection.

**NOTES.** We are entirely convinced that the specimens that we have examined represent but a single species—*P. spinifera* (Leach). Major Austen has kindly compared one of our specimens from "king vulture" with the type of *vulturis* in the British Museum and has identified it as this species. Our specimen from frigate bird agrees exactly with the very good description of *spinifera* given by Speiser and as this species is known to occur characteristically on the frigate bird, we do not doubt the correctness of our determination. The distribution of the species is remarkable, but it should be borne in mind

that certain of its hosts are wide ranging forms, both as species and as individuals.

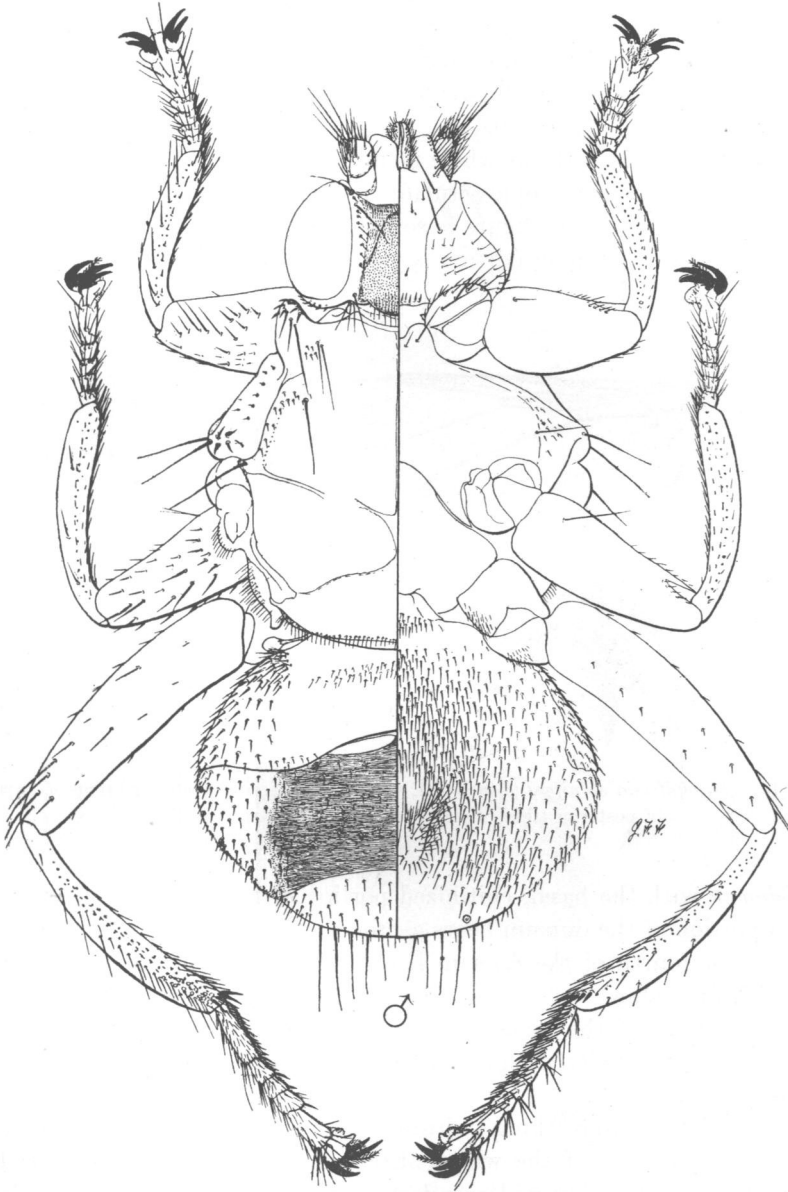


Fig. 13. *Pseudodfersia spinifera* (Leach), male. From paratype of *P. diomedae* Coq.

We present the following notes on the morphology of the species.

*Head* with no strong fronto-orbital bristles.

*Thorax* with the mesonotum almost bare, the scutellum with a marginal row of very small setae. Sternum practically entirely bare. The tibiae and

tarsi show what are probably good specific characters in the arrangement of the setae and in the presence of small, tooth-like projections on the tarsi. The hind tarsi (Fig. 14 *B*) have a row of these teeth along each ventral margin of each segment; on the front tarsi there are but two of these teeth near the base of the last segment. The hind tibiae have, in addition to setae and small spines, a large number of small circular structures near their apices (Fig. 14 *C*) which are probably sensory pits.

*Wings* (Fig. 14 *A*) with the whole membrane, back to the basal cross veins, densely beset with microscopic setulae which cannot be shown in the figure; the stippled portion in the figure is so densely beset with these setulae as to appear gray, the remaining portion is yellowish and has only a thin covering of setulae.

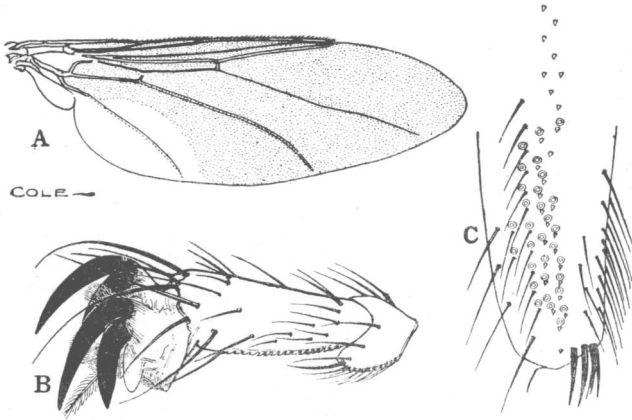


Fig. 14. *Pseudofiersia spinifera* (Leach): *A*, wing; *B*, portion of posterior tarsus; *C*, apex of posterior tibia. From paratype of *P. diomedae* Coq.

*Abdomen* with the basal, chitinized portion of the dorsum extensive. The median portion of the dorsum bears a broad area of fine, dense striations and the posterior fourth of the dorsum is chitinized. The ventral side is thickly beset with fine setae.

The genitalia of the male show a pair of quite long, tapering external processes and internally a pair of pointed structures, probably the superior forceps.

The specimens from "king vulture" differ very slightly from the others, having the anal area of the wing entirely bare of setulae and the cell *2M* (second basal) noticeably wider and shorter. However, the latter character is somewhat variable in the specimens examined.

Genus **Ornithomyia** Latreille.

*Ornithomyia avicularia* (Linnaeus).

Figs. 15, 16.

1909. *Ornithomyia avicularia* (L.), Massonat, *Ann. de l'Université de Lyon*, N.S. (1), xxviii. 271-78; Pl. 4, figs. 33-34.

1921. *Ornithomyia anchineuria* Speiser, Cole, *Proc. Calif. Acad. Sci.* (4), xi. 344.

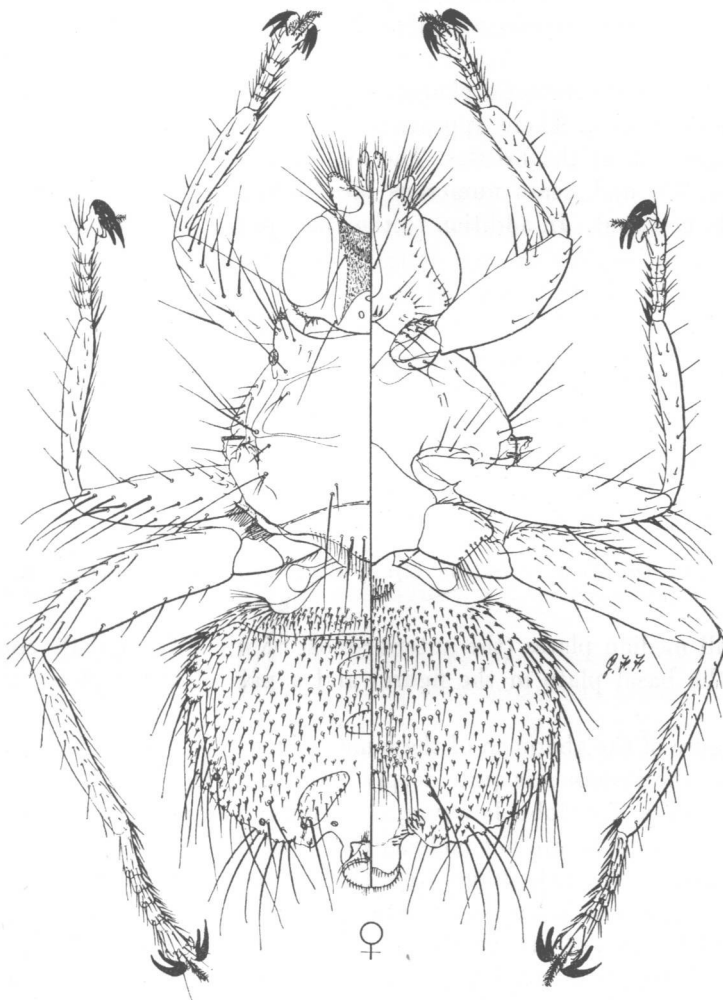


Fig. 15. *Ornithomyia avicularia* (L.), female.

**PREVIOUS RECORDS.** A widely distributed European and North American species on many passerine and raptorial birds.

**SPECIMENS EXAMINED.** Two females, one from Keyport, Washington, without indication of host, and one from *Sayornis sayi*, Pacific Grove, California,

both in the Stanford University collection; one male from *Cyanocitta stelleri*, Upper Alsea River Valley, Oregon, in the collection of the junior author. This last specimen has previously been recorded by Cole (ref. cited) as *O. anchineuria* Speiser.

NOTES. There have been numerous descriptions of this species but only that given by Massonat (ref. cited) is sufficiently precise and accompanied by such figures as to make identification definitely possible. Our specimens agree very closely with the figures given by this author, but as there are certain chaetotactic details which he has not included we are figuring it again.

Some of the chaetotactic characters are possibly generic and some are undoubtedly specific. There appears to be some slight variation in the size and arrangement of the bristles. The abdomen is densely beset with small setae (Fig. 15) and bears numerous large setae, the position of which is apparently constant. In addition to the basal plate there are on the dorsum

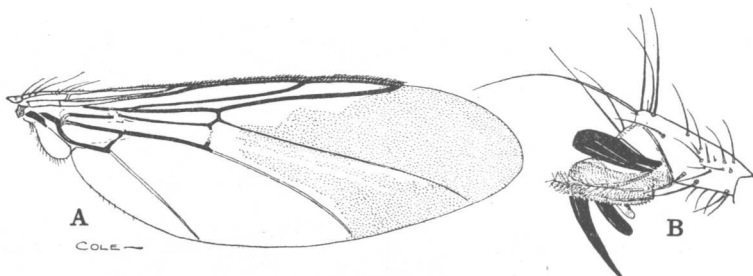


Fig. 16. *Ornithomyia avicularia* (L.): A, wing; B, portion of anterior tarsus.

three small median plates (the anterior-most of which is partially concealed beneath the basal plate in the figure) and a pair of larger plates near the apex.

The figure of the abdomen of the female given by Massonat indicates that the apex of the abdomen is quite deeply bilobed, while in our specimens there is a median lobe. This lobe, however, is membranous and is probably more or less retractile, and we are not inclined to regard this difference as important. The abdomen of the male differs from that of the female chiefly in not being lobed at the apex and in having a complete, transverse, pre-apical plate instead of the paired plates of the female. The genitalia show no external processes; the internal structures consist of a pair of slender, pointed, lateral processes and a pointed median process.

The wing venation is characteristic,  $R_1$  (first vein) ending considerably before the radio-medial (first) cross-vein. The fine setulae are confined to a definite area as indicated in the figure. The costa is covered with short, bristly setae, especially dense beyond the end of  $R_1$ .

Genus **Stilbometopa** Coquillet.*Stilbometopa impressa* (Bigot).

Figs. 17, 18.

1885. *Olfersia impressa* Bigot, *Ann. Soc. Ent. France*, p. 257.1902. *Stilbometopa impressa* (Bigot), Speiser, *Zeitschr. f. syst. Hym. und Dipt.* II. 163.

PREVIOUS RECORDS. Originally recorded by Bigot from California and recorded by Speiser from a specimen from California.

SPECIMENS EXAMINED. A female taken from "valley quail," *Lophortyx californica*, California, in the collection of the California Academy of Sciences; one female from Mecca, California, without indication of host, in the same collection; one broken specimen of undeterminable sex from "quail," Mount Hamilton, California, in the Stanford University collection; one female, without indication of host, from San Diego, California, June, 1921.

NOTES. Speiser (ref. cited) gives a very good re-description of this species from the type. It is an easily recognizable form of very peculiar character. It is interesting to note that the type of the genus which is the only other included species, *S. fulvifrons* (Walker), also infests gallinaceous birds, Austen having reported it from *Ortyx virginiana*, *Geotrygon sylvatica* and *G. montana*, among other hosts.

The colour of the body is evidently to some extent variable, some specimens being yellowish brown, others blackish. The setae on the legs and antennae are blackish, those on the frons and mesonotum yellowish. The face, clypeus and underside of the head are yellowish. There are few setae on the mesonotum and these are placed in definite areas as indicated (Fig. 17).

The antennae in Fig. 17 are pointing downward, their shape is better shown in Fig. 18 B.

The prothoracic spiracles are very large and heavily chitinized. The scutellum has a distinctive shape, being very broad and almost emarginate posteriorly. On each side of the thorax, just under the vestigial squamae, is a remarkable, heavily chitinized, hammer-shaped projection, that is very distinctive of the species.

The abdomen has a dense covering of short setae borne upon small tubercles, most of these setae being short and heavy. The basal, chitinized portion of the dorsum is large and the remainder is membranous except for a pair of plates near the apex. The ventral side is entirely membranous except for a pair of plates on the anterior margin of the vulva.

The ungues (Fig. 18 C) have the outer tooth much longer than the second; the few setae on the last tarsal segment are strong, a blunt seta near the base of the pulvilli being especially noticeable.

The wings (Fig. 18 A) are entirely destitute of the microscopic setulae that are present in all the other bird-infesting forms known to us. The veins near the base and anterior margin of the wing are heavy and black and there is a thick anal cross-vein ( $Cu_2$ ).



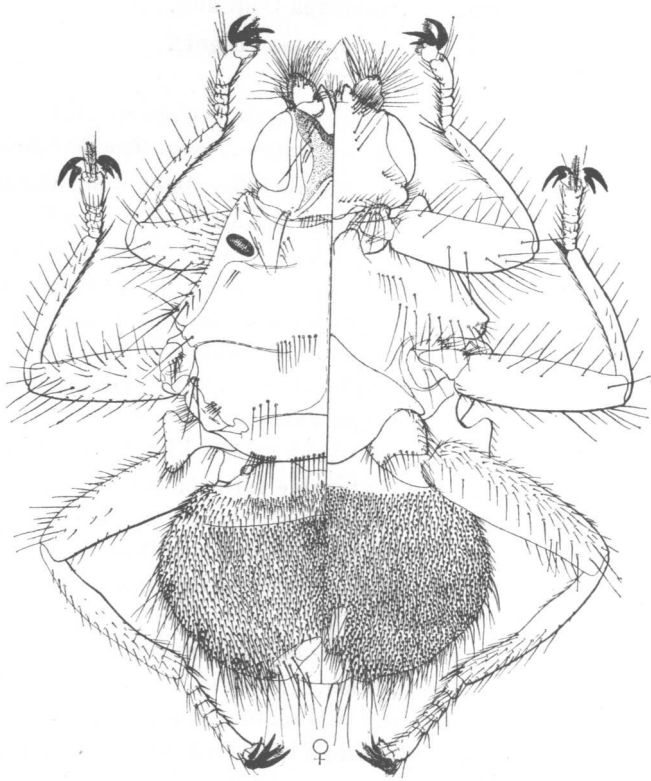


Fig. 17. *Stilbometopa impressa* (Bigot), female.

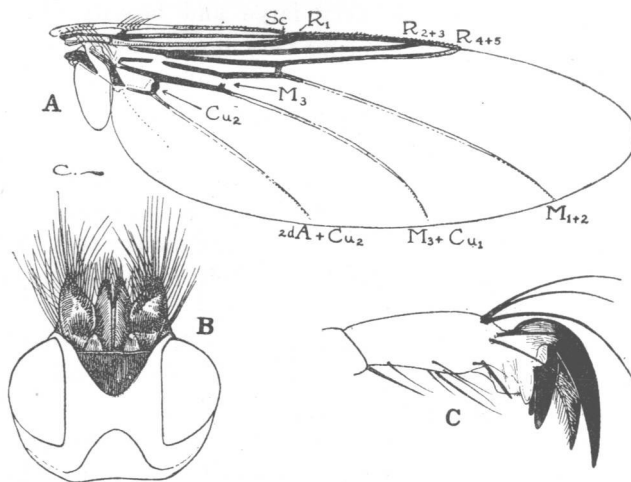


Fig. 18. *Stilbometopa impressa* (Bigot): A, wing, lettering in accordance with the Comstock-Needham system; B, head; C, portion of tarsus.

Genus **Ornithoica** Rondani.

*Ornithoica promiscua* n. sp.

Figs. 19, 20.

SPECIMENS EXAMINED. Holotype, a female, in the collection of the California Academy of Sciences, taken from *Pipilo crissalis carolae*, Castle

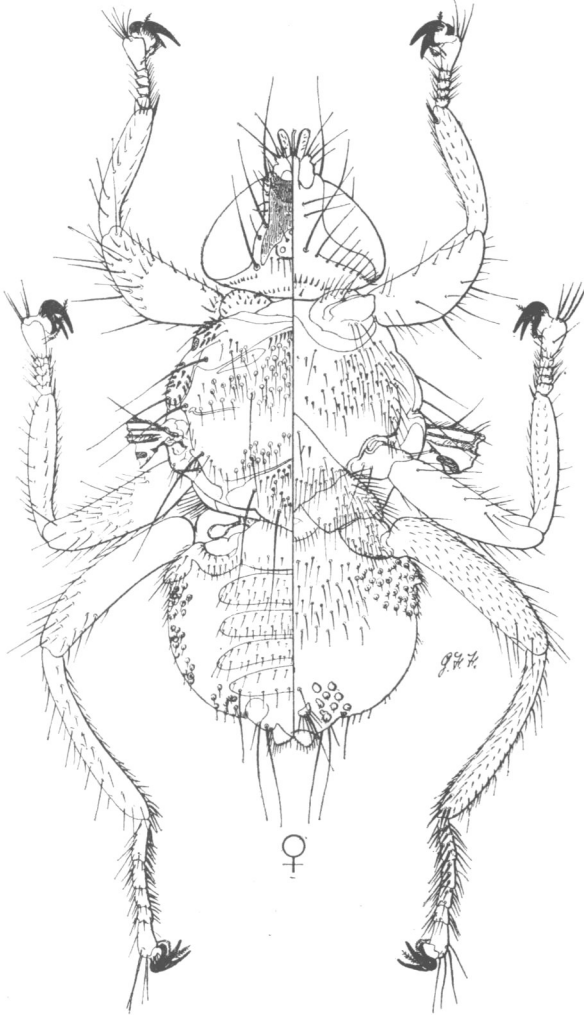


Fig. 19. *Ornithoica promiscua* n. sp., female. From the holotype.

Hot Springs, Lake County, California, Sept. 23, 1920 (J. Maillard). Three female paratypes all from California; one from "fox sparrow," San Francisco, Dec. 5, 1919 (L. Little), in the same collection; one from *Regulus calendula*, Pacific Grove, Jan. 25, 1904; one from *Falco sparverius*, King's River; the last two in the Stanford University collection.

**Female** (Fig. 19). Length (on slide) 2.5 mm. A yellowish brown species, the thorax darker than the legs.

*Head* with the frons probably almost parallel-sided in perfect specimens but in the holotype curving in slightly. Frontal orbits with at least three strong setae and several smaller setae. Ocellar setae small. Ventral side with a row of slender setae more or less paralleling the orbits.

*Thorax* with several short, stout, black setae on the humeral callosities and on the margin in front of the wing. Mesonotum with numerous small, pale setae, all with distinct pustulations about the base. There is a single long seta just behind the humeral callosity, two in front of the wing and one just behind the wing. Scutellum with small, pale, pustulated setae on the disc and with four long, black setae. Halteres rather small and delicate.

On the ventral side both meso- and meta-sternum are beset with numerous fine setae, mingled with a few that are small and stout.

*Wings* (Fig. 20 A) with a well-defined anal cell;  $R_{2+3}$  distinctly curved toward the costa and bristly to the tip; *m-cu* cross-vein broken, the upper part obsolete; vein above cell 2*M*, broken near the middle; distal half of the wing covered with microscopic setulae as shown in the figure.

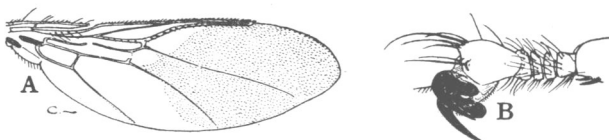


Fig. 20. *Ornithoica promiscua* n. sp.: A, wing; B, anterior tarsus.

*Legs* comparatively strong, the anterior femora noticeably thickened; setae arranged in a rather definite fashion, as shown in the figure. Claws (Fig. 20 B) rather slender.

*Abdomen* above with a chitinized basal plate extending from side to side, with four quite large plates occupying the median half and with a small plate on each side of the anal region, the basal plate and the succeeding four with numerous small setae and the para-anal plates or their immediate region with two long setae. Lateral margins with a number of small, stout setae which are borne on tubercles. On the ventral side there is a median region beset with small setae, a region along the anterior, lateral margin with numerous setae on tubercles and a smaller region of these near the genital opening. Near the genital opening there is also a pair of small plates bearing several slender setae.

NOTES. One other species of this genus, *O. confluens* (Say), has been recorded from North America, and, as far as we can learn, all references to this species have been based upon Say's description. We regard *confluens* as unrecognizable from this description and are therefore describing our species as new. *O. confluens* was taken from *Ardea candidissima*.

Austen (1903) states that *O. vicina* (Walker) may be a synonym of *confluens*, that *O. beccariina* Rondani from Amboina, on *Ardea alba*, is identical with

*O. exilis* (Walker) from New Guinea, and that this too is probably the same as *vicina*.

Our species is certainly very close to *O. turdi* (Latreille) (Massonat, 1909) from Europe. Certain differences are evident on the basis of Massonat's description and figures, but it is not at all improbable that these differences might disappear upon a comparison of specimens.

Two specimens from "California russet-backed thrush," *Hylocichla ustulata*, without indication of locality, differ somewhat from the typical *promiscua*, the setae being in general fewer and smaller, approaching more closely *turdi*, but our material is not in the best of condition, and for the present we place them provisionally with *promiscua*.

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- AUSTEN, E. E. (1903). Notes on *Hippoboscidae* (Diptera Pupipara) in the Collection of the British Museum. *Ann. Mag. Nat. Hist.* (7), XII. 255-266.
- MASSONAT, E. (1909). Contribution a l'Étude des Pupipares. *Ann. de l'Université de Lyon*, N.S. (1), XXVIII. 1-356; Pls. 1-7.