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DAVID S. JORDAN,

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NEW MALLOPHAGA,  
III.

Comprising

MALLOPHAGA FROM BIRDS OF PANAMA, BAJA CALIFORNIA  
AND ALASKA,

BY

VERNON L. KELLOGG,

Professor of Entomology, Leland Stanford Junior Univer

MALLOPHAGA FROM BIRDS OF CALIFORNIA,

BY

VERNON L. KELLOGG AND BERTHA L. CHAPMAN.

THE ANATOMY OF THE MALLOPHAGA,

BY

ROBERT E. SNODGRASS,

Assistant in Entomology, Leland Stanford Junior University.

*Issued February 28, 1899.*

SAN FRANCISCO,  
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## AUTHOR'S PREFACE.

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The papers presented herewith constitute the third contribution from the Entomological Laboratory of this University (Stanford) to the knowledge of the North American Mallophaga. The two previous papers are respectively, Kellogg, New Mallophaga, I, 1896<sup>1</sup> and Kellogg, New Mallophaga, II, 1896<sup>1</sup> and contain in addition to descriptions of species, an introduction to the study of the group, comprising keys to genera, terminology, bibliography, etc.

Mr. Snodgrass's paper presents the results of the first serious attempt to study comparatively the anatomy of these insects. There is yet needed to make the Mallophaga fairly known a study of their embryonic and post-embryonic life-history. It is hoped that this study can soon be undertaken.

Types of the new species described will be placed in the collections of this University, in the collections of the California Academy of Sciences, and in the collections of the University of Kansas. The authors have to express their obligations for services kindly rendered in connection with the preparation of this paper to Mr. Leverett M. Loomis, Curator of the Department of Ornithology, California Academy of Sciences, to Messrs. R. C. McGregor, J. F. Abbott, Cloudsley Rutter, A. W. Greeley, W. H. Osgood, J. C. Brown, R. C. McLain, R. W. Doane and E. M. Ehrhorn, to Prof. Walter E. Miller and to Miss Mary H. Wellman, artist.

V. L. K.

STANFORD UNIVERSITY,  
April 15, 1897.

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<sup>1</sup> Proc. Cal. Acad. Sci., 2nd Ser., Vol. VI.





# MALLOPHAGA FROM BIRDS OF PANAMA, BAJA CALIFORNIA, AND ALASKA.

(With Plates I-IV.)

BY VERNON L. KELLOGG.

## CONTENTS.

Introduction.

Descriptions of New Species, and Identifications of Old Species.

Docophorus.

Nirmus.

Lipeurus.

Goniodes.

Eurymetopus.

Trinoton.

Colpocephalum.

Menopon.

Physostomum.

List of Hosts, with Parasites.

## INTRODUCTION.

The Mallophaga described and identified in this paper were collected by Mr. R. C. McGregor (from the Panama birds), by Mr. J. F. Abbott (from the Baja Californian birds) and by Messrs. Cloudsley Rutter and A. W. Greeley (from the Alaskan birds), all these collectors being students of Stanford University. The birds in each case were obtained personally by the collector, and the Mallophaga taken from the freshly killed specimens or newly made skins. The determinations of the Panama birds were made by Mr. Robert Ridgway, curator of birds, U. S. National Museum; the determinations of the Baja Californian birds by Mr. W. W. Price, student of Stanford University, and the determinations of the Alaskan birds by the collectors.

The sequence of genera in the following paper does not indicate the author's views with regard to the natural relationships of these genera, nor even with regard to the phyletic rank of the suborders. The Amblycerous genera, coming last in the present arrangement, are undoubtedly the more generalized of the two subordinal groups. The sequence is that adopted in the European monographs and followed by me in my two previous papers (New Mallophaga, I, 1896, and New Mallophaga, II, 1896), and is retained for the sake of uniformity. The sequence of the species of each genus is determined by the host, the sequence of hosts being that adopted in the Check-List of North American Birds (2nd Edition, 1895), published by the American Ornithologists' Union. The names of the hosts are those used in the Check-List.

Wherever a species of Mallophaga is met, which has been previously identified by me on an American host, reference is made only to this previous identification, where the synonymy, European hosts, and figure and measurements of the species are given.

### Docophorus.

*Docophorous lari* Denny. (See Kellogg, New Mallophaga, I, 1896, p. 98, pl. iv, fig. 4.)

Specimens from *Larus* sp. (Baja California) and from *Larus glaucescens* (North Pacific Ocean, off Alaska). Taken previously by me from several species of *Larus* (Bay of Monterey, California.)

*Docophorus icterodes* Nitzsch. (See Kellogg, New Mallophaga, I, 1896, p. 96, pl. iv, fig. 1).

Specimens from the Red-crested Merganser, *Merganser serrator* (Kodiak Island, Alaska). Previously taken by me from same host species and from seven other duck species (Kansas and California).

**Docophorus cordiceps** Giebel. (Plate I, fig. 2).

Insecta Epizoa, 1874, p. 103.

*Docophorus glareolæ* Giebel, Zeitschr. f. ges. Naturwiss., 1866, vol. xxviii, p. 312.

*Docophorus nitzschia* Giebel, Zeitschr. f. ges. Naturwiss., 1866, vol. xxviii, p. 312.

*Docophorus mollis*, Nitzsch (ed. Giebel), Zeitschr. f. ges. Naturwiss. 1861, vol. xviii, p. 312.

*Docophorus frater* Giebel, Insecta Epizoa, 1874, p. 103.

*Docophorus cordiceps* Giebel, Piaget, Les Pediculines, 1880, p. 80 and p. 664, pl. vi, fig. 2; Picaglia, Pediculini dell' istituto anat.-zool. d. R. Univ. d. Modena, 1885, reprint, p. 11.

A male, a female and a young specimen which may be referred to this species from *Tringa macularia* (Panama), and a male from *Tringa* sp. (Baja California). It is probable that Denny's *D. cephalus* (Monograph. Anoplur. Brit., p. 81, pl. ii, fig. 8; and Grube, Middendorff's Reise, 1851, p. 470) is this species.

The species may be recognized by its general dark coloration, broad head, short clypeus, and prominent and characteristic genitalia. I figure the male; Piaget has figured the female. The measurements of my specimens are as follows: male, body, length 1.6 mm., width .72 mm.; head, length .56 mm., width .62 mm.; female, body, length 1.65 mm., width .87 mm.; head, length .62 mm., width .75 mm.

**Docophorus latifrons** Nitzsch. (Plate I, figs. 5 and 8).

Germer's Mag. Entomol., 1818, vol. iii, p. 290.

*Pediculus cuculi* Fabricius, Syst. Ent., 1775, p. 807.

*Pediculus fasciatus* Scopoli, Entomol. Carniol, 1763, p. 383.

*Docophorus latifrons* N., Denny, Monograph. Anoplur. Brit., 1842, p. 97, pl. i, fig. 4; Giebel, Insecta Epizoa, 1874, p. 93; Piaget, Les Pediculines, 1880, p. 36, pl. ii, fig. 7.

Numerous specimens from a California Cuckoo, *Coccyzus americanus occidentalis* (Baja California), which are referable to this long-known *Docophorus* of the cuckoos, but on account of the markedly larger size, color differences, and other minor differences must be given a varietal name.

Var. *occidentalis* Kellogg. Male, body, length 2.06 mm., width .89 mm.; head, length .75 mm., width .75 mm. Female, body, length 2.5 mm., width 1.12 mm.; head, length .84 mm., width .85 mm. Piaget gives the following dimensions for *latifrons*: female, body, length 1.9 mm., width, .85 mm.; head, length .65 mm., width .6 mm. The male *latifrons* is 1.6 mm. long. My specimens have two long hairs on the temporal margins instead of one as described for *latifrons*, and have a distinct hair, not referred to in the descriptions of *latifrons*, in the posterior angles of the prothorax. The blotches on the ventral aspect of the abdomen of the males are with my specimens not oval, but transversely elongate, differing markedly from those of the female. The head and thorax of var. *occidentalis* are reddish brown, the ground color of the abdomen whitish, and the blotches blackish brown.

### *Docophorus californiensis* Kellogg.

New Mallophaga, II, 1896, p. 483, pl. lxvi, fig. 6.

Eleven specimens from a Narrow-fronted Woodpecker, *Melanerpes formicivorus angustifrons* (Baja California). Type specimens taken from the Californian Woodpecker, *Melanerpes formicivorus bairdi* (Palo Alto, California).

**Docophorus rufus** n. sp. (Plate I, figs. 6 and 9).

A dozen specimens from the Ash-throated Flycatcher, *Myiarchus cinerascens nuttingi* (Baja California). A member, probably, of the group *femorati* of which *communis* is the chief representative. I have not found on my specimens the characteristic longish hair rising vertically from the dorsal surface of the anterior angles of the clypeus, but the broad clypeus, signature, genital blotches, and pustulated lateral abdominal blotches are of the *femorati* type. The species differs distinctly from *communis* in color, in the peculiar anterior convexity of the clypeus, in the extent of the transverse abdominal blotches, in the presence of transverse median blotches on the ventral aspect of the abdomen, and in the character of the genital blotches.

Description of the male. Body, length 1.56 mm., width .31 mm.; reddish brown, lighter on head and thorax, because the darker lateral abdominal blotches nearly cover the abdomen; broad headed; with ventral median transverse blotches on abdomen.

Head, length .5 mm., width .48 mm.; forehead broad, with expanded frontal uncolored part of clypeus flatly convex, with a shallow, median, curving emargination; no hairs on this frontal margin; sides of forehead with a pair of short hairs and a shorter single one in front of and near the trabeculæ; the trabeculæ very large, acute; antennæ when projected backward not quite reaching the occipital margin; the inconspicuous, slightly pendulous eyes with a hair, and two hairs on the flatly convex temporal margin; occipital margin nearly straight, bare; color, reddish brown; signature large, broad, anterior margin almost straight, the dark, sharp posterior point projecting beyond the mandibles;

antennal bands interrupted distinctly at the suture; occipital bands distinct, divergent, connected at base; ocular bands indistinct; trabeculæ weakly colored at base, uncolored distally; antennæ colored.

Prothorax quadrangular (as exposed), with a single hair in the posterior angles; posterior margin flatly convex; median part paler; lateral regions darker, and an indistinct posterior border. Metathorax rather short, posterior margin angulated, with a series of pustulated hairs; colored like the prothorax, paler in middle and with fairly distinct lateral borders. Legs concolorous with ground color of thorax, with small, darker, inconspicuous marginal markings. Sternal markings consisting of intercoxal lines and a very small median double blotch on prothorax. (Metathorax obscure).

Abdomen short, just as long as head and thorax; two to three long hairs in posterior angles of segments and numerous pustulated and other long hairs on dorsal surface; narrow, blackish, lateral bands; large dark brown lateral blotch, with clear stigmatal spots and about five pustulations along posterior margin, and leaving only a narrow median part of the abdomen uncovered; on segment 8 a complete transverse band; segment 9 rounded behind, with a narrow blackish posterior border, with a few longish hairs; genitalia showing through in segments 6-9; on ventral surface of segments 1-8 a large transverse median blotch reaching almost to the lateral margins.

Female. Body, length 1.94 mm., width .8 mm.; head, length .6 mm., width .56 mm.; the transverse blotches of abdomen but little smaller than those of male; segment 9 uncolored, with small brown lateral blotches, the posterior margin distinctly angularly emarginated;

ventral abdominal blotches smaller than those of male and not reaching so far laterally, those of posterior segments forming a genital blotch with broad, curving anterior part, narrower median part, and separate small lateral reniform parts.

**Docophorus communis** Nitzsch. (See Kellogg, *New Mallophaga*, II, 1896, p. 486, pl. lxvi, fig. 7).

Several specimens from the Saint Lucas Cardinal, *Cardinalis cardinalis igneus* (Baja California). Taken previously by me from 16 species of passerine birds (Kansas and California).

**Docophorus panamensis** n. sp. (Plate I, fig. 1).

From a tanagrine bird, *Phænicothraupis fuscicauda* (Panama). A *Nirmus*-like form but with distinctly long trabeculæ. By shape of head and thorax allied to the *angustifrontes* group of the woodpeckers; resembling my *D. jungens* (*New Mallophaga*, II, 1896, p. 481, pl. lxvi, fig. 4) from *Colaptes auratus* (Kansas).

Description of female. Body, length 1.75 mm., width .61 mm.; narrow, Nirmoid, whitish with distinct brown lateral bands on thorax and abdomen, and quadrangular lateral transverse blotches.

Head, length .5 mm., width .5 mm.; triangular, with narrow front, slightly emarginated; three short hairs on each side of the anterior half of the forehead, and three longer hairs and a prickle in front of the trabeculæ; the trabeculæ prominent, extending beyond the tip of first segment of the antennæ; the antennæ rather thick, segment 2 longest, with a prominent short spiny hair; eyes rather large, with a prickle; temporal margin

rounding, with one long hair and a few prickles; occipital margin slightly sinuous; forehead whitish with narrow brown antennal bands terminating at the suture; a palely colored broad suture with straight posterior margin and emarginated anterior border; whole hind head light brown with occipital margin very narrowly bordered with blackish brown.

Prothorax quadrangular, posterior angles rounded, with one hair, posterior margin flatly convex; whitish with dark brown lateral borders extending inward along the posterior margin. Metathorax angulated on abdomen, each latero-posterior side with nine long hairs (including the one in the lateral angle); lateral borders unevenly blackish brown; ground color of segment whitish tinged posteriorly with light brown, this posterior coloration interrupted by a median longitudinal whitish line. Legs very pale brown. Sternal markings consisting of distinct intercoxal lines, and faint traces of light brown median blotches.

Abdomen elongate-elliptical; a few longish hairs in posterior angles, and numerous weak long hairs on dorsal surface of segments in transverse series; ground color whitish with distinct, narrow lateral bands, darkest on anterior segments, and light brown, quadrangular, transverse lateral blotches on all segments, the two blotches of segment 8 meeting on the median line; segment 9 feebly emarginate, with no hairs on the posterior margin.

### **Docophorus domesticus Kellogg.**

New Mallophaga, II, 1896, p. 475, pl. lxx, fig. 4.

A female and an immature specimen from the Black Martin, *Progne subis hesperus* (Baja California). De-



scribed from a Purple Martin, *Progne subis* (Lawrence, Kansas).

**Docophorus laticeps** Giebel. (Plate I, figs. 4 and 7).

Insecta Epizoa, 1874, p. 88.

*Philopterus cincli* Gervais, Hist. nat. d. Insectes aptères, 1847, p. 336.

*Docophorus cincli* Denny, Monograph. Anoplur. Brit., 1842, p. 85, pl. v, fig. 8.

*Docophorus laticeps* Giebel, Piaget, Les Pediculines, 1880, p. 65; Kœnig; Ein Beitrag zur Mallophagen-fauna, 1884, p. 3, pl. i, figs. 1-5; pl. ii, figs. 6, 7.

One adult female and two immature specimens from the American Dipper, *Cinclus mexicanus* (Kodiak Island, Alaska), which may be referred to this species, but which constitute a distinct variety characterized by the elongate, slender forehead with emarginated front. The species was found on *Cinclus aquaticus*, the European Dipper.

Var. *americanus* Kellogg. Female, body, length 2.06 mm., width .75 mm.; head, length .6 mm., width .5 mm.; thus being one-third longer than the species dimensions as given by Kœnig; head elongate, with narrow tapering forehead; front uncolored, with slight, narrowly rounded emargination; signature long, narrow, with posterior point reaching the mandibles; antennal bands distinct; trabeculæ long, slender; abdomen elongate-elliptical, with lateral triangular blotches with stigmatal spots and pustulations as in the species types; also, narrow blackish lateral bands; segment 8 wholly colored; ventral surface of abdomen with transverse median blotches; segment 7 with a narrower median blotch (touching blotch of segment 6) and two small lateral reniform blotches; segment 8 wholly colored or nearly so.

*Docophorus rutteri* n. sp. (Plate I, fig. 3).

A female and an immature specimen from an Oregon Chickadee, *Parus atricapillus occidentalis* (Kodiak Island, Alaska). Denny has described two species of *Docophorus* from *Parus*, one, *pallescens* (Monograph. Anoplur. Brit., p. 82, pl. i, fig. 8) from *Parus palustris* and *P. major*, being based on immature specimens, and characterized by an emarginate clypeal front; the other, *pari* (ibid, p. 87, pl. vi, fig. 6) from *Parus caudatus*, *P. ater*, and *P. ceruleus*, being of chestnut ground color, without lateral abdominal blotches and with a subacuminate head, and without series of pustuled hairs along posterior margins of metathorax, in all of which diagnostic characters my specimen differs from *pari*. It agrees with it in hairy abdomen, acute trabeculæ, angulated metathorax, and general shape of abdomen.

Description of female. Body, length 2. mm., width .91 mm.; well marked with smoky brown blotches with large conspicuous pustulations, and many long hairs on dorsal aspect of abdomen.

Head, length .53 mm., width .6 mm.; a specially stiff, spiny short hair in each anterior angle of the flatly convex front, a hair before the suture and two before the trabeculæ; the trabeculæ long, slender, and weakly curving; antennæ when projecting backward barely reaching the occipital margin, with annulated segments; eye rather prominent, with a hair; a hair just behind the eye and three more on the rounded temporal angles; occipital margin weakly sinuous, the middle third slightly convex; signature large, distinct, with darker posterior acuminate point projecting beyond the mandibles, surrounded by a nearly uncolored region; antennal bands interrupted, widening at base; occipital bands

distinct, blackish brown, diverging, and with anterior extremities reaching the blackish, distinct, curving, linear ocular blotches; region between the occipital bands pale; temples dark brown.

Prothorax small, short, margins rounding, with one long pustulated hair in posterior angle, another on posterior margin just a little inside of the angles, and four grouped together in the posterior median region of the segment; median region pale to uncolored, darkening laterally until the blackish lateral borders are reached. Metathorax roundly angulated on the abdomen; an unpustulated hair in the lateral angles and ten long hairs on each half of the posterior margin, rising from conspicuous pustulations; median region palest, lateral and posterior regions blackish brown, causing the clear pustulations to be very prominent. Legs smoky brown.

Abdomen oval; lateral angles projecting, with long hairs; dorsal surface of segments with single transverse series of long weak hairs; median region almost uncolored; prominent blackish brown, subtriangular, lateral, transverse blotches, with very conspicuous uncolored stigmatal spots and pustulations; segment 8 wholly colored, dark brown; segment 9 with small triangular lateral brown blotches; shallow, angular emargination behind.

### Nirmus.

**Nirmus punctatus** Nitzsch. (See Kellogg, New Mallophaga, I, 1896, p. 109, pl. vi, figs. 1 and 2.)

Specimens from *Larus* sp. (Baja California). Taken previously by me from several species of *Larus* (Bay of Monterey, California).

**Nirmus furvus** Nitzsch. (Plate II, fig. 1).

Zeitschr. f. ges. Naturwiss. (ed. Giebel), 1866, vol. xxviii, p. 374.

*Nirmus furvus* N., Burmeister, Handb. d. Ent., 1832, vol. ii, p. 427; Giebel, Insecta Epizoa, 1874, p. 163, pl. v, figs. 2 and 3; Piaget, Les Pediculines, 1880, p. 169, pl. xiv, fig. 3; Supplement, 1885, p. 25; Osborn, Insects Affecting Domestic Animals, Bull. 5, N. S., Div. of Ent., U. S. Dept. Ag. 1896, p. 225.

A male and a female from the Spotted Sandpiper, *Actitis macularia* (Panama). My specimens do not possess the median longitudinal uncolored line across the first six or seven segments of the abdomen, as described for the types of the species, and besides, are very much darker, and are without distinct lateral transverse blotches on the abdominal segments. They are, too, a distinctly wider and less slender form, the head averaging nearly one-fifth wider in both sexes. However, in the present uncertain status of the species *furvus* (see Piaget, Les Pediculines, p. 170) I refer my specimens to the species, distinguishing them by a varietal name. Piaget's variety *alpha* (Supplement, p. 25) from *Vanellus cayensis* has, like my specimens, no uncolored median abdominal line, but no reference is made to any such characteristic dark chestnut to smoky general coloration of the body, as is shown by my specimens. Osborn's specimen is from *Phalaropus tricolor* (Museum Iowa Agricultural College).

Var. *ravus* Kellogg. Male, body, length 1.18 mm., width .34 mm.; head, length .37 mm., width .28 mm. Female, body, length 1.43 mm., width .37 mm.; head, length .40 mm., width .31 mm. Both sexes dark chestnut-brown to smoky, without median uncolored line on any abdominal segment, and without distinct abdominal blotches.

**Nirmus fissus** Nitzsch. (Plate II, fig. 2).

Germer's Mag. Entomol., 1818, vol. iii, p. 291.

*Nirmus fissus* N., Burmeister, Handb. d. Ent., 1835, vol. ii, p. 427;

Denny, Monograph. Anoplur. Brit., 1842, p. 148, pl. x, fig. 6;

Walckenaer, Ins. Apt., 1844, vol. iii, p. 344.

*Nirmus bicuspis* N., Giebel, Insecta Epizoa, 1874, p. 155, pl. v, figs.

11 and 12; Piaget, Les Pediculines, 1880, p. 184, pl. xv, fig. 7.

Several specimens, including male, female and immature specimens, from *Tringa* sp. (Baja California). My specimens are larger than the types of *bicuspis* and offer distinct though minor differences. I have given them a varietal name.

Var. *major* Kellogg. Measurements. Male, body, length 1.61 mm., width .38 mm.; head, length .3 mm., width .31 mm. Female, body, length 1.87 mm., width .44 mm.; head, length .47 mm., width .33 mm. Differs from types of *fissus* (which were taken from "*Charadrius minor*") by having a hair in the eye, by having four pustulated hairs on each lateral half of the posterior margin of the metathorax instead of three, two being median and two being near the angle; by having the median longitudinal uncolored line of the abdomen limited to the first two segments, and by being markedly larger. Piaget's specimens of *fissus* are: length, male, 1.3 mm. to 1.4 mm.; female, 1.5 mm.

**Nirmus fuscus** Nitzsch. (See Kellogg, New Mallophaga, II, 1896, p. 499, pl. lxvii, fig. 7).

Many specimens from a Sparrow Hawk, *Falco sparverius* (Panama), a Lower Californian Sparrow Hawk, *Falco sparverius peninsularis*, a Duck Hawk, *Falco peregrinus anatum*, and a Saint Lucas Redtail, *Buteo borealis lucusanus* (Baja California). Taken previously by me from three species of hawks at Lawrence, Kansas. The

size of these specimens from Panama and Baja Californian birds corresponds with that of the specimens previously taken by me from the Kansas birds, and is fully one-third greater than that recorded for the European specimens. The American specimens are at least varietally distinct from the typical Old World forms. There are variations manifest among the American specimens but I have not enough material yet to attempt to distinguish varieties.

**Nirmus splendidus** n. sp. (Plate II, figs. 3 and 6).

Males, females and young from a Caracara, *Polyborus cheriway* (Baja California). Species of *Docophorus*, *Lipeurus*, *Menopon*, and *Colpocephalum* have been taken from *Polyborus* by the European authors, but heretofore no *Nirmus*. The new species is unlike any of the *Nirmi* yet described from raptorial birds. It is large and strikingly marked.

Description of the male. Body, length 2.19 mm., width .84 mm.; large, broad-bodied, whitish with prominent lateral transverse brown abdominal blotches; head and thorax almost entirely colored.

Head, length .62 mm., width .6 mm.; forehead broad between trabeculæ and narrowly parabolic in front; forehead with four short separated hairs on each side; trabeculæ rather large for *Nirmus*, antennæ short; eye large, prominent, with a long hair, and with a fine prickle just behind it; temporal margins flatly convex, with two very long hairs; occipital margin straight; whole head strongly colored with exception of a pale, broad, clypeal, sutural line, and a short median longitudinal line leading from it backwards to the mandibles; the antennal bands narrow, and a little darker than

general color of head, running entirely around frontal margin of head, although paler and nearly "interrupted" at the clypeal suture; trabeculae nearly uncolored.

Prothorax short, oblong, with one hair in posterior angles; segment almost wholly colored. Metathorax short, the whole thorax being little more than one-half the length of the head; obtusely angulated on abdomen; posterior margin with a series of long hairs; segment mostly colored, darkest in median region; a broad white posterior border. Sternal markings consisting of inconspicuous intercoxal lines, and a small, indistinct median blotch on metathorax. Legs pale, though tinged with brown, with distinct, dark brown marginal markings.

Abdomen ovate; posterior angles of segments 1 and 2 without hairs, of segment 3 with a single hair, and of succeeding segments with two hairs; dorsal surface with numerous longish hairs; whitish with distinct lateral transverse blotches, each, with a clear stigmatal spot and some pustulations on segments 1-7; segment 8 with a curving, continuous brown transverse blotch; segment 9 rounded behind, with numerous longish hairs; uncolored except where the chitinized genitalia show through. Ventral surface all whitish except for a well defined and characteristic brown genital blotch on segments 7-9 (see fig. 6, pl. ii).

Female. Body, length 2.37 mm., width .97 mm.; head, length .62 mm., width .62 mm.; the increased size of the female is due to the larger abdomen, the head and thorax being of about the same size in both sexes; lateral abdominal blotches are not so long as in the male; segment 9 is shorter, bears two small blotches, and is slightly emarginated behind.

**Nirmus atopus** n. sp. (Plate II, fig. 4).

From a bird of the cuckoo family (Cuculidæ), *Piaya cayana thermophila* (Panama). This new form is one of the circumfasciate *Nirmi* of the general character of Rudow's *alchata* (Piaget, Les Pediculines, p. 165, pl. xiii, fig. 12) and allied forms. The few described members of this group have been found on columbine and gallinaceous birds.

Description of female. Body, length 1.84 mm., width .63 mm.; abdomen expanding posteriorly to segment 6; pale brownish white with brown lateral abdominal and thoracic bands and circumfasciate head.

Head, length .59 mm., width .53 mm.; forehead broad, rounded in front, with very few very fine hairs on the margin; trabeculæ small but distinct, acute; antennæ slender, with segment 5 longer than segments 3 or 4; temples rounded, with two long hairs and two or three very fine prickles on margins; eye without a hair, not especially prominent; occipital margin straight, bare; ground color of head whitish with small, inconspicuous brown ocular blotches, temples very narrowly margined with brown, and rather broad chitin band, subtranslucent brownish along the entire front and lateral margins of forehead, and ending posteriorly in small elliptical expansions directed diagonally inwards.

Prothorax very short, quadrangular; lateral margins straight; posterior angles rounded, with one long hair; posterior margin straight; lateral borders brownish, the coloring extending along the posterior margin of the segment. Metathorax pentagonal, lateral margins bare, posterior margin obtusely angled on abdomen, with one hair in latero-posterior angle and four pustulated hairs in two pairs, one pair almost in the latero-



posterior angle on each lateral half of the margin; lateral borders blackish brown, the color extending inward, but paling, in latero-posterior angles. Legs of pale ground color of the body, with narrow dark marginal markings. Sternal markings consisting of intercoxal lines, a small triangular blotch on mesothorax which fits like an apex to a larger pentagonal blotch on the metathorax.

Abdomen widening posteriorly to segment 6, then tapering bluntly; posterior segments with weak longish hairs in posterior angles; numerous weak, longish hairs on dorsal aspect in the broad median uncolored longitudinal line; lateral bands brown, distinct, extending posteriorly only through segment 7; pale brown, quadrangular, lateral, transverse blotches; last segment convex behind, with a very slight median emargination.

**Nirmus virgatus** n. sp. (Plate II. fig. 5).

Males and females from an icterine bird, *Amblycercus holosericeus* (Panama). Much like *N. illustris* Kellogg (New Mallophaga, II, p. 494, pl. lxxvii, fig. 4), from the Red-winged Blackbird, *Agelaius phoeniceus* (Lawrence, Kansas), and like *ornatissimus* Giebel (Insecta Epizoa, p. 144). The new form has a narrower front with the anterior angles not rounded, and does not possess the distinct bands internal to the antennal bands of the head of *illustris*. The lateral bands of the abdomen are wider, and the lateral transverse abdominal blotches are much more clearly indicated.

Description of male. Body, length 1.28 mm., width .47 mm.; whitish with striking broad black lateral borders of thorax and abdomen, black antennal and ocular bands, chestnut-brown outlines of transverse,

lateral abdominal blotches on dorsal aspect, and chestnut-brown transverse median blotches on ventral aspect of abdomen.

Head, length .37 mm., width .37 mm.; front truncate or with a very shallow concavity; a few small hairs on sides of forehead: trabeculae long; antennae slender, segment 5 distinctly longer than either segments 3 or 4; eye distinct, slightly pendulous; temples not much expanded, margins flatly rounded, with one long hair and a few prickles; occipital margin straight; ground color whitish to uncolored; broad black antennal bands running to anterior angles of head and bending in angularly at base of trabeculae; rest of forehead and trabeculae uncolored; no colored clypeal signature; antennae with segment 1 uncolored, other segments entirely blackish brown; ocular bands narrow, blackish; anterior part of temporal margins narrowly blackish; a brown, shield-shaped occipital signature showing through; mandibles and oesophageal sclerite showing through, brown.

Prothorax quadrangular, with rounded posterior angles with one hair in angle; segment whitish with broad lateral blackish brown borders. Metathorax angulated on abdomen; lateral angles obtuse; five long hairs on each latero-posterior margin; segment whitish, with uneven broad blackish lateral borders. Legs whitish with blackish brown blotches and semiannulations. Sternal markings consisting of distinct, chestnut-brown intercoxal lines, with expanded inner ends touching a small median blotch.

Abdomen elongate-ovate, with not very long hairs in posterior angles, and two hairs on the posterior margin of the dorsal aspect of each segment; ground color clear to whitish; broad lateral bands, from which project inwards the outlines of lateral transverse blotches which

are oblong on segments 2-6, and tapering on segments 7-8; on the ventral aspect each segment has a chestnut-brown median blotch which shows through above; segments 8 and 9 are narrow; segment 9 projects narrowly backward, is narrowly but flatly rounded behind, and is mostly colored.

Female. Body, length 1.5 mm., width .53 mm.; head, length .41 mm., width .43 mm.; the head is a little wider in proportion to its length than in the male; last segment with distinct triangular lateral blotches and angularly emarginated behind.

**Nirmus peninsularis** n. sp. (Plate II, fig. 9).

Numerous specimens from a Phainopepla, *Phainopepla nitens* (Baja California). A member of the difficult group *interrupto-fasciati*, to which belongs my species *vulgatus* (New Mallophaga, II, p. 496, pl. lxxvii, fig. 5), from seven passerine species, *simplex* (l.c., p. 492, pl. lxxvii, fig. 2) from the Robin, *Merula migratoria*, and the strongly marked species *eustigmus* (l.c., p. 493, pl. lxxvii, fig. 3) from Anna's Humming-bird, *Trochilus annæ*. The species from *Phainopepla* resembles most closely *brachythorax* Giebel (Insecta Epizoa, p. 134) from *Ampelis cedrorum*.

Description of female. Body, length 1.86 mm., width .41 mm.; long, slender, pale, with narrow marginal markings on head and intercoxal lines showing through on thorax.

Head, length .37 mm., width .31 mm.; elongate-triangular, with bluntly rounded apex; marginal hairs of forehead inconspicuous; trabeculæ small, uncolored but distinct; antennæ when projected backward reaching the occipital margin of head; eye not prominent, with a prickle; temples straight, with a single long hair in

obtuse angle between temporal and occipital margin; occipital margin very flatly convex, ground color whitish; a blackish brown narrow lateral border on temples and forehead, this border turning in angularly at antennal fossa; front of clypeus uncolored and an indistinct, uncolored elongate-oval fossa widening posteriorly; mandibles and oesophageal sclerite showing through pale brown; no occipital border.

Prothorax quadrangular, with slightly convex, lateral and posterior margins; posterior angles with one small hair; ground color whitish, a blackish brown blotch in anterior angles, and posterior margin weakly bordered by the intercoxal lines of ventral surface showing through. Metathorax in outline a semicircle with anterior curving part slightly flattened and posterior margin slightly convex; posterior angles with three long pustulated hairs and three shorter, weaker, non-pustulated ones; one of the long hairs is in the apex of the angle, the other hairs are ranged along the posterior margin near the angle; segment whitish with darker anterior marginal markings. Sternal markings consisting of distinct intercoxal lines. Legs concolorous with thorax, with dark brown dorsal marginal markings.

Abdomen elongate, subparallel sided; segments 1 and 2 without hairs in posterior angles, segments 3-6 with one to two short, weak hairs in angles; segment 7 with three hairs in angles, and segments 8 and 9 with a few weak, curving hairs; segment 9 very short, with slight emargination; segments 5 and 6 with a hair on dorsal surface on each side rising from the posterior margin of segment just inward from the lateral band; dorsal surface otherwise naked; color of abdomen whitish, with narrow translucent lateral bands, each segmental portion passing the suture anteriorly.

Male. Body, length 1.34 mm., width .37 mm.; head, length .33 mm., width .26 mm.; being thus markedly shorter than the female; abdomen widening distinctly posteriorly, so that segment 5, which is widest, is more than one and one-half times as wide as segment 1; segment 8 short and much contracted within segment 7; segment 9 truncate behind; the genitalia showing indistinctly through segments 7-9; an indistinct, median pale brownish coloring on all segments.

**Nirmus interpositus** n. sp. (Plate II, fig. 7).

Three females from Vieillot's Warbler, *Dendroica bryanti* (Panama). A member of the group *interruptofasciati*, intermediate in markings between *N. vulgatus* Kellogg (New Mallophaga, II, p. 496, pl. lxxvii, fig. 5), from several passerine birds from California and Kansas, and *eustigmus* Kellogg (l.c., p. 493, pl. lxxvii, fig. 3), from *Trochilus anne*, California. In size the new species is shorter than *vulgatus* but of the same width, and is both shorter and narrower than *eustigmus*. In general outline of body it resembles *eustigmus* more than *vulgatus*, but differs from *eustigmus* in having the sixth abdominal segment widest instead of the fourth.

Description of the female. Body, length 1.41 mm., width .41 mm.; whitish with distinct, broad, black, lateral abdominal bands and thoracic borders; head nearly equilaterally triangular.

Head, length .31 mm., width .34 mm.; outline of head nearly that of an equilateral triangle; the lateral margins of the head are weakly convex outward and the apex is parabolically curved; there are five or six short, inconspicuous hairs on each lateral margin of the forehead; the trabeculae extend to the end of the

first antennal segment and are uncolored; eye with a prickle; temporal margins with one long hair in the apex of the rounded, nearly right angle; occipital margin bare, very flatly convex; ground color whitish with a faint golden brown tinge; forehead and temporal margins narrowly bordered with blackish brown; front of clypeus uncolored; antennæ uncolored; occipital margin not bordered or only very narrowly and indistinctly so, an indistinct, pale brown, shield-shaped occipital signature showing through.

Prothorax very short, widely rectangular; a single longish hair in posterior angles; color whitish, with the intercoxal lines of under side showing through, and distinct blackish brown lateral borders. Metathorax short, lateral margins bare, sinuous; posterior margin flatly convex, with six or seven longish hairs on each half beginning in the posterior angle; whitish, with an uneven, blackish brown lateral border, and the strongly colored intercoxal lines of underside showing through. Legs whitish with blackish brown dorsal marginal markings. Sternal markings consisting of distinct intercoxal lines and indistinct pale median blotches.

Abdomen narrowest anteriorly, widening posteriorly to segment 4; segments 4-6 about same width, segment 7 slightly narrower, segments 8 and 9 short; short, weak single hairs in posterior angles of segments 3-7, with one or two shorter, weaker hairs in segments 5-7; dorsal surface with no or very inconspicuous hairs; whitish with distinct, rather broad, blackish brown lateral bands on segments 1-7, the segmental parts of the bands passing the suture and separated by nearly uncolored narrow spaces; covering the middle region of segments 6-7 a large, pale brown, shield-shaped blotch; segment

8 with a transverse blotch, pale brown, darker outwardly, and behind not reaching the lateral margins; segment 9 with two very small pale brown linear lateral blotches, and feebly emarginated behind.

**Nirmus audax** n. sp. (Plate II, fig. 8).

From the yellow-headed Tit, *Auriparus flaviceps* (Baja California). A member of the group *interrupto-fasciati*, of darker ground color and with much more pronounced abdominal blotches than is usual in this group (see *vulgatus* Kellogg, New Mallophaga, II, 1896, p. 496, pl. lxxvii, fig. 5).

Description of female. Body, length 1.6 mm., width .58 mm.; rather short and broad for *Nirmus*, especially of the *interrupto-fasciati* type; brownish ground with dark lateral blotches on thorax and abdomen, and blackish lateral bands and marginal markings.

Head, length .38 mm., width .41 mm.; the outline being nearly that of an equilateral triangle with blunted and curving apex and slightly convex legs; the marginal hairs of the forehead are few and very small; trabeculæ distinct, uncolored; temporal margins with a long hair in the rounded angle and several prickles; occipital margin weakly concave laterally and weakly convex in the middle; anterior part of forehead with nearly uncolored ground, with two brownish linear blotches bounding the oval fossa laterally; rest of head brownish with darker lateral borders and suggestions of occipital and ocular bands; antennæ colored.

Prothorax short, rectangular, with a single hair in posterior angles; color pale brownish in the middle, with the lateral regions dark brown, darkest on lateral margins. Metathorax angulated behind, with several strong hairs along each latero-posterior margin; latero-

anterior margins bare, convex. Color brownish, paler in middle, stronger laterally and posteriorly, with uneven, blackish latero-anterior borders, and latero-posterior borders nearly uncolored. Legs brown with paler regions at extremities of segments and blackish dorsal margins, sternal markings consisting of distinct intercoxal lines, those between pro- and mesocoxæ with angulated spurs nearly touching; between the metacoxal lines a median blotch.

Abdomen short and broad, in shape an ellipse, segment 4 being the widest; ground color very pale brownish; segments 1-7 with narrow black lateral bands, the segmental parts distinct and passing the suture; quadrangular brown lateral blotches darkest internally on segments 1-7; segment 8 wholly colored; segment 9 uncolored and weakly emarginate behind; ventral surface of segments with a brown median blotch, the blotches of segments 6-7 fusing.

### **Lipeurus.**

**Lipeurus confidens** n. sp. (Plate III, fig. 1).

Four females from a Black-footed Albatross, *Diomedea nigripes* (North Pacific Ocean). A species which in outline of body, color and markings is very like Piaget's species *tricolor* (Les Pediculines, p. 363, pl. xxx, fig. 4) from *Diomedea fuliginosa* (collection in the Museum of Leyden), but which is one and one-third times as large, without circumfasciate antennal bands, without occipital bands, with metathorax not without hairs as described for *tricolor* but with longish hairs in the posterior angles, without median abdominal blotches, and with last segment of female not acutely but bluntly two-pointed.



Description of female. Body, length 4.13 mm., width 1.03 mm.; large, whitish with sharply defined, black marginal markings, the lateral abdominal bands consisting of segmental pairs of contiguous subtriangular blotches.

Head, length .81 mm., width .7 mm.; subtriangular, widest just behind the eyes; front parabolic, with uncolored margin without hairs; a longish hair at the suture, with three in front of it (the foremost the longest) and two behind it on each side of the forehead; antennæ rather elongate, slender, segment 1 large and as long as segment 2; anterior angles of antennary fossæ acute but projecting little; the fossæ shallow; eyes prominent; temporal margins most convex just behind the eyes, obtusely angulated behind, and bearing a single weak hair and a few short spines; occipital margin nearly straight, bare; ground color whitish; strong, blackish brown antennal bands interrupted at the suture, widening posteriorly and extending back as far as the eye; two triangular blotches on occipital margins appearing as pointed continuations of the lateral bands of prothorax; antennæ uncolored.

Prothorax, as exposed, short, quadrangular, with flatly convex posterior margin and a longish spine in each posterior angle; color whitish, with even, strong, blackish lateral borders, turning in for a little distance at posterior angles. Metathorax with lateral concavities and five hairs in posterior angles, four of these hairs being long, strong, colored, and set closely together in a small uncolored space; posterior margin straight or even slightly concave; segment whitish with uneven, broad lateral borders, widest in middle and not reaching the posterior angles. Legs uncolored except for the chestnut-brown tarsi. No sternal markings.

Abdomen, fourth segment widest; segments of about equal length; posterior angles with few weak, not long, hairs; color whitish, with very narrow, clear lateral margin which sends expanded processes inward, three in each segment; the foremost of the three is the smallest and is contiguous to the suture; the hinder two are covered by two triangular blackish blotches which on some segments are contiguous, on others distinctly separate; segments 8 and 9 narrow, colored laterally; posterior margin of segment 9 truncate, with a very small angular emargination; two short hairs on each of the blunt points.

**Lipeurus densus** Kellogg. (Plate III, fig. 2).

New Mallophaga, I, 1896, p. 114, pl. vii, figs. 1 and 2.

A single male from a Black-footed Albatross, *Diomedea nigripes* (North Pacific Ocean, off Alaska). This specimen is a full millimeter longer and is much more completely blotched with dark brown than the original type specimen, a female; but I think they are of the same species. The female described is undoubtedly not fully grown and colored. While the antennæ vary in the sexes, that of the male bears no projection: it is simply heavier and larger, with its first segment largest; in the female, segment 3 is the longest. It is a male of this species, probably, which Taschenberg (*Die Mallophagen*, 1882, p. 145, pl. v, fig. 1a) describes and figures as the female of *ferox*.

Description of male. Body, length 5.8 mm., width 1.25 mm.; ground color very pale brown, but body mostly covered by large, dark brown blotches, head and thorax slightly longer than abdomen.

Head, length 1.3 mm., width 1.06 mm.; front parabolic, with a group of three distinct hairs at each side

and two or three shorter ones along margin in front of antennary fossæ; antennæ large, long, (almost 1 mm.), without projection on any segment; segment 1 largest and other segments successively decreasing in width and length, uncolored except for an indefinite brownish annulation on segment 2; eyes projecting, conspicuous; temporal margins slightly expanded, rounded behind, with one short, weak hair and a few prickles; ground color brownish white; even, blackish brown antennal bands running around in front, the small portion of clypeus lying in front of the band being dark subtranslucent brown; temporal regions bounded within by diverging occipital bands, all blackish brown, these blotches acutely pointed in front and almost reaching to, but distinctly separate from, the bases of the antennal bands; on the forehead a dark brown lateral blotch on each side and in front of the mandibles.

Prothorax short and quadrangular as exposed; two short, weak hairs in posterior angles, one lying in on posterior margin; narrow median region of segment whitish, widest behind; lateral portions of segment blackish brown, paling inwardly. Metathorax large, long, with lateral margins concave, posterior margin weakly and flatly concave; a single short, weak hair in the apex of the posterior angles, and five longer, stronger, light brown hairs in a very small elongate-elliptical, uncolored space near the apex of the angles; segments all blackish brown, except a whitish, bluntly pointed, arrow-head-shaped, median region; projecting laterally from the posterior tip of this whitish space is on each side a small, linear, whitish space. Legs long, strong, coxæ nearly uncolored; femora dark brown, with uncolored extremities and tibiæ mostly colored. Sternal markings, prosternum with narrow, pericoxal

lines; mesosternum with a rather large, brownish, median blotch; metasternum with weak indications of a median blotch.

Abdomen short, nowhere broader than thorax, with subparallel sides until segment 7 is reached, when the posterior tapering is begun; segments 1-6 of about equal size; segment 7 longer than others; segments 8-10 successively narrower and shorter; an uncolored median longitudinal line extending whole length of abdomen, rest of surface colored blackish brown by large quadrangular lateral blotches, which have clear stigmatal spots and are palest along inner margin; last segment angularly emarginated, with three short hairs on each point; segments 1-4 with a single very short hair in each posterior angle, segments 5-9 with longer hairs.

**Lipeurus forficulatus** Nitzsch. (See Kellogg, New Mallophaga, I, 1896, pl. ix, figs. 3, 4, 5 and 6).

Many specimens from a Californian Brown Pelican, *Pelecanus californicus* (Baja California). Taken previously by me from same host species (Bay of Monterey, California).

**Lipeurus gracilicornis** Piaget. (Plate III, fig. 3).

Les Pediculines, 1880, p. 309, pl. xxv, fig. 6.

Many specimens including males, females, and young from a Man o'War Bird, *Fregata aquila* (Panama). My specimens, to which I give a varietal name, differ from Piaget's types (taken from *Fregata minor*), as described, in three important particulars, viz., character of antennæ, metathoracic hairs, and size. In other particulars the specimens from the two bird species agree well.

Var. *major* Kellogg. Measurements (Piaget's meas-

urements of the type specimens are in parentheses), male, body, length 3.12 mm. (2.5 mm.), width .37 mm. (.29 mm.); head, length .66 mm. (.58 mm.), width .39 mm. (.29 mm.) Female, body, length 3.10 mm. (2.4 mm.), width .69 mm. (.53 mm.); head, length .69 mm. (.63 mm.), width .50 mm. (.41 mm.) Distinctly larger than the types of the species; third segment of antenna of male with an appendage; metathorax with six long hairs, five together and one alone. I figure the female as Piaget has figured the male of the species type.

**Lipeurus protervus** n. sp. (Plate III, fig. 4).

Many specimens from a Willow Ptarmigan, *Lagopus lagopus* (Kodiak Island, North Pacific Ocean). On this Ptarmigan were some specimens of *Goniodes mammillatus* Rudow, found by me on the California Partridge, *Callipepla californica* (New Mallophaga, II, 1896, p. 509, pl. lxxix fig. 2), but this *Lipeurus*, while of similar general character to *Lipeurus docophoroides* Piaget taken by me from *Callipepla californica* (New Mallophaga, II, 1896, p. 508, pl. lxxviii, fig. 8), is distinctly of another species. The most readily noticeable difference is in the character of the lateral abdominal blotches, those of *docophoroides* leaving a comparatively wide, unblotched median region, while those of the new species leave but a narrow, median, unblotched line. The blotches of the first segment meet in the new species; they do not, even nearly, in *docophoroides*.

Description of female. Body, length 2 mm., width .72 mm.; short and broad, and sub-Docophoroid in form; whitish ground color with nearly completely colored head and thorax, and abdomen with large, lateral, quadrangular blotches.

Head, length .5 mm., width .5 mm.; front rounded,

with four very small, inconspicuous hairs on each side; trabeculae small, distinct, acute, uncolored; antennae rather short, segment 2 longest, segment 5 longer than 3 or 4, segments 4 and 5 colored, others uncolored or very weakly colored; eye large, with a hair; temples widest just behind the eyes; temporal margins converging posteriorly, nearly straight, with two long hairs and prickles; occipital margin concave; head pale brown in median region, temples, occipital border, and antennal bands with rim around the front, dark brown; a pale, almost uncolored transversal linear space in front of the mouth, and a similarly pale U-shaped space bounding the median region of the hind-head.

Prothorax small, short, quadrangular as exposed, with a single long hair in each rounded posterior angle; segment wholly brown except an uncolored posterior border. Metathorax small, not as long as broad, posterior margin obtusely angled on abdomen; two long pustulated hairs in a clear space on posterior margin near the lateral angles and two long pustulated hairs in a clear space on posterior margin midway between lateral angles and posterior angles; whole segment brown except a small, angular, median, whitish or uncolored space on anterior margin. Legs pale brown with narrow dark brown marginal markings. Sternal markings consisting of intercoxal lines and a shield-shaped median blotch on metasternum.

Abdomen elliptical, posterior angles of segments projecting slightly and with one to two longish weak hairs; ground color whitish with large quadrangular lateral brown blotches on segments 1-7, these blotches nearly meeting inwardly and separated intersegmentally by a whitish space about one-half as large as a blotch; the outer margins of the blotches are blackish,

forming narrow lateral bands; each blotch with a stigmal spot, and a few (three or four) pustulations at inner end, in which are seated longish hairs; a long hair arises from a demi-pustulation on the posterior margin of each blotch just behind the stigmal spot; segment 8 wholly colored and segment 9 nearly so; posterior margin of last segment minutely emarginated.

***Lipeurus macgregori* n. sp.** (Plate III, figs. 5 and 6.)

Numerous specimens from three individuals of the Ani, *Crotophaga sulcirostris* (Panama). This striking *Lipeurus* with its small Nirmoid body, and, except for the antennæ, Docophoroid head, shows no near resemblance to any other *Lipeurus* so far described.

Description of the male. Body, length 1.81 mm., width .56 mm.; short and broad for *Lipeurus*, Nirmoid in shape, head with slightly expanded anterior border of clypeus uncolored, and slightly emarginated as with many *Docophori*; ground color of body whitish with strong, dark brown, lateral borders of head, and lateral, transverse blotches of thorax and abdomen.

Head, length .53 mm., width .47 mm.; thus nearly as broad as long, triangular, with sinuate sides and truncated apex; anterior border of clypeus slightly expanded, uncolored, feebly emarginate; seven or eight distinct, rather long hairs on lateral margin; an angular concavity on lateral margin midway between trabecula and anterior angle; trabeculæ prominent; antennary fossæ deep; eye prominent, almost pendulous, with a hair in it and a prickle just behind it; temporal margins convex, with three long hairs, a fourth one on occipital margin of temple; occipital margin sinuous, bare; antennæ long and large, segment 1 heavy, nearly as long as the rest of the segments together; segment

2 next largest and longest, segment 3 with simple appendage at distal extremity, segments 4 and 5 short, subequal; color whitish, with strongly colored, dark brown temples, angulated antennal bands, and lighter brown, distinct signature, pointed behind, straight in front; mandibles and œsophageal sclerite showing through dark brown; trabeculæ and antennæ paler smoky brown.

Prothorax short, quadrangular, wider than long, with one pustulated hair in posterior angle; a large, nearly square, dark brown, lateral transverse blotch nearly covering each lateral half of the segment, the broad, median line between them whitish. Metathorax short, but little longer than prothorax; posterior margin nearly straight, with five long pustulated hairs ranged along each lateral fourth, the inner two of the hairs may have only demi-pustulations. Sternal markings consisting of distinct, blackish brown intercoxal lines, and a pale brown, indistinct median blotch on metathorax. Legs pale smoky brown with darker margins and semiannulations.

Abdomen elongate-ovate; segment 1 conspicuously narrower than metathorax; one or two short hairs in posterior angles of anterior segments, two or three long hairs in angles of segments 5-9; ground color whitish with broad, dark brown, lateral, transverse blotches on segments 1-7, these blotches subquadrangular, but narrower inwards, and leaving only a broad, median, whitish, longitudinal line on middle of abdomen; in this whitish space a few longish hairs on each segment; rather large, uncolored, stigmatal spots in the transverse blotches of segments 2-7; the transverse blotch on segment 8 continuous across the segment and curving; segment 9 with two backward-projecting, short,



horn-like processes, dark brown, and a narrowly rounded, uncolored posterior border; genitalia extending through segments 6-9 and strongly chitinized.

Female. Body, length 2.41 mm., width .78 mm.; head, length .6 mm., width .53 mm.; considerably larger; abdomen more elongate; antennæ rather long, slender, segment 2 longest; lateral, transverse blotches of abdomen less tapering inwards; blotches of segment 8 distinct; segment conspicuously emarginate behind.

### Goniodes.

**Goniodes mammillatus** Rudow. (See Kellogg, New Mallophaga, II, 1896, p. 509, pl. lxxix, fig. 2).

Specimens from the Ptarmigan, *Lagopus lagopus* (Kodiak Island, off Alaska). Previously taken by me from a Californian Partridge, *Callipepla californica* (Mountain View, California).

### Eurymetopus.

**Eurymetopus taurus** Nitzsch. (See Kellogg, New Mallophaga I, 1896, p. 135, pl. xi, figs. 3, 4, 5 and 6).

Specimens from the Black-footed Albatross, *Diomedea nigripes* (North Pacific Ocean, off Alaska). Previously taken by me from *Diomedea albatrus* (Bay of Monterey, California).

### Trinoton.

**Trinoton luridum** Nitzsch. (See Kellogg, New Mallophaga I, 1896, p. 152, pl. xiii, fig. 4).

Specimens from a Green-winged Teal, *Anas carolinensis* (Kodiak Island, off Alaska). Previously taken by me from same host species and six other duck species (Kansas and California).

## Colpocephalum.

*Colpocephalum abbotti* n. sp. (Plate IV, fig. 9).

Taken from a gull, *Larus* sp. (Baja California). This new form is of the general type of *fuscipes* Piaget (Les Pediculines, p. 567, pl. xlvii, fig. 7) from *Larus dominicanus*, and of *funebre* Kellogg (New Mallophaga, I, p. 147, pl. xii, fig. 7) from *Larus glaucescens* (Bay of Monterey). It most nearly in general aspect, and especially in the branching, uncolored median line of abdomen, thorax, and head, resembles *sulcatum* Piaget (Les Pediculines, p. 565, pl. xlvii, fig. 5) from *Sterna nigra*, but is one-half larger, and has transverse series of hairs on the dorsal aspect of the abdomen, while *sulcatum* is here naked.

Description of female. Body, length 2.34 mm., width .88 mm.; rather large, long abdomen; abdomen sombre in color with narrow, black, lateral borders on hind head, thorax, and abdomen; a conspicuous, uncolored, median line on first five segments of abdomen, all of thorax, and hind head, the line dividing in the head and sending a branch to each lateral margin just in front of the ocular emargination.

Head, length .47 mm., width .7 mm.; front broad, very flatly convex, with numerous hairs of which four are longer than the others; on the lateral margins of the forehead in front of the ocular emargination a very long hair, with another shorter one close to it, and two in the angle; the palpi projecting beyond the lateral margins of the head; the ocular emargination deep, angular, with a prominent fringe and a longish hair rising just inward of the double eye; temples rather narrow, projecting, with four long hairs on the margin and one rising at some distance inward from the

occipital margin; six uncolored spots on the forehead, from two of which single long hairs arise and from the remaining four short hairs; occipital margin flatly concave, bare; head smoky brown with narrow black occipital border and curved ocular blotches; a broad, short-stemmed, uncolored Y, the prongs slightly angulated in the middle and terminating broadly in front of the eyes; the stem interrupts the black occipital border and is continuous with a median, uncolored, longitudinal line which traverses the thorax and the first few abdominal segments.

Prothorax broader than long, with obtuse lateral angles containing one longish hair and a spine in the apex of the angle, and a second longish hair arising from a little within and back of the apex; the latero-posterior margins bare, with a single longish hair in the slight angle which may be taken to separate the latero-posterior margin from the true posterior margin; two longish hairs on each half of the flatly convex posterior margin; color smoky brown with narrow black border on latero-posterior margins and on visible parts of latero-anterior margins; the small, slightly curving, longitudinal chitin bars at ends of the indistinct, usual transverse bar are black; the ground color of the segment is darker in posterior half, and the segment is bisected longitudinally by the median, uncolored line. Metathorax with a fairly distinct suture setting off the mesothorax; lateral margins bare; posterior angles with a hair and spines; posterior margin straight, with four weak hairs not on the very margin; color smoky brown with narrow black lateral borders. Legs slightly lighter than segments, and with ill-defined, darker marginal markings. Sternal markings distinct, a median shield on prothorax; a small, elongate, rather

cone-shaped median blotch on mesothorax, and a large, broadly diamond-shaped, median blotch on metathorax; intercoxal lines between pro- and mesothorax distinct.

Abdomen elongate-elliptical; segments with a single long weak hair and some short ones in posterior angles, and some short ones along lateral margins; a single transverse series of not very closely set weak hairs along posterior margin of each segment; general color light smoky brown with very narrow blackish lateral bands; last segment parabolic behind, with short hairs, and at each side a few longish hairs.

**Colpocephalum spineum** n. sp. (Plate IV, fig. 1).

A single male from a Man o'War Bird, *Fregata aquila* (Panama). Piaget has taken a small *Colpocephalum* from *Fregata minor* (*anguliceps*, Les Pediculines, p. 569, pl. xlvii, fig. 8), to which this new form must show some resemblance in size and characteristic quadrangular shape of forehead; but the shape of the abdomen, not at all elliptical as described for *anguliceps*, but elongate-oblong with nearly parallel sides, and the distinct and characteristic abdominal markings and lateral hairs of the prothorax, serve to make any reference of my specimen to *anguliceps* impossible.

Description of male. Body, length 1.53 mm., width .44 mm.; elongate, narrow, with subparallel sides; pale golden brown with large dark brown head blotches and lateral brown blotches on abdomen.

Head, length .34 mm., width .47 mm.; forehead nearly quadrangular, with a few short hairs along the front and four short ones and two longish ones on sides; palpi and antennæ slightly projecting beyond the margin of the head; temples broad with flatly convex lat-

eral margins bearing numerous hairs of various lengths, two at least being long; occipital margin broadly concave; pale golden brown with broad blackish brown occipital border, greatly expanded triangularly at bases of the occipital bands; ocular blotches large, and a distinct blotch on each side of the front rami of the mandibles extending diagonally to the front margin.

Prothorax short, with a spine and longish hair in each lateral angle and four longish hairs and two spines along each lateral half of the posterior margin. Metathorax longer and wider than prothorax, almost as wide as abdomen; several spines in a double row along the lateral margins, some strong spines in the lateral angles, and a series of ten or twelve strong hairs along the nearly straight posterior margin, whole thorax of pale brown ground color of body. Legs concolorous with the thorax, with dark brown markings near distal extremity of femur and on tibiae. No distinct sternal markings.

Abdomen slender, elongate, with nearly parallel sides, with one long hair in posterior angles of segments 3-8 and numerous short hairs along lateral margins; dorsal surface covered with short spiny hairs, a series along the posterior margin of each segment being composed of longer but still spine-like hairs; color pale golden brown, the sutures whitish, and distinct subelliptical dark brown lateral blotches on segments 3-8, giving the abdomen a strikingly marked character; segment 9 but little narrower than segment 8 and broadly truncate behind; posterior margin with several long hairs and more shorter ones; dorsal surface with a transverse series of longish hairs.

**Colpocephalum maculatum** Piaget. (Plate IV, fig. 2).

Les Pediculines, 1880, p. 516, pl. xliii, fig. 1.

A male and a female from a Caracara, *Polyborus cheriway* (Baja California), which I refer with much doubt to this species of Piaget, taken from a *Polyborus brasiliensis* (Zool. Garden of Rotterdam). Piaget says that *maculatum* much resembles *C. flavescens*, the common *Colpocephalum* of raptorial birds (see Kellogg, New Mallophaga, II, 1896, p. 525 pl. lxxi, fig. 4). My specimens do not resemble *flavescens* at all closely, lacking the cross bands of the abdomen, being rather differently shaped, etc. But Piaget's description and figure of *maculatum* show it also to differ from *flavescens* in these and other particulars. My specimens measure: Male, body, length 1.62 mm., width .66 mm.; head, length .34 mm., width .53 mm. Female, body, length 2. mm., width .72 mm.; head, length .34 mm., width .53 mm.

**Colpocephalum subæquale** Nitzsch. (See Kellogg, New Mallophaga, II, 1896, p. 525, pl. lxxii, fig. 1).

Specimens from an American Raven, *Corvus corax sinuatus* (Baja California). Taken previously by me from *Corvus americanus* (Palo Alto, California).

**Colpocephalum diffusum** n. sp. (Plate IV, figs. 3 and 4).

A well marked species found upon a surprisingly large number of widely related bird species from Panama. Mr. McGregor brought specimens from the following birds: *Amblycercus holosericeus*, *Arremonops striaticeps*, *Saltator albicollis*, *Phœnicothrampus fuscicauda*, *Elainea subpagana*, *Dendroica bryanti*, *Piaya cayana thermophila* (2 specimens), *Chiroxiphia lanceolata*, and *Ardea virescens*! From the condition of affairs I should suspect straggling, but Mr. McGregor informs me that

the birds were shot and the parasites collected on different days. We seem to have here a condition similar to the condition shown by *Dearyphagus communis*. In the list of hosts of this *Cilicapsalium*, however, there are bird species of several unrelated families such as the Fringillidae, Cuculidae, Ardeidae.

The specimens of the parasite vary somewhat in strength of color and hence distinctness of bands and blotches. Some of the weaker colored specimens, however, are evidently pupae or freshly moulted adults. I have described the markings as shown in some well colored specimens from *A. hippocrepis holosericus*.

Description of the male. Body, length 1.25 mm., width .53 mm.; ground color very pale, with distinct, blackish brown markings on head, thorax, and abdomen: transverse bands of abdomen uneven in size, the first and last bands being much larger than the middle ones.

Head, length .84 mm., width .47 mm.; a few short hairs on frontal margins, palpi barely projecting; ocular fringe distinct; temples broad, with a few long hairs, color whitish with prominent blackish ocular blotches projecting forward and connecting by a weakly colored, uneven broad line with the small but distinct blackish clypeal blotches; temples clear without dark margin, occipital margin narrowly bordered with blackish in the median part.

Prothorax: the part of the prothorax not concealed by the head is almost of the shape of a semicircle, a little flattened at the pole; the lateral angles lie very close to the occipital margin of the head, are obtuse, and bear three spines; there are three longish hairs on each lateral half of the rounded posterior margin; the segment is almost whitish with indications of darker

borders and indistinct lines caused by the sternal markings showing through. Metathorax pentagonal, posterior margin straight, with four longish hairs and a spine (between the first two) on each lateral half; the posterior angles with two spines; color whitish with dark brown anterior angles, and sternal markings indistinctly showing through. Legs concolorous with thorax, with brownish and blackish markings. Sternal markings distinct, blackish brown, consisting of a median wedge-shaped blotch on prosternum connected by lateral processes with the intercoxal lines; a peculiar four-appendaged blotch on mesosternum composed of median blotch and meso-peri-coxal lines; and a pale median metasternal blotch with darker intercoxal lines.

Abdomen short, broadly elliptical, not turbinate; two or three distinct spines in posterior angles of segments; longish hairs in the angles and on the dorsal surface; segment 1 large; segments 2 and 3 not so large but larger than segments 4-7; segment 8 larger than segment 2 or segment 3; broad blackish brown lateral bands with the sutures distinct; no transverse bands on dorsal surface, but those of ventral surface showing through; these transversal bands arranged as follows: a single broad band covering all of segment 1 and anterior half of segment 2, narrow bands on segments 3-7, and one continuous band or blotch covering all of segments 8 and 9; the genitalia strongly chitinized, conspicuous, and extending through segments 2-9; last segment rounded behind, with a few short hairs; on the ventral surface of segment 2, a group of four very strong, long spines near each posterior angle.

Female. Body, length 1.56 mm., width .66 mm.; head, length .34 mm.; width .5 mm.; abdomen more elongate and the segments differently shaped; segment



1 very long, with straight posterior margin; segment 2 a little shorter, with distinctly curving posterior margin; segment 3 still shorter, with curving margin; segments 4-7 very short; segment 8 longer; ventral bands about as in male, with the last great band or blotch reaching anteriorly, with convex anterior margin, into segment 5.

### Menopon.

#### **Menopon titan** var. **linearis** Kellogg.

New Mallophaga, I, 1896, p. 163, pl. xv, fig. 2.

Many specimens from a Californian Brown Pelican, *Pelecanus californicus* (Baja California). Described from same host species from Bay of Monterey, California.

#### **Menopon auri-fasciatum** n. sp. (Plate IV, fig. 5).

From a Man o' War Bird, *Fregata aquila* (Panama). Not at all like *M. intermedium* Piaget (Les Pediculines, p. 497, pl. xl, fig. 4) from *Fregata minor*.

Description of female. Body, length 2.19 mm., width 1.03 mm.; whitish with golden yellow transverse abdominal bands; dorsal surface of abdomen with many strong hairs in transverse series.

Head, length .31 mm., width .7 mm.; half-moon shaped, with smooth, even convex border; two short hairs on the front on each side of the middle, and two longish hairs and three shorter ones on each side in front of the antennal cavity; four very long hairs and several short ones in each temple; occipital margin concave, with six rather long hairs; pale yellowish white with black ocular flecks and small brown blotches just inside of the antennary cavities.

Prothorax rather large, with three short spines and a

long hair along the narrowly rounded margin of the lateral angles, and five long hairs on each lateral half of the flatly rounding posterior margin; the lateral margins narrowly darker than the rest of segment, which presents no blotches; the uncolored transverse chitin bar is distinct, and the curving longitudinal bars at its extremities are darker than general color of segment. Metathorax as short as or shorter than prothorax, with very slight lateral emargination; lateral posterior angle with several small spines, and posterior margin, which is flatly convex, bears, beginning in lateral angles, two long hairs, then a spine, then eight long hairs, on each lateral half; a narrow transverse pale brown blotch runs across the segment near the posterior margin and expands at its lateral extremities. Legs of pale ground color of thorax with narrow darker marginal markings.

Abdomen ovate, rather turbinate, with longish hairs in the posterior angles of the segments and a single series of strong hairs across the dorsal aspect of each segment, ranged along the posterior margin of a pale brown transverse band which extends entirely across each segment; this band covers only about one-half the dorsal aspect of each segment, the uncovered half being of the whitish ground color of the general body, ninth segment flatly convex behind, with fringe of uncolored fine hairs, and with a few long hairs at lateral rounded angles.

**Menopon striatum** n. sp. (Plate IV, fig. 6).

Six specimens from a Willow Ptarmigan, *Lagopus lagopus* (Kodiak Island, North Pacific Ocean). Nearly twice as large as Grube's *M. lagopi* from *Lagopus alpinus*, though in general appearance the species must be

similar. Grube describes the temples of *lagopi* with but one long hair; *striatum* has four, and the prothorax of *lagopi* is figured by Grube as being extraordinarily long.

Description of female. Body, length 2.22 mm., width .91 mm.; well marked, with entire transversal abdominal bands, with wide, whitish intersegmental spaces, and distinct, blackish, narrow lateral bands.

Head, length .3 mm., width .66 mm.; broadly parabolic in front, with slight rectangular orbital emargination; half a dozen short hairs on each lateral margin of forehead and three long hairs in region just in front of orbital emargination; the palpi projecting, as also the antennæ; temples narrow, five longish hairs, two more rising from occipital margin of temporal region; occipital margin concave, straight in the middle; ground color light brown, palest in median region, with very narrow blackish occipital border, blackish curving ocular blotches, and transversal dark brown bar in mandibular region.

Prothorax rather large, long; lateral angles obtuse, with three spines; posterior margin, from angle to angle, making a flattened semicircle and bearing 14 long hairs; ground color pale smoky brown, regions of lateral angles distinctly darker, transverse chitin bar dark, narrow, with a spine rising from each extremity; curving chitin bars at extremities of the transverse bar distinct, narrow. Metathorax with a broad whitish sutural space separating the small colored mesothoracic region from metathorax; metathorax with nearly straight posterior margin, and a series of hairs along straight posterior margin of broad chestnut-brown; transverse bar with narrow blackish lateral borders. Legs pale to smoky brown, with narrow, blackish dorsal

marginings and conspicuous spiny hairs. Sternal markings consisting of pale brown linear transversal blotch on prosternum, distinct, narrow blackish diagonal intercoxal lines between pro- and mesolegs, with pale brown median triangular blotch emarginated on anterior margin, very pale, indistinct intercoxal lines between meso- and metalegs, with a pale brown triangular median blotch between them, and another smaller pale brown median blotch apparently between the metacoxæ, really on first abdominal segment.

Abdomen elongate-elliptical; two to three or four longish hairs in lateral angles of segments; on segments 1-8 a regular series of alternating whitish (sutural) and chestnut-brown transversal (segmental) bands, each colored band bearing a single series of longish hairs on small pustules along its posterior margin; a longer hair on larger pustule at each end of each of these series; narrow, segmentally interrupted blackish lateral bands, separated from the brown transverse bands by a narrow whitish space; segment 9 wholly chestnut-brown except pale to uncolored posterior border; posterior margin with thick-set fringe of uncolored longer and shorter hairs. Ventral surface of abdomen of segments 2-8 with a median pale brown transversal band, bearing numerous fine hairs rising from small pustules; segment 9 mostly colored.

**Menopon præcursor** n. sp. (Plate IV, fig. 8).

Many specimens from a Gila Woodpecker, *Melanerpes uropygialis* (Baja California). Denny is the only author who has hitherto described a *Menopon* from the woodpeckers (*M. pici*, from *Picus viridis*, Monograph. Anoplur. Brit. p. 219, pl. xx, fig. 5). From his brief de-

scription and strange illustration I cannot determine whether my specimens resemble his or not.

Description of the female. Body, length 1.56 mm., width .75 mm.; golden brown, with chestnut-brown transverse abdominal bands.

Head, length .28 mm., width .58 mm.; being thus twice as wide as long; very few short hairs along front; from a partly clear spot on the dorsal surface on each side of the forehead three hairs arise of which one is very long; the palpi project by the length of the terminal segment; no distinct ocular fringe; the temples narrow and bearing three very long hairs and two or three shorter ones; occipital margin weakly concave, with six longish hairs, two being median; ground color of head pale subtranslucent brown, with nearly uncolored temples; black ocular flecks, irregular brownish ocular blotches, and a very narrow blackish occipital border. On the ventral surface are two backward-projecting, segmented, pointed, chitinous processes arising apparently at about the origin of the labial palpi.

Prothorax large, the obtuse lateral angles projecting even with the insertion of the last of the three long occipital hairs; the lateral margins and posterior margin (separated by a very obtuse but obvious angulation) with a few longish, slightly pustulated hairs (two on each lateral margin and six on the posterior margin); a spine in each lateral angle; the regions of the lateral angles smoky, with narrow blackish border on lateral margin; the straight, transverse chitin bar uncolored, the curving, longitudinal chitin bars blackish; middle region of segment concolorous with middle region of head. Metathorax short, but little wider than prothorax; posterior margin straight, with a series of longish hairs; region of posterior angles and an indistinct

transverse blotch entirely across segment darker. Legs concolorous with the pale ground color of the body, with very narrow darker dorsal margining. Sternal markings consisting of a narrow transversal median blotch on prosternum, and intercoxal lines curving backward at inner ends on mesosternum.

Abdomen rather short and broad, ovate; posterior angles projecting but slightly and bearing two to three long hairs; on the lateral margins of each segment a spine; a transverse series of hairs across each segment near its posterior margin; ground color very pale yellowish brown, with a chestnut-brown transverse band entirely across each segment except the ninth; posterior margin of segment 9 flatly angulated and with a close fringe of hairs.

Male. Body, length 1.34 mm., width .6 mm.; head, length .25 mm., width .53 mm.; the few specimens of males in the lot taken from the single bird examined are paler in color than the females; the transverse band of the eighth abdominal segment is hardly noticeable; segment 9 flatly rounded behind, with a few prominent hairs.

### Physostomum.

With regard to the characters used in distinguishing species in this genus I am in much doubt. I believe that the genus is not at all well understood and that the specific determinations including my own (see *New Mallophaga II*, 1896, p. 513, *et. seq.*) need a thorough revision. This revision cannot, however, be undertaken until much more material is in hand. I describe the two following species with this doubt in mind, simply giving here as best I can additional data, for the

reviser. In the case of the two species here described, the unrelated hosts accredited to each suggest that we have to do in this genus with a few species of wide range of host, or with many species of very similar appearance.

**Physostomum pallens** n. sp. (Plate IV, fig. 7).

Specimens from a Prothonotary Warbler, *Protonotaria citrea* and from a Flycatcher, *Elainia subpagana* (Panama).

Description of female. Body, length 3.6 mm., width .87 mm.; pale buffy brown, with blackish brown head markings and thoracic markings and lateral abdominal bands.

Head, length .67 mm., width .66 mm.; front slightly expanded, flatly rounded; with laterally projecting palettes; several short prickle-like hairs in the slight ocular emargination; temples projecting backward, acute, with three long hairs, one on margin just behind the eye, and two close together on dorsal surface near the margin farther back; color whitish to clear with usual brown longitudinally arranged lateral blotches.

Prothorax hexagonal, front and posterior margins concave; a long hair and two spines in each lateral angle, and a long hair and two or three spines on each lateral margin near the posterior angles; lateral margins unevenly bordered with blackish brown, interrupted by a nearly uncolored spot in each lateral angle. Metathorax longer than prothorax, with straight posterior margin, and a single hair and spine in each posterior angle; a slight, rounded swelling behind anterior angles bearing spines; blackish brown, narrow, even, submarginal, longitudinal bands. Legs uncolored.

Abdomen parallel-sided, with a single hair and spine or prickle in posterior angles of segments; whitish with distinct, even, blackish brown submarginal longitudinal bands; vulva flatly rounded, with fringe of fine hairs; posterior margin of last segment flatly rounded, with fine, uncolored hairs.

**Physostomum invadens** n. sp.

Specimens from a woodpecker, *Melanerpes wagleri* and from *Chiroxiphia lanceolata* (Panama). The finding of this species on *Melanerpes* is the first recorded occurrence of *Physostomum* on a non-passerine bird.

Description of female. Body, length 3 mm., width .81 mm; pale translucent brownish with dark brown to blackish head and thoracic markings and lateral abdominal bands; in outline and structural characters very like *pallens*.

Head, length .66 mm., width .6 mm.; almost identical with that of *pallens*; ground color browner; the hairs of ocular emargination rather longer and fewer. Prothorax with lateral angles hardly apparent, but marked by the presence of a long hair and spine. Legs with a little brownish coloring. Abdomen with longer hairs and more in posterior angles of segments, and with two hairs on posterior margin of each segment just a little distance inward from posterior angle. Lateral bands of abdomen rather broad and marginal; in each of these broad brown longitudinal bands the true lateral bands, chitinized, may be seen.



## LIST OF HOSTS, WITH PARASITES.

Larus glaucescens	Melanerpes wagleri.
Docophorus lari	Physostomum invadens.
Larus sp.	Melanerpes uropygialis.
Docophorus lari.	Menopon præcursor.
Nirmus punctatus.	Melanerpes formicivorus angus- tifrons.
Colpocephalum abbotti.	Docophorus californiensis.
Diomedea nigripes.	Myiarchus cinerascens nuttingi.
Lipeurus confidens.	Docophorus rufus.
densus.	Elainea subpagana.
Eurymetopus taurus.	Physostomum pallens.
Pelecanus californicus.	Colpocephalum diffusum.
Lipeurus forficulatus.	Corvus corax sinuatus.
Menopon titan var. linearis.	Colpocephalum subæquale.
Fregata aquila.	Amblycercus holosericeus.
Lipeurus gracilicornis, var.	Nirmus virgatus.
major.	Colpocephalum diffusum.
Colpocephalum spineum.	Arremonops striaticeps.
Menopon auri-fasciatum.	Colpocephalum diffusum.
Merganser serrator.	Saltator albicollis.
Docophorus iterodes.	Colpocephalum diffusum.
Anas carolinensis.	Chiroxiphia lanceolata.
Trinoton luridum.	Physostomum invadens.
Ardea virescens.	Colpocephalum diffusum.
Colpocephalum diffusum.	Cardinalis cardinalis igneus.
Tringa macularia.	Docophorus communis.
Docophorus cordiceps.	Phœnicothraupis fuscicauda.
Nirmus furvus var. ravus.	Docophorus panamensis.
Tringa sp.	Colpocephalum diffusum.
Nirmus fissus var. major.	Progne subis hesperus.
Lagopus lagopus.	Docophorus domesticus.
Lipenus protervus.	Phainopepla nitens.
Goniodes mammillatus.	Nirmus peninsularis.
Menopon striatum.	Protonotaria citrea.
Polyborus cheriway.	Physostomum pallens.
Nirmus splendidus.	Dendroica bryanti.
Colpocephalum maculatum.	Nirmus interpositus.
Falco sparverius peninsularis.	Colpocephalum diffusum.
Nirmus fuscus.	Cinclus mexicanus.
Crotophaga sulcirostris.	Docophorus laticeps var. amer- icanus.
Lipeurus macgregori.	Parus atri-capillus occidentalis.
Coccyzus americanus occidentalis.	Docophorus rutteri.
Docophorus latifrons var. occi- dentalis.	Auriparus flaviceps.
Piaya cayana thermophila.	Nirmus audax.
Nirmus atopus.	
Colpocephalum diffusum.	

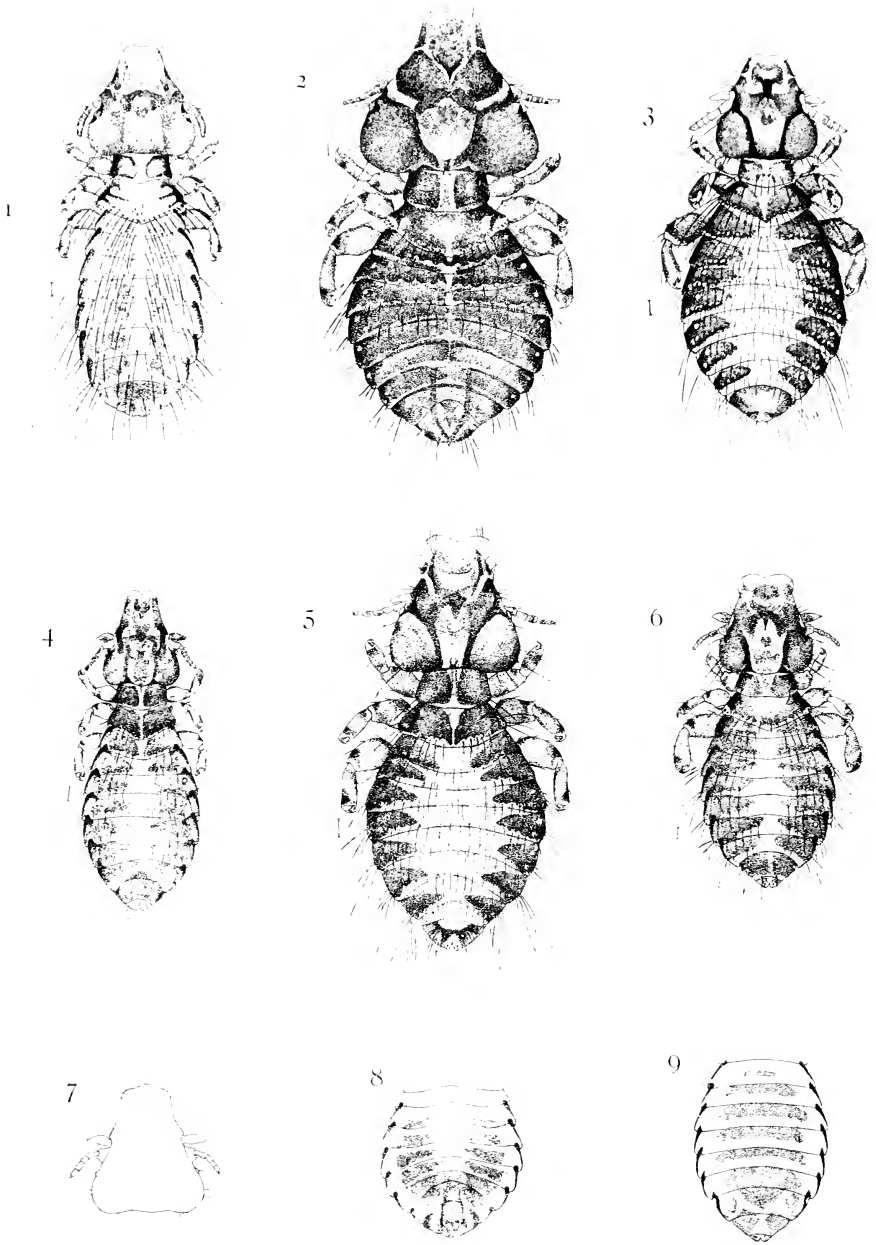
## EXPLANATION OF PLATES.

PLATE I.—Fig. 1, *Docophorus panamensis* Kellogg, ♀. Fig. 2, *D. cordiceps* Giebel, ♂. Fig. 3, *D. rutteri* Kellogg, ♀. Fig. 4, *D. laticeps* G., var. *americanus* Kellogg, ♀. Fig. 5, *D. latifrons* N., var. *occidentalis* Kellogg, ♀. Fig. 6, *D. rufus* Kellogg, ♀. Fig. 7, *D. laticeps* G., outline of head. Fig. 8, *D. latifrons* N., var. *occidentalis* Kellogg, abdomen of ♂, ventral aspect. Fig. 9, *D. rufus* Kellogg, abdomen of ♀, ventral aspect.

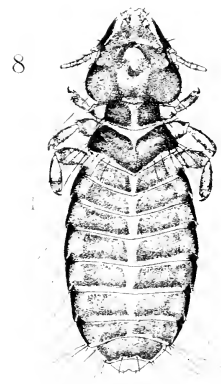
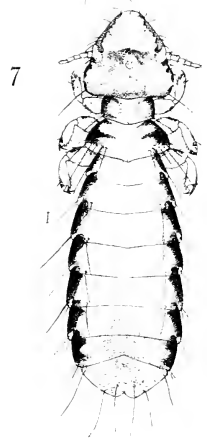
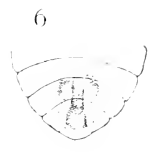
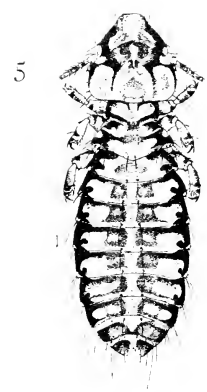
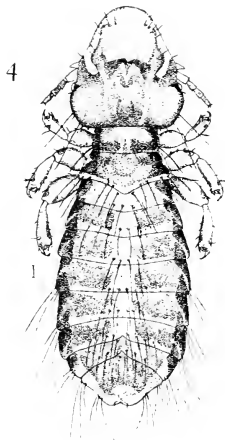
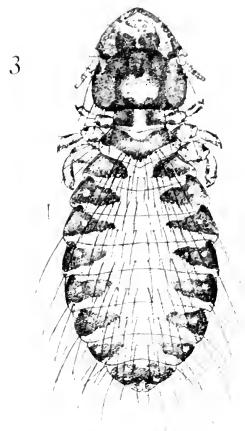
PLATE II.—Fig. 1, *Nirmus furvus* N., var. *ravus* Kellogg, ♀. Fig. 2, *N. fissus* N., var. *major* Kellogg, ♀. Fig. 3, *N. splendidus* Kellogg, ♀. Fig. 4, *N. atopus* Kellogg, ♀. Fig. 5, *N. virgatus* Kellogg, ♀. Fig. 6, *N. splendidus* Kellogg, genital blotch of ♂. Fig. 7, *N. interpositus* Kellogg, ♀. Fig. 8, *N. audax* Kellogg, ♀. Fig. 9, *N. peninsularis* Kellogg, ♀.

PLATE III.—Fig. 1, *Lipeurus confidens* Kellogg, ♀. Fig. 2, *L. densus* Kellogg, head of ♂. Fig. 3, *L. gracilicornis* P., var. *major* Kellogg, ♂. Fig. 4, *L. protervus* Kellogg, ♀. Fig. 5, *L. macgregori* Kellogg, head of ♂. Fig. 6, *L. macgregori* Kellogg, ♀.

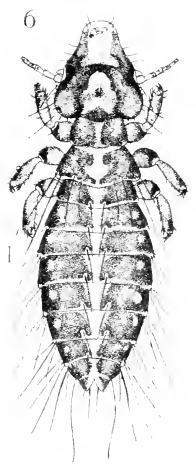
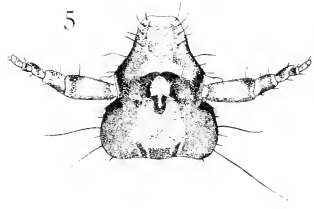
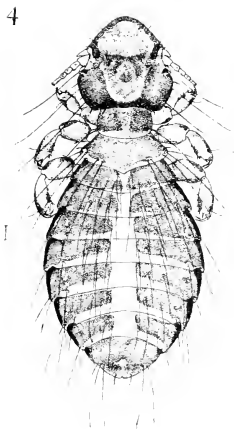
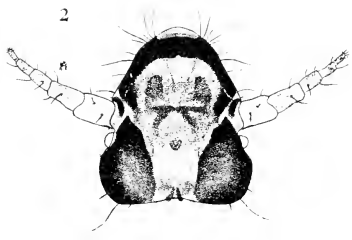
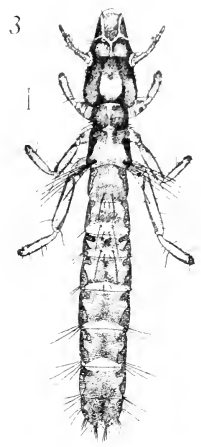
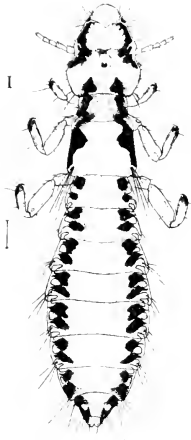
PLATE IV. Fig. 1, *Colpocephalum spineum* Kellogg, ♂. Fig. 2, *C. maculatum* P., ♂. Fig. 3, *C. diffusum* Kellogg, ♂. Fig. 4, *C. diffusum* Kellogg, ventral aspect of abdomen of ♀. Fig. 5, *Menopon auri-fasciatum* Kellogg, ♀. Fig. 6, *M. striatum* Kellogg, ♀. Fig. 7, *Physostomum pallescens* Kellogg, ♀. Fig. 8, *Menopon præcursor* Kellogg, ♀. Fig. 9, *Colpocephalum abbotti* Kellogg, ♀.

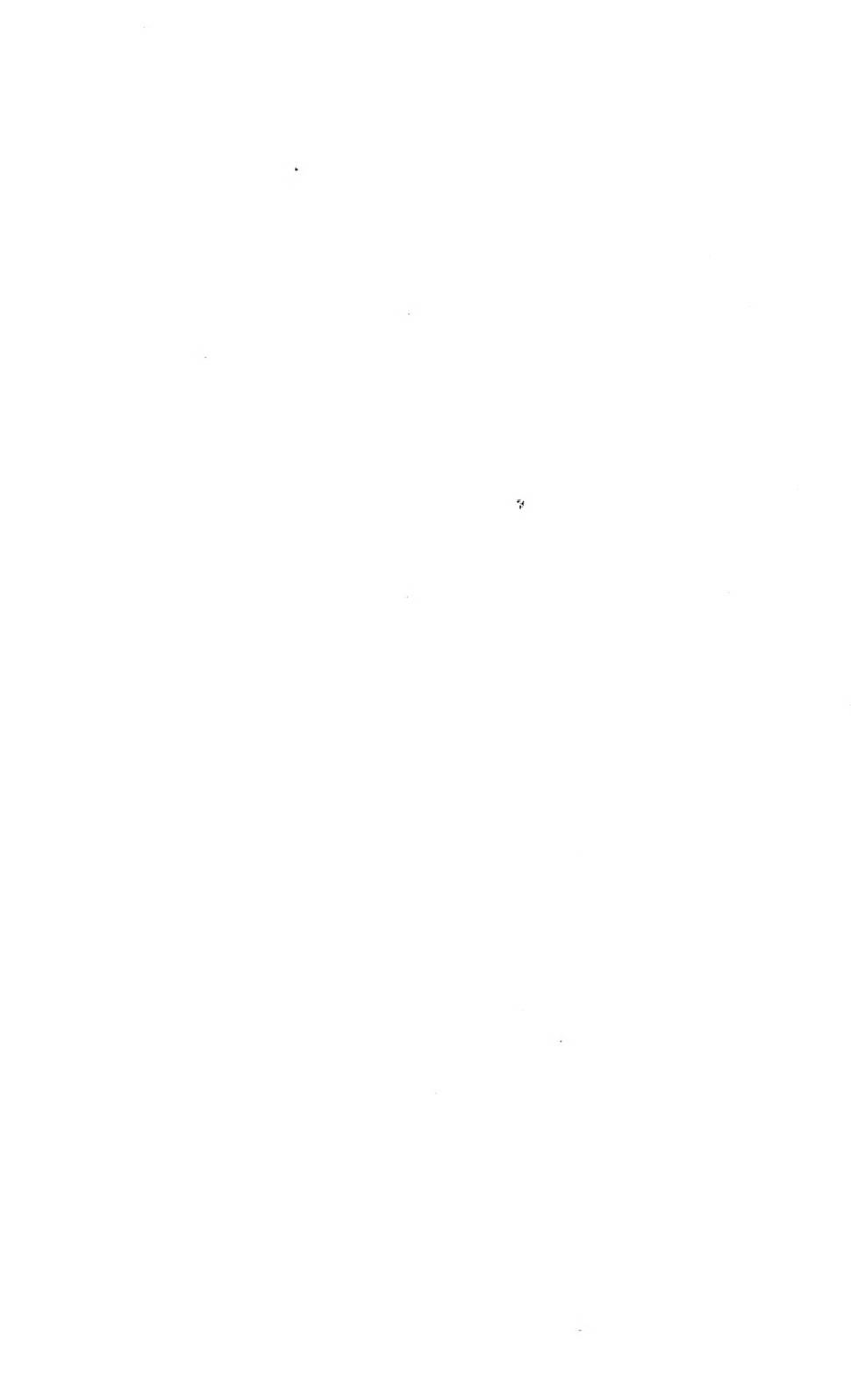




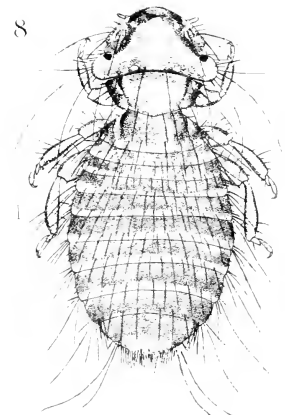
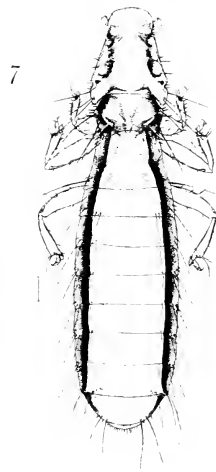
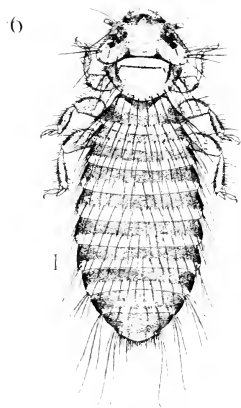
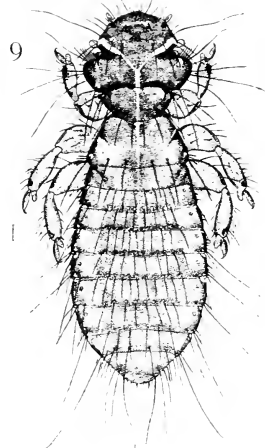
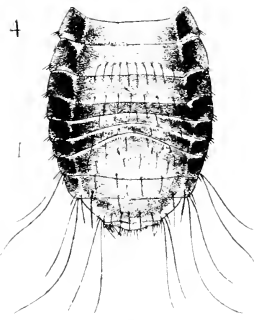
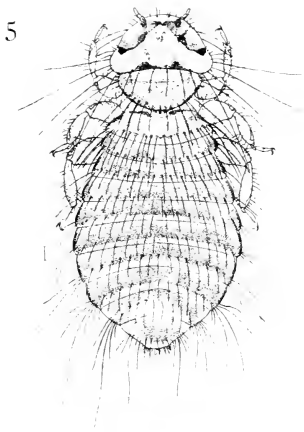
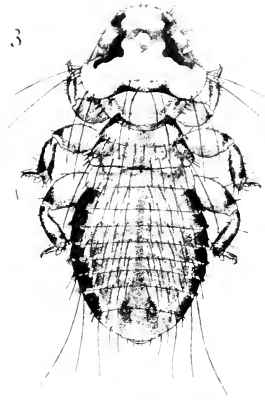
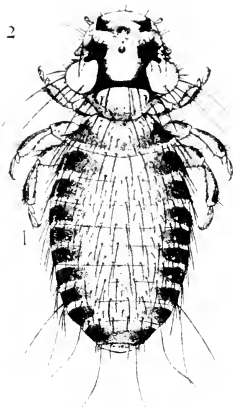
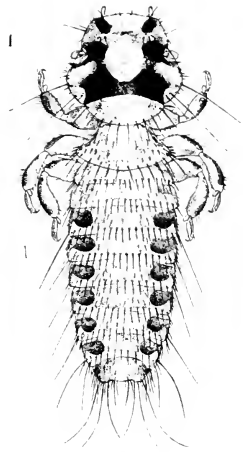














# MALLOPHAGA FROM BIRDS OF CALIFORNIA.

(With Plates V to IX.)

BY VERNON L. KELLOGG AND BERTHA L. CHAPMAN.

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## INTRODUCTION.

The Mallophaga described and referred to in this paper were collected by Messrs. Snodgrass, Osgood, Brown, and McLain, students of Stanford University, California, Mr. Ed. M. Ehrhorn, Horticultural Commissioner for Santa Clara County, California, and by the senior author, Mr. Kellogg. All of the specimens from birds of the Bay of Monterey, California, were taken by Mr. Kellogg from just-killed birds or freshly made skins collected by Mr. Leverett M. Loomis, Curator of the Department of Ornithology, California Academy of Sciences. The authors desire to acknowledge their obligations to these various collectors.

The sequence of genera in this paper is that adopted in the European monographs and in the papers of the senior author (Kellogg, *New Mallophaga I*, 1896;\* *New Mallophaga II*, 1896;\* *Mallophaga from Birds of*

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\* Proc. Cal. Acad. Sci., 2d. Ser. Vol. VI.

Panama, Baja California, and Alaska, in *New Mallophaga* III, 1899). The sequence of species in each genus is determined by the hosts, the sequence of hosts being that of the A. O. U. Check-List of North American Birds, 2d. edition, 1895.

### Docophorus.

**Docophorus procax** n. sp. (Plate V, fig. 1).

Many specimens from two Pigeon Guillemots, *Cephus columba* (Bay of Monterey, California). A member of the group *trianguliferi* Piaget (Les Pediculines, p. 113), and most resembling *pilosus* Piaget (ibid, p. 116, pl. x, fig. 4) from a flamingo, *Phaenicopterus antiquorum*, but differing in the hairs of clypeus, of metathorax, shape of abdominal blotches, etc.

Description of the male. Body, length 1.45 mm., width .76 mm.; head comparatively large, with frontal part of clypeus uncolored and expanded; thorax and first segment of abdomen golden brown with darker markings; abdomen oval, pale, whitish medially, with dark brown transverse bands and blackish lateral bands.

Head, length .52 mm., width .54 mm.; conical, temples wide, sides rapidly approaching each other anteriorly; frontal uncolored clypeal space expanded; front straight or feebly concave; no hairs on the rounding uncolored clypeal region but one short marginal prickle at the point where the clypeus begins to swell beyond the sides of the head; a second short prickle before the suture; two dorsal hairs just before the clear uncolored clypeal region; two short prickles in front of the trabeculæ; trabeculæ large, reaching nearly to the end of the second segment of the antennæ, well col-

ored with pale brown, a short prickle at the base; antennæ small, of the same golden brown as the head, with slightly darker markings; eye inconspicuous, with two short prickles and an ocular fleck; temples rounded, with two long hairs and several prickles; occipital margin straight; clypeal signature broadly shield-shaped, sides constricted anteriorly, with posterior angle reaching almost to the mandibles; the quadrangular space in the middle of the signature is slightly darker than the most anterior portion; antennal bands interrupted by the suture, the bands turning in at the suture, nearly meeting on the median line, the bands themselves becoming narrow and acuminate; the posterior ends of the antennal bands bend in and back till they meet the dark blotch caused by the mandibles showing through the head; ocular blotches distinct; temporal borders narrow, occipital bands distinct, slightly diverging anteriorly; occipital border not extending to the sides of the head.

Prothorax broad, with sides diverging; posterior angles rounding; lateral borders dark, extending in along the posterior margin. Metathorax pentagonal, sides strongly divergent, posterior margin angular, with slightly rounding tip on the abdomen; one short prickle and one long pustulated hair in the posterior angles, three pustulated hairs each side of the posterior marginal angle; segment pale in the middle, growing darker laterally and posteriorly. Legs of the same golden brown as the thorax, darker lateral borders and annulations, claws also dark. Sternal markings consist of dark brown intercoxal lines and a pale median metathoracic blotch.

Abdomen broadly ovate, turbinate; segments 2 to 7 with prominent posterior angles, each bearing

from one to three long hairs; segment 1 wholly golden brown, the transverse blotches meeting near the posterior margin in an acute point; the transverse lateral blotches of segments 2 to 7 are separated by a transparent whitish median space; the lateral margins of the segments are dark brown to black; along the posterior margins of the transverse lateral bands are partially uncolored spots bearing long hairs; stigmatal spots distinct; segment 8 wholly pale brown, darker in the middle, owing to the dark genitalia showing through; segment 9 very small and uncolored; genitalia distinct, dark brown reaching as far forward as segment 6.

Female. Body, length 1.62 mm., width .78 mm.; head, length .56 mm., width .53 mm.; abdomen not so broad in comparison with the length as in the male, not turbinated, and the median whitish space larger.

**Docophorus lari** Denny. (See Kellogg, *New Mallophaga*, I, 1896, p. 98, pl. iv, fig. 4).

Specimens from *Larus delewarensis*, *L. occidentalis* (three birds), and *L. heermanni* (two birds) (Bay of Monterey, California). Previously taken by Kellogg from these and other species of *Larus*.

**Docophorus melanocephalus** Burmeister. (See Kellogg, *New Mallophaga*, I, 1896, p. 99, pl. iv, fig. 6).

Two specimens from the Royal Tern, *Sterna maxima* (Bay of Monterey, California), and two specimens from the Pomarine Jaeger, *Stercorarius pomarinus* (Bay of Monterey, California). Previously taken by Kellogg from *Sterna maxima* (same locality).

**Docophorus validus** n. sp. (Plate V, fig. 2).

A single female specimen of this striking *Docophorus* from a Black-vented Shearwater, *Puffinus opisthomelas*

(Bay of Monterey, California). In general shape and in certain special characters this new form somewhat resembles *D. brevi-antennatus* Piaget (Les Pediculines, p. 108, pl. ix, fig. 9) from *Sula australis* (Museum of Leyden); the differences, however, in shape of meta-thorax, abdominal blotches, etc., are marked.

Description of the female. Body, length 2.25 mm., width 1.18 mm.; large triangular head with narrow, emarginate front; abdomen nearly circular, with strongly marked, lateral, transverse blotches, mostly acute inwardly.

Head, length .72 mm., width .72 mm., front of the head before the trabeculæ elongate and markedly narrowing anteriorly; dark lateral margins extending slightly beyond the narrow, concave, uncolored clypeal region, terminating in a sharp, slightly incurving angle; a short prickle on the anterior margin of this projecting angle, a short hair on the lateral margin of the front, near the suture; two dorsal hairs extending beyond the lateral margin of the head; trabeculæ large, reaching to the end of the second segment of the antennæ; segment 1 of the antenna long, segment 5 but little longer than segments 3 or 4; eyes prominent, with a short spine and a hair; temples slightly protruding, parabolic, with two long hairs and three short spines; occipital margin slightly convex upon the prothorax; signature distinct, anteriorly concave; deeper chestnut-brown along the anterior margin than through the wide median portion, posteriorly narrowing into a dark, narrow, acuminate point reaching to the mandibles; the anterior portion of this posterior point is darker than the rest of the signature; antennal bands broad, even, of a dark, rich, golden brown, paling slightly in the anterior portion, beyond the suture; posterior extremities bending inwardly, separated by a

pale median space between the occipital bands; occipital bands much paler than the temporal borders, indistinctly fading anteriorly into dark ocular blotches; temporal margins narrowly bordered with dark brown; occipital blotches distinct.

Prothorax small, oblong; angles rounding, with one long hair; lateral blotches distinct, separated by a pale median line, darker along the posterior margin near the angle, and fading gradually anteriorly. Metathorax only two-thirds as wide as the head, with strongly diverging sides, rounding, posterior angles; posterior margin broadly rounded upon the abdomen; one very short prickle and one long hair in a pale brown space on the posterior angle; six long pustulated hairs on the posterior margin; lateral markings little darker than the general dark brown of the metathorax.

Abdomen nearly circular; transverse, lateral blotches distinct, acute inwardly, and darkest at the inner ends; each bearing from one to four pustulated hairs; segment 8 entirely dark brown; segment 9 rounding, with a narrow, angular emargination; one fine hair each side of this emargination.

**Docophorus icterodes** Nitzsch. (See Kellogg, *New Mallophaga*, I, 1896, p. 96, pl. iv, fig. 1).

Specimens from a Lesser Scaup Duck, *Aythya affinis*, and from an American Scaup Duck, *Aythya marila nearctica* (Palo Alto, California). Previously taken by Kellogg from the first named host species, and from six other duck species.

**Docophorus fusiformis** Denny. (Plate V, fig. 3).

*Monographia Anoplurorum Britanniae*, 1842, p. 84, pl. i, fig. 2.

*Docophorus fusiformis* D., Giebel, *Insecta Epizoa*, 1874, p. 104; Piaget, *Les Pediculines*, 1880, p. 86, pl. vi, fig. 7.

*Docophorus fssiformis* D., Osborn, *Insects Affecting Domestic Animals*, Bull. 5, N. S., Div. of Ent., U. S. Dept. Ag., 1896, p. 217.



One male from a Least Sandpiper, *Tringa minutilla* (Palo Alto, California). Denny's specimens were taken from the same host; Giebel's single specimen from the same host, and Piaget's from *Tringa subarquata*. Osborn's specimens are from the "black-billed sandpiper" (Burrnett collection). Our specimen has no emargination of the clypeal front, a character especially noted by Denny and Piaget. But Giebel's specimen is like ours: "der Vorderrand ist nicht tief ausgeschnitten, sondern nur sanft concav." The species can be recognized by the large elongate head, the dark coloration, and narrow genitalia. Our specimen, figured, measures: body, length, 1.31 mm., width .5 mm.; head, length .5 mm., width .44 mm.

**Docophorus fuliginosus** Kellogg.

New Mallophaga, I, 1896, p. 80, pl. iii, fig. 2.

Specimens from the Black-bellied Plover, *Squatarola squatarola*, and from the Semipalmated Plover, *Aegialitis semipalmata* (Pacific Grove, California). Described from *Squatarola squatarola* (Kansas and California).

**Docophorus pictus** Giebel. (Plate V, fig. 4).

Insecta Epizoa, 1874, p. 74.

*Docophorus pictus* G., Piaget, Les Pediculines, 1880, p. 23.

Numerous specimens from a Golden Eagle, *Aquila chrysaetos* (Palo Alto, California). The specimens are of the characteristic group infesting eagles, of which *platystomus* N. (Giebel, Insecta Epizoa, p. 69, pl. ix, fig. 1; Piaget, Les Pediculines, p. 17, pl. i, fig. 1) may be taken as type. So many species have been described in this group, on what seems to us slight differences, that one may well despair of making a satisfactory reference of his specimens to any one of the forms to the exclusion

of all others. From this same host half a dozen species of *Docophorus* (all of the *platystomus* type) have been described.

The truncate, not emarginated, clypeal front, and the slight dilation of the uncolored part of the clypeus lead us to refer our specimens to a species proposed by Giebel for specimens collected from the same host as that of our specimens. Osborn (*Insects Affecting Domestic Animals*, 1896, p. 218,) describes a species *halieti* from the Bald Eagle, *Haliaeetus leucocephalus* (Florida). This species has a marked lateral, anterior, clypeal dilation, and the front is emarginate.

The members of the group may be recognized by the uncolored front of the clypeus more or less dilated. We figure a female. Measurements: Male, body, length 2.22 mm., width 1.2 mm.; head, length .85 mm., width .91 mm. Female, body, length 2.81 mm., width 1.4 mm.; head, length .94 mm., width 1. mm.

***Docophorus cursor* Nitzsch.** (See Kellogg, *New Mallophaga*, II, 1896, p. 484, pl. lxvi, fig. 1).

Specimens from two individuals of the American Long-eared Owl, *Asio wilsonianus*, (Ontario, California). Taken previously by Kellogg from *Bubo virginianus* (Lawrence, Kansas). Recorded by Osborn from *Asio wilsonianus* (Ames, Iowa, and Lincoln, Nebraska).

***Docophorus speotyti* Osborn.**

*Insects Affecting Domestic Animals*, 1896, Bull. No. 5, Div. o  
Ent., U. S. Dept. Ag., p. 222, fig. 144.

Specimens from a Spotted Owl, *Syrnium nebulosum* (La Honda, California). Agrees well with Osborn's description (except that the abdomen is narrow, with subparallel sides in the *female*, while it is more ellipti-

cal, widest at segment 4, in the *male*, just the reverse of the condition according to Osborn).

**Docophorus ceblebrachys** Nitzsch. (See Kellogg, New Mallophaga, II, 1896, p. 485, pl. lxvi, fig 3).

Many specimens from a Snowy Owl, *Nyctea nyctea* (Pullman, Washington). Taken previously by Kellogg from same host (Kansas).

**Docophorus singularis** n. sp. (Plate V, fig. 5).

Specimens from a Nuttall's Woodpecker, *Dryobates nuttallii* (Ione, California). Not like any other woodpecker-infesting *Docophori*, but belongs rather to the group *femorati*.

Description of the female. Body, length 1.43 mm., width .71 mm.; dark chestnut-brown with distinct bands on the head and thorax, angular, lateral, transverse blotches on the abdomen; unique in the possession of bipartite trabeculæ.

Head, length .65 mm., width .53 mm.; large, broadly concave, uncolored clypeal region broad with straight to slightly concave front; one marginal hair in front of distinct suture, two dorsal hairs near the lateral margin, one rather short and stiff, extending forward beyond the clypeal margin, the second very long; two dorsal hairs in front of the trabeculæ; the trabeculæ divided, anterior part short and acutely angulated, extending around the base of the posterior portion of the trabeculæ on the ventral surface, the posterior portion of the trabeculæ nearly as long as the first two segments of the antennæ, about the same width throughout, a deep chestnut-brown at the base, with uncolored tip; antennæ with the first two joints long and about equal, pale golden brown, last three joints darker chestnut-brown,

a few short spines on the joints, especially numerous and strong on the first two joints; eye with one long hair, and near the posterior margin a second long hair; temples rounding, with three long, pustulated, marginal hairs and one short prickle, occipital margin slightly convex; signature distinct, anterior margin concave, with a slight lateral constriction near the anterior angles, posterior angles extended backward, posterior margin extending in a long, acute angle beyond the mandibles; antennal bands distinctly interrupted at the suture, dark chestnut-brown, posterior extremities inward and back, meeting well defined, diverging occipital bands; temples dark chestnut-brown, with narrow blackish margins, interrupted by large pustulations.

Prothorax small, lateral margins strongly rounding; one long pustulated hair in the posterior angle; lateral blotches dark chestnut-brown, separated by a pale median line; blackish lateral borders. Metathorax with strongly divergent lateral margins nearly as wide as the head; a series of long pustulated hairs on the angulated posterior margin; lateral blotches dark, separated by a pale median line which widens distinctly near the middle; bands of blackish brown on the lateral and posterior margins. Sternal markings composed only of the distinct intercoxal lines between the pro- and mesothoracic legs. Legs pale brown with dark bands.

Abdomen broadly ovate, segments distinctly narrowing on the median line; one to three long hairs in the posterior angles; many long, pustulated, dorsal hairs in a transverse series on the posterior margin of each segment; lateral transverse triangular blotches dark chestnut-brown, slightly darker on the lateral margin; median portion of the abdomen uncolored; posterior margin of the transverse blotches interrupted by uncolored pustulations; segment 8 entirely dark brown;

segment 9 narrowly emarginate, rounding, with two short prickles on the posterior margin; two dark lateral blotches separated by a broad uncolored space; genital blotches distinctly dark brown, broadly rounding on segments 5 and 6, posterior margin rapidly tapering to segment 8.

Male same size as female; last segment broadly, flatly rounded, with several long hairs on each side of the bare median third of the posterior margin.

### **Docophorus californiensis** Kellogg.

New Mallophaga, II, 1896, p. 483, pl. lxvi, fig. 6.

Specimens from Williamson's Woodpecker, *Sphyrapicus thyroideus* (El Dorado county, California), the White-headed Woodpecker, *Xenopicus albolarvatus* (El Dorado county, and Kings River Cañon, California), and the Californian Woodpecker, *Melanerpes formicivorus bairdi* (Palo Alto, California). Types collected by Kellogg from *Melanerpes formicivorus bairdi* (Palo Alto, California). The specimens from the El Dorado county birds show narrow heads and bodies, but this is probably due to shrinking in drying, as all the specimens of the small collections from this locality appear to have suffered in the same way.

### **Docophorus rufus** Kellogg.

Mallophaga from Birds of Panama, Baja California and Alaska, in New Mallophaga, III, 1899, p. 7, pl. i, figs. 6 and 9.

Three specimens from an Ash-throated Flycatcher, *Myiarchus cinerascens* (Alameda county, California) and three specimens from another specimen of the same bird species from Ontario, California. Described by Kellogg from *Myiarchus cinerascens nuttingi* (Baja California).

**Docophorus fusco-ventralis** Osborn.

Insects Affecting Domestic Animals, 1896, Bull. 5, N. S., Div of Ent., U. S. Dept. of Ag., p. 221.

One specimen from an Ash-throated Flycatcher, *Myiarchus cinerascens* (Palo Alto, California). Osborn's specimens were from the Wood Pewee, *Contopus virens* (Cornell University Collection; Burnett Collection).

Agrees well with Osborn's description, except that the fuscous coloration of ventral aspect is in broad transverse bands separated by distinct, paler sutural bands, instead of being "beneath uniformly dark brown."

**Docophorus communis.** (See Kellogg, New Mallophaga, II, 1896, p. 486, pl. lxvi, fig. 7).

Under this name we group together a large number of very similar forms; or if dissimilar, forms connected by gradatory specimens. These forms are taken from passerine birds and belong to Piaget's group *femorati* (Les Pediculines, p. 53), characterized by the large truncate or feebly convex or weakly emarginated clypeus, with long hair in each anterior angle, by the especially large third pair of legs, and by the conspicuous pustulated hairs of the thorax and abdomen. The marked variation (notably in size of hindmost legs) among individuals from a single bird specimen (let alone bird species) and the series of gradatory forms connecting all the variations manifest in the group make it impossible for us to attempt to distinguish different species in this mass of material. Piaget has, indeed, attempted to define half a dozen varieties of *communis*, but in no very confident manner. The group *femorati* can furnish time-killing work for any student bold enough to undertake its discipline.

*Docophori* of this group, referable to the species *communis*, in its widest sense, have been determined by us

from the following passerine hosts, all from California: Ash-throated Flycatcher, *Myiarchus cinerascens*; Western Flycatcher, *Empidonax difficilis*, two specimens; Mexican Horned Lark, *Otocoris alpestris chrysolæna*; Blue-fronted Jay, *Cyanocitta stelleri frontalis*, three specimens; California Jay, *Aphelocoma californica*; Western Meadow Lark, *Sturnella magna neglecta*; Brewer's Blackbird, *Scolecophagus cyanocephalus*; Pine Siskin, *Spinus pinus*; Western Lark Sparrow, *Chondestes grammacus strigatus*, two specimens; Intermediate Sparrow, *Zonotrichia leucophrys intermedia*; Gambel's Sparrow, *Zonotrichia leucophrys gambelii*, three specimens; Golden-crowned Sparrow, *Zonotrichia coronata*, two specimens; *Spizella* sp.; Western Chipping Sparrow, *Spizella socialis arizonæ*; Bell's Sparrow, *Amphispiza belli*; Samuel's Song Sparrow, *Melospiza fasciata samuelis*, two specimens; California Towhee, *Pipilo fuscus crissalis*, two specimens; Black-headed Grosbeak, *Zamelodia melanocephala*; Western Blue Grosbeak, *Guiraca caerulea eurhyncha*, three specimens; Louisiana Tanager, *Piranga ludoviciana*, two specimens; Cedar Waxwing, *Ampelis cedrorum*; Northern Shrike, *Lanius borealis*; California Shrike, *Lanius ludovicianus gambeli*, two specimens; Cassin's Vireo, *Vireo solitarius cassinii*; Yellow Warbler, *Dendroica aestiva*; Vigor's Wren, *Thryothorus bewickii spilurus*; Plain Titmouse, *Parus inornatus*, three specimens; Audubon's Hermit Thrush, *Turdus aonalaschka auduboni*; Western Bluebird, *Sialia mexicana occidentalis*. Previously taken by Kellogg from sixteen species of passerine birds.

**Docophorus mirinotatus** n. sp. (Plate V, fig. 6).

A female and several immature specimens from a Thurber's Junco, *Junco hyemalis thurberi* (Goat Mt.,

alt. 11,500 ft., Kings River Cañon, California). This Nirmoid form does not much resemble any other *Docophorus* known to us. The strangely emarginated, transverse abdominal blotches are unique.

Description of the female. Body, length 1.65 mm., width .53 mm., slender, Nirmoid in form, with head wider than thorax and almost as wide as abdomen; abdomen yellowish white, with narrow blackish lateral bands, and transverse bands with their anterior margins widely and irregularly emarginated.

Head, length .46 mm., width .43 mm.; clypeus broad, with straight or very slightly concave front; one short hair in the lateral margin near the front, a second longer hair in front of the suture; eye with a long hair; temples flatly rounding, with two very long hairs and two or three prickles; markings indistinct; antennal bands interrupted at the suture; occipital bands widely separated posteriorly but converging rapidly anteriorly, forming a triangle with the mandibles at apex; trabeculae slender, short.

Prothorax narrow, quadrangular, with a long hair in the posterior angle; pale medially, with distinct dark lateral bands. Metathorax with a series of long hairs along the posterior margin which is distinctly angulated on the abdomen; lateral, dark brown borders.

Abdomen slender, elongate-elliptical; from one to three long hairs in the posterior angles of the segments and a dorsal, transverse series of long pustulated hairs on each segment rising near the middle of the segments; segments with median blotches which are widely and irregularly emarginate anteriorly, the blotches also interrupted by the pustulations which fade into the medial emargination; the transverse blotches distinctly darker on the posterior margin just



beneath the uncolored medial space and extending laterally not quite to the lateral bands; distinct narrow blackish bands on the lateral margins; last segment narrowly, angularly emarginate, with a short hair on the posterior margin each side of the emargination, and with pale brown transverse blotches, but no dark bands on lateral margins.

**Docophorus mirus** n. sp. (Plate V, fig. 7).

A few specimens from two Vigor's Wrens, *Thryothorus bewickii spilurus* (Palo Alto, California). Characterized by the very large head and small abdomen, the head being two-fifths as long as the whole body and almost, if not quite, as wide.

Description of the female. Body, length 1.5 mm., width .65 mm.; head very large in proportion to the body, five-sixths as wide as the abdomen and two-thirds as long.

Head, length .56 mm., width .53 mm., broadly conical; uncolored clypeal front slightly concave in the middle, a rather long stiff dorsal hair rising near the lateral margin and extending forward beyond the margin of the head, a short hair on the margin in front of a distinct suture, two rather long hairs before the trabeculae which reach as far as the end of the second segment of the antennae; segment 2 of the antennae long, segment 5 longer than either segment 3 or 4; eye distinct, a long hair on the dorsal surface and a shorter hair arising near the posterior angle; three long hairs and a short prickle on the rounding angle of the temples; occipital margin slightly convex; signature distinct, pale fulvous, anterior margin slightly concave; lateral margins straight, though the dark, narrow lines of the inner bands make it appear that there is a strong

constriction near the anterior margin; posterior angles rounding; posterior margin extending back beyond the mandibles in a dark, narrow point; antennal bands marginal, narrow, dark chestnut-brown, interrupted by the distinct suture, bending in to meet the anterior ends of the occipital bands in an indefinite, pale fulvous band; temples bordered anteriorly with a narrow border of dark chestnut; occipital bands narrow but distinct posteriorly, widely diverging and apparently connecting with the antennal bands.

Prothorax narrow, about half as wide as the head; lateral margin convex, one long pustulated hair in the posterior angles; a narrow lateral border of dark chestnut-brown. Metathorax with sides convex and strongly diverging; a series of long pustulated hairs on the posterior margin which is obtusely angled on the abdomen; lateral margin bordered with dark chestnut-brown. Legs fuscous, with dark fuscous borders and semiannulations; third pair of legs conspicuously large; a few scattered hairs and spines.

Abdomen broadly ovoid, short in comparison with the large head; first three segments longer than the others, their posterior margins more nearly straight; segments 4 to 8 narrowed, especially in the middle; last segment narrowly emarginate; many long pustulated hairs on the abdomen arranged in series on the posterior margin of each segment, especially thick along the middle; three or four short prickles on the lateral margin of the emargination of the last segment; first four segments dark chestnut-brown, segments 5 to 9 paler fuscous.

Male. Body, length 1.46 mm., width .53 mm.; head, length .53 mm., width .5 mm.; last abdominal segment rounded, with a fringe of about ten rather long weak hairs.

## Nirmus.

*Nirmus fusco-marginatus* Denny. (Plate V, fig. 9).

Monograph. Anoplur. Brit., 1842, p. 136, pl. x, fig. 1.

*Nirmus fusco-marginatus* D., Giebel, Insecta Epizoa, 1874, p. 178;

Piaget, Les Pediculines, 1880, p. 202, pl. xvi, fig. 6.

Many specimens of a *Nirmus* which may be referred to as a variety of this species of Denny, from an American Eared Grebe, *Colymbus nigricollis californicus*; also two specimens (rather smaller) from two Pigeon Guillemots, *Cepphus columba*, and a single specimen from the American Herring Gull, *Larus argentatus smithsonianus* (all the birds from the Bay of Monterey, California). Denny's types were taken from *Podiceps auritus* (Ireland), and Piaget's specimens from *Podiceps cristatus*. It seems to me that the *Nirmus podicipis* of Denny (Monograph. Anoplur. Brit. p. 142, pl. x, fig. 9) and the *Lipeurus runcinatus* Nitzsch (Giebel, Insecta Epizoa, p. 238) are both referable to *fusco-marginatus*. The antennal characters seem to be the same. As Piaget notes, the differing in the antennæ of male and female makes it difficult to refer the species to *Nirmus*. It is a form showing a transition to *Lipeurus*. Our specimens are one-fourth larger than the types of the species and differ in some minor particulars.

Var. *americanus* Kellogg and Chapman. (Plate V, fig. 9). Female, body, length 2.62 mm., width .81 mm.; head, length .56 mm., width .44 mm. Differs from the species type in having a spine in the posterior angles of the prothorax, and a hair on each lateral half of the posterior margin; the metathorax has six hairs and a spine on each lateral half of the posterior margin. The species is easily recognizable by its long slender body, short, narrow, pointed head, and the black, lateral, triangular, abdominal blotches with brown inward-projecting processes.

**Nirmus pacificus** n. sp. (Plate V, fig. 8).

Two males from a Tufted Puffin, *Lunda cirrhata*; one male from a Black-bodied Shearwater, *Puffinus griseus*; and specimens, males and females, from two Pigeon Guillemots, *Cephus columba*—all the birds from the Bay of Monterey, California. The specimen from *Puffinus* is almost certainly a straggler, as no other specimen was taken from the fifty-five individuals of *Puffinus* examined. The new species belongs to Piaget's group *zonati* (Les Pediculines, p. 187), and is most like *citrinus* (ibid. p. 190, pl. xvi, fig. 8). The metathorax, however, is angulated, not flatly rounded, as with *citrinus*, on the abdomen, and there are other differences.

Description of the male. Body, length 1.46 mm., width .5 mm.; short, broad, Docophoroid in form; light golden brown with conspicuous broad, dark antennal bands and dark brown to black lateral abdominal bands interrupted segmentally.

Head, length .5 mm., width .4 mm.; broadly conical; clypeal front very slightly concave; three marginal hairs on the front, one on the clear portion, and two before the suture; a short marginal prickle in front of the trabeculae, one dorsal hair just back of the first marginal, a second dorsal hair near the second marginal, two dorsal hairs between the suture and the trabeculae which are distinct and slightly colored; the antennae are short, segments 2 and 5 being longer than the others; color, the light golden brown of the head marked with slightly darker brown; eyes inconspicuous, with two short prickles; temples with sides nearly straight, rounding on posterior angles, with one very long hair, one shorter, weaker hair, and two short prickles; occipital margin concave; clypeus with a pale

but distinct pentagonal signature; antennal bands broad and dark, continuing beyond the suture; behind the obtuse posterior angle of the signature a narrow longitudinal uncolored space extending to the mandibles; temples bordered by a very narrow line of dark brown slightly broader just below the eye; a distinct though pale occipital signature.

Prothorax quadrangular, very short, broadly rounded, angles with one rather long hair; pale medially with dark brown lateral margins that bend in along the posterior margin. Metathorax pentagonal with widely diverging sides; posterior angles acute; six hairs in the angle and along the posterior margin; the posterior margin with a distinct elongate angle on the abdomen; dark lateral markings broadest on the posterior angles. Legs pale golden brown with slightly darker marginal markings.

Abdomen slightly elongate-oval, turbinate; posterior margins of segments 1-3 angulated, and anterior margins of segments 6-9 more obtusely angled; lateral angles of segments with one to three hairs; a few hairs on dorsal surface arranged along the posterior margins of the segments; posterior margin of segment 9 broadly rounded, with ten rather long hairs, several shorter hairs on dorsal surface of segment; color of abdomen fuscous; segment 1 without distinct lateral blotches, but segments 2-7 with dark brown to black lateral blotches, darkest in anterior angles and extending along the anterior margin of each segment almost to the median line; segment 8 but little darker in anterior angle, and segment 9 of an even pale fuscous; genitalia distinctly showing through, extending to segment 6.

Female, body, length 1.75 mm., width .6 mm.; head, length .55 mm., width .47 mm.; lateral abdominal

bands distinct, blackish, the posterior part of each segmental portion tapering acuminate; segment 8 without lateral bands; segment 9 widely, angularly emarginate behind, with a single very fine short hair on each obtuse posterior point.

**Nirmus maritimus** n. sp. (Plate VI, fig. 1.)

Many specimens from numerous individuals of the Ancient Murrelet, *Synthliboramphus antiquus*, Cassin's Auklet, *Ptychoramphus aleuticus*, Rhinoceros Auklet, *Cerorhinca monocerata*. Also a single specimen (straggler) from a Pacific Fulmar, *Fulmarus glacialis glupischa*. All of these birds from the Bay of Monterey, California. Resembling *N. citrinus* Nitzsch (Giebel, Insecta Epizoa, p. 177; Piaget, Les Pediculines, p. 190, pl. xvi, fig. 8) from *Alca torda*, but more slender, with elongate head, angulated posterior margin of metathorax, different disposition of hairs of the head, etc.

Description of the female. Body, length 1.96 mm., width .46 mm.; slender, elongate; pale fuscous with darker lateral borders on the head and thorax and broad lateral bands on the abdomen.

Head, length .5 mm., width .37 mm.; narrowly elongate, conical, with clypeal front convex; three marginal hairs, the first one near the front and the third in front of the suture, the second is midway between these; a short prickle in front of the trabeculæ which reach to the end of the first segment of the antennæ; antennæ short, not reaching more than two-thirds of the distance to the occipital margin; segment 2 longer than segment 1, and segment 5 longer than segments 3 or 4; a few short hairs on the segment; eye with a hair and a short prickle; temples with sides nearly parallel; one long hair, one short hair, and three short

prickles on the margin; occipital margin slightly concave; signature distinct, shield-shaped, anterior margin convex, posterior margin produced in a narrow point; antennal bands broad, interrupted by a distinct uncolored suture; the anterior extremities of the antennal bands bend broadly in at the suture, being separated medially by a narrow uncolored line that reaches nearly if not quite to the mandibles; ocular blotch fading inwardly; temporal borders narrow but well defined, broader just below the eye, gradually narrowing till it disappears before the occipital angle; a distinct conical occipital signature showing through from the under side of the head.

Prothorax with sides slightly diverging; posterior angles rounding, with one short hair; marginal borders dark golden brown, darker on the inner margin of the border; interrupted on the posterior margin by a broad pale median line. Metathorax with broadly rounding sides, diverging posteriorly; three hairs in the posterior angles; one long and one short hair on the posterior margin each side of the long, acute, median angle; lateral margins bordered with dark golden brown, darker on the inner margin. Legs pale fuscous with narrow dark marginal bands. Sternal markings consisting of pale fuscous intercoxal markings and a distinct median sternal blotch.

Abdomen narrow, elliptical; sides of the middle segments parallel; posterior angles with from one to two hairs; four dorsal hairs on the posterior margins of the segments, two near the middle and one each side near the lateral margin; transverse bands fuscous; lateral bands deep golden brown, broader anteriorly and extending beyond the suture into the segment in front; segments 2-6 with a pale posterior border; segments

7 and 8 with pale longitudinal median band; last segment narrowly rounding, with a narrow emargination; one short hair on the posterior margin, each side of the emargination; ventral surface with broad transverse median blotches.

Male. Body, length 1.5 mm., width .4 mm.; head, length .46 mm., width .34 mm.; distinctly shorter than the female; abdomen more broadly elliptical; segments 7 and 8 narrowed distinctly in the middle; last segment broadly rounded, with ten long hairs on the posterior margin; transverse bands distinctly dark on segments 1 to 6; last segment evenly pale yellow; genitalia darker brown, extending anteriorly to segment 5.

**Nirmus triangulatus** Nitzsch. (Plate VI, fig. 2).

Zeitschr. f. ges. Naturwiss. (Giebel), 1866, vol. xxviii, p. 378.

*Nirmus normifer* Grube, v. Middendorff's Sibir. Reise, 1851, Zool. i, p. 478, pl. i, fig. 8.

*Nirmus triangulatus* N., Giebel, Insecta Epizoa, 1874, p. 177; Piaget, Les Pediculines, 1880, p. 201, pl. xvi, fig. 5.

Many specimens of this striking *Nirmus* from one out of two birds shot of the Pomarine Jaeger, *Stercorarius pomarinus* (Bay of Monterey, California). Our specimens differ from Piaget's figure in having the head distinctly shorter and narrower in front, giving the insect an appearance markedly different from the effect given by the figure. There is probably no doubt, however, regarding the identity of the species.

Nitzsch's specimens were taken from "*Lestris crepidata*," Grube's from "*Lestris richardsoni*," and Piaget's from *Stercorarius pomarinus* and *Larus canus* (Zool. Garden of Rotterdam).

The species may be readily recognized by the characteristic black, subtriangular, lateral, abdominal blotches, and the chestnut-brown, median, abdominal



blotches (see figure). My specimens measured: Male, body, length 1.8 mm., width .62 mm.; head, length .53 mm., width .53 mm. Female, body, length 2.1 mm., width .63 mm.; head, length .6 mm., width .6 mm.

**Nirmus lineolatus** var. **atri-marginatus**. Kellogg and Chapman (For *lineolatus* see Kellogg, New Mallophaga, I, 1896, p. 113, pl. vi, figs. 7, 8 and 9).

Many specimens from *Larus canus*, *vega*, *brachyrhynchus* and *Rissa tridactyla pollicaris* (Bay of Monterey, California). A readily recognized variety of *lineolatus*, characterized by the presence of black temporal borders, usually strongly marked, sometimes weakly so. Other characters those of *lineolatus*.

**Nirmus punctatus** Nitzsch. (See Kellogg, New Mallophaga, I, 1896, p. 109, pl. vi, figs. 1 and 2).

Specimens from *Larus delewarensis* (Bay of Monterey, California). Taken previously by Kellogg from *Larus occidentalis* (same locality).

**Nirmus giganticola** Kellogg.

New Mallophaga, I, 1896, p. 105, pl. v, fig. 6.

Many specimens from a Short-tailed Albatross, *Diomedea albatrus*, and a single specimen from a Dark-bodied Shearwater, *Puffinus griseus* (Bay of Monterey, California). Described from *Diomedea albatrus* (same locality).

**Nirmus complexivus** n. sp. (Plate VI, fig. 3).

Many taken from the Sanderling, *Calidris arenaria* (Pacific Grove, California); found on every one of fifteen birds shot, and two specimens from a Least Sandpiper, *Tringa minutilla* (Palo Alto, California). This

form belongs to the group *zonati*, of Piaget (Les Pediculines p. 187) and shows but slight differences from several of the species of this group already described, one or two from the same host, indeed; but on the other hand Nitzsch's and Piaget's species differ among themselves but little, and the American specimens differ quite as much from any described species. In fact they are interesting as showing a combination of several characters which are presented as diagnostic of *cingulatus* (the interrupted first abdominal band), *zonarius* (the hairs and spines of the temples, and the head longer than wide), and *scalaris* (the size). In addition they present characters (metathoracic hairs, *et al.*) which are not shown by any one of the described species. I describe the American form therefore as a new species. The group needs revision; probably four or five of the present species should be reduced to varieties of the oldest named form, i. e. *cingulatus*.

Description of the female. Body, length 1.71 mm., width .5 mm.; readily distinguishable by its general dark color, and rounding, uncolored clypeus with the distinct colored signature, on each side of which lie the narrow triangular projections of the anterior ends of the antennal bands; the posterior ends of the antennal bands bend so strongly in at the suture that they mark the fore part of the head off from the hind part into a small cone.

Head, length .4 mm., width .34 mm.; elongate, triangular, with clypeus broadly rounding, the uncolored region slightly expanded beyond the suture; two short hairs on the rounding margin of the uncolored clypeus, one rather long hair in front of the trabeculæ; trabeculæ prominent, angular, reaching beyond the first joint of the antennæ; antennæ short, reaching barely two-

thirds of the distance to the occipital margin, pale fulvous with darker, broad annulations; segment 5 half as long again as segments 3 or 4; eyes distinct, with a hair and an ocular fleck; temples broadly rounding, with three long pustulated hairs, one short hair, and one prickle on the margin; occipital margin straight; clypeal signature constricted anteriorly, with the posterior, lateral angles projecting slightly backward; the posterior angle extending back indistinctly to the mandibles; antennal bands conspicuous, blackish brown, extending into long, paler, triangular projections on the clypeus; the blackish posterior ends extending in, meeting on the median line; ocular blotches contiguous with the dark temporal borders; occipital bands very definite, looking like two dark bars, bending outwards towards the ocular blotch but fading into the dark chestnut-brown of the temples; occipital blotch distinct; a pale transverse space behind the bent antennal bands, running like a curving bar across the head from margin to margin; occipital signature dark fuscous, spear-head-shaped.

Prothorax short, sides rounding; lateral quadrangular blotches separated by a narrow uncolored median line; lateral margin distinctly bordered with dark brown. Metathorax with strongly rounding sides; a short prickle in the anterior angle, a short prickle and a long pustulated hair near the middle of the lateral margin, two long pustulated hairs and two shorter hairs in the posterior angles, two short hairs on the posterior margin; the posterior margin rounding slightly upon the abdomen; strong, dark lateral bands. Legs light fulvous with dark marginal bands. Sternal markings consisting of intercoxal lines extending backward to the tip of the coxa of the second pair of legs;

a median sternal blotch rounding posteriorly with a sharp constriction about midway to the arrow-headed anterior portion.

Abdomen elongate, with one or two slender hairs in the posterior angles of the segments, two strong, pustulated hairs in the posterior margins of the segments; abdomen dark fulvous brown with broad, ill-defined, darker lateral bands, and a transverse linear band along the posterior margin of each segment of a darker brown, adjacent to which are the small uncolored stig-matal spots; the uncolored sutural lines distinct; segment 1 has the transverse band divided by a narrow uncolored median line; segments 8 and 9 more evenly colored; last segment angularly emarginated, with two anal blotches; two short hairs on the posterior margin each side of the emargination.

**Nirmus actophilus** n. sp. (Plate VI, fig. 4).

Many specimens from nine out of fifteen individuals shot of the Sanderling, *Calidris arenaria* (Bay of Monterey, California). A member of Piaget's group *obscurosuturati* (Les Pediculines, p. 169) and resembling somewhat *inaequalis* (ibid., p. 176, pl. xv, fig. 1) from *Numenius arquata*.

Description of the female. Body, length 1.59 mm., width .4 mm.; pale, with distinct, narrow, lateral bands of dark brown to black, head darker brown than the thorax, with dark narrow marginal markings.

Head, length .37 mm., width .28 mm.; conical, but little wider through the temples; clypeus broadly rounded, with four marginal hairs, three on the front before the suture, and one long one before the trabeculae, also a short prickle just at the angle of the trabeculae; a dorsal hair between the two anterior marginal hairs,

two other dorsal hairs on each side near the anterior extremity of the incurving antennal bands; trabeculae distinct, reaching nearly to the end of the first segment of the antennae; antennae with segment 2 longer than segment 1, and segment 5 longer than segments 3 or 4; color pale fulvous, slightly darker on the last three segments, sutures uncolored, lateral margins slightly darker fuscous; eyes not conspicuous, flattened, with a fine hair and a short prickle; temporal margins slightly rounded, with one long weak hair, one very short hair, and three short prickles; occipital margin concave; clypeal markings distinct, marginal; signature short, distinct anterior margin fading into a broadly rounded posterior angle; behind the signature a transverse linear uncolored space, continuous with the clypeal sutures, forming a distinct uncolored transverse bar across the forehead; antennal bands well defined, bending forward at the clypeal suture into broad, quadrangular ends, posterior extremities bending backward nearly to the distinct ocular blotches, which meet posteriorly the anterior ends of the narrow black temporal borders; occipital blotches small; a distinct, elongate, oval, occipital signature showing through from the ventral side; the mandibles distinctly showing through the head, the oesophageal sclerite showing faintly.

Prothorax with flatly rounded lateral margins, each posterior angle with one pustulated hair; general color pale brown to whitish, with narrow dark lateral bands. Metathorax expanded posteriorly, angles extended, with three long pustulated hairs, and some short weak hairs in the angle and along the lateral third of the posterior margin: posterior margin slightly angulated on the abdomen; narrow black submarginal markings, broadening but less definite on the anterior angles: intercoxal

lines, and a narrow, lanceolate, median, sternal blotch showing through. Legs of an even fuscous, first pair lighter than the second or third pair.

Abdomen elongate, slightly attenuated anteriorly; segments 8 and 9 tapering rapidly; posterior angles acute, each containing from one to three hairs; dorsal surface with a few hairs, four on the posterior margins of segments 1 to 7, two near the middle and two near the lateral margins; ground color pale fawn, gradually growing darker posteriorly, with dark brown lateral bands which send out from their anterior half an indefinite line that partially surrounds the stigmatal spot; segment 9 angularly emarginate, each broadly rounded angle bearing a short bristle; ventral surface with broad transverse bands of dark fawn, which give a darker tone to the paler transverse bands of the dorsal surface; a more definite series of hairs on the posterior margin of the segments than above; segment 8 with a group of three short hairs near the lateral margin.

### **Nirmus cordatus** Osborn.

Insects Affecting Domestic Animals, Bull. 5, N. S., Div. of Ent.,  
U. S. Dept. Ag., 1896, p. 228, pl. ii, fig. *a*.

One female specimen from a Great Marbled Godwit, *Limosa fedoa* (Pacific Grove, California). We had determined this to be an undescribed form, and had partially written a description when Professor Osborn's paper appeared, naming and describing the species from a single female and an immature specimen from the Hudsonian Godwit, *Limosa hæmastica* (Burnett Collection, locality?). Our specimen agrees well with Osborn's description, except that it is somewhat larger, being 2.75 mm., long (Osborn's type 2.44 mm.), and 1.2

mm. wide, (Osborn's type .94 mm.); head, length .7 mm., (Osborn, .66 mm.), width .85 mm., (Osborn, .73 mm.) Osborn's figure, after a photograph, shows the characteristic outline, but we think there is also needed a figure showing the markings which are also very characteristic. The broad rounding anterior emarginations of first two transverse abdominal bands differ notably from the not uncommon narrow angular emarginations of these bands.

**Nirmus incœnis** n. sp. (Plate VI, fig. 5).

A single female from a Black-bellied Plover, *Squat-  
arola squatarola* (Pacific Grove, California). Distinctly  
different from Kellogg's *orarius* (New Mallophaga I,  
1896, p. 104, pl. v, fig. 5) from *Charadrius dominicus*  
(Lawrence, Kansas) or *boophilus* (ibid, p. 107, pl. v,  
fig. 7) from *Ægialitis vocifera* (Lawrence, Kansas).

Description of the female. Body, length 1.65 mm.,  
width .31 mm.; strikingly elongate, narrow; head long,  
with subparallel sides; pale golden brown with very  
narrow blackish lateral borders on the head, thorax, and  
abdomen; an ill-defined brownish band across the  
head in front of the antennal bands.

Head, length .37 mm., width .21 mm.; clypeal front  
broadly rounding, with three marginal hairs about  
equally distant apart, the third just before the suture,  
one hair arising from the dorsal surface, extending be-  
yond the lateral margin of the head, a short fine hair  
in front of the small acuminate trabeculæ, antennæ  
short, segment 2 longer than segment 1, and segment  
5 longer than segments 3 or 4; eye flat, with a  
prickle near its posterior angle; temples with sides  
parallel, with one long hair, one short fine hair, and  
one short prickle on the margin; occipital margin

straight and bare; general color of the head golden brown, a narrow, irregular, marginal border on the clypeal front, darker on the inner margin; a weak brown band across the head in front of the antennal bands, which are narrow and distinctly dark golden brown; small ocular blotches and temples with very narrow dark brown borders.

Prothorax quadrangular, with rounding, posterior angles, each with one hair; transverse blotches golden brown, darker on the lateral margins and in the anterior and posterior angles; a broad, pale, median line separating the transverse blotches. Metathorax more than twice as long as the prothorax, and as wide as the head; sides diverging but little; a slight constriction near the anterior angles; a series of hairs on the rounding posterior margin; same golden brown as the prothorax, a narrow marginal border and a small brown spot in the anterior angles, a narrow but well defined border on the posterior half of the metathorax, the anterior ends bending in, making the slight constriction appear more than it really is. Legs paler golden brown than the thorax, with very narrow marginal borders of dark brown.

Abdomen narrow, elongate, with parallel sides, not tapering till segment 7; segment 1 narrower and shorter than those that follow; posterior angles but little extended, with one or two fine hairs; four long pustulated hairs on the posterior margins of the segments; transverse bands on segments 2 to 8 are golden brown, darkening towards the lateral margins where the lateral band is dark, narrow, and clearly defined; segments 7 to 9 without lateral bands; a pale transverse median band, caused by the uncolored stigmal spots, thus the transverse blotches appear like two dark bands across each



segment; segment 9 narrowly emarginate, with two pale brown blotches.

**Nirmus opacus** n. sp. (Plate VI, fig. 6).

Several specimens from two individuals of the Semipalmated Plover, *Egialitis semipalmata* (Pacific Grove, California). The new species belongs to the group *bicuspidati* (Piaget, Les Pediculines, p. 184), being in size, outline and marking much like *bicuspis* N. (Giebel, Insecta Epizoa, p. 155, pl. v, figs. 11 and 12; Piaget, Les Pediculines, p. 184, pl. xv, fig. 7) from "*Charadrius minor*," *C. hiaticula* and *Recurvirostra avocetta*.

Description of the male. Body, length 1.11 mm., width .47 mm.; body dark colored all over, with narrow black lateral abdominal bands.

Head, length .4 mm., width .31 mm.; elongate-conical, with broad, rounding front; uncolored clypeal region slightly expanded in front of the suture; five marginal hairs, one in the rounding anterior angle, one just behind this, one at the suture, and two before the trabeculæ; a few dorsal hairs project beyond the margin; trabeculæ distinct, rather slender, acute, prominent for *Nirmus*; antennæ short, not reaching the occipital margin when projected backward, segment 2 longest, segments 3 and 4 short, subequal, segment 5 longer, concolorous with ground color of the head; eyes flat, with a long hair and a fine prickle; temporal margins flatly rounding, with two long hairs and two prickles; occipital margin straight; front of clypeus uncolored; signature large, colored, shield-shaped, from its posterior point a narrow uncolored line runs backward to the mandibles or beyond; antennal bands distinct, blackish brown, interrupted at suture, the part behind the suture curving, with anterior extremity

expanded; hind head separated from fore head by an angulated, rather broad pale transversal space; temples unevenly bordered with blackish brown.

Prothorax quadrangular, with posterior angles nearly rectangular, with one long hair; brown with blackish, even, lateral borders. Metathorax pentagonal, angulated on abdomen; lateral angles with one short hair and three long pustulated hairs, and two long pustulated and one short pustulated on each postero-lateral margin; brown, darker in anterior angles. Legs concolorous with palest color of the thorax, and with narrow dark dorsal margining. Sternal markings composed of distinct intercoxal lines, a linear median blotch on prothorax and a more distinct, larger median blotch on metathorax.

Abdomen elongate-elliptical; posterior angles of segments projecting slightly, with three or four longish hairs beginning with segment 3; dorsal hairs of segment 1 arranged as follows: two on each side of the median line (one in the inner anterior and one in the inner posterior angle of each lateral blotch); segment 2 with four pustulated hairs along the posterior margin; segments 3 and 4 with six pustulated hairs on posterior margin; segments 5 and 6 with two pustulated hairs near the middle of the posterior margin, and a very long hair on the posterior margin near the posterior angles; segment 8 with six pustulated hairs along the posterior margin; segment 9 with eight dorsal hairs and four long marginal hairs; dark brown, with distinct narrow black lateral bands; a narrow uncolored median line reaching nearly to posterior margin of segment 2; the dark brown transverse blotches on segments 6-8 broadly emarginated posteriorly; segment 9 with elongate-elliptical transverse lateral blotches meet-

ing on the median line (there are four pustulated hairs on each blotch); genitalia distinct, extending to posterior margin of segment 4.

Female. Body, length 1.75 mm., width .45 mm.; head, length .47 mm., width .28 mm. Metathorax with but two pustulated hairs on each postero-lateral margin; the narrow uncolored median line extends entirely through segment 2, and slightly into segment 3; segments 3-6 with four pustulated hairs on posterior margin, segment 7 with two median pustulated hairs on posterior margin, and segment 8 with two pustulated hairs in the rounding posterior angles; segment 9 deeply, angularly emarginated, the acute joints with a short prickle.

**Nirmus fuscus** Nitzsch. (See Kellogg, New Mallophaga, II, 1896, p. 499, pl. lxxvii, fig. 7).

Specimens from the Western Goshawk, *Accipiter atricapillus striatulus* (Pullman, Washington), the Desert Sparrow Hawk, *Falco sparverius deserticolus* (Palo Alto, California), the Western Red-tailed Hawk, *Buteo borealis calurus* (Palo Alto, California), and the White-tailed Kite, *Elanus leucurus* (Palo Alto, California). Taken previously by Kellogg from *Buteo swainsoni*, *Circus hudsonius* and *Archibuteo lagopus sancti-johannis*, all from Lawrence, Kansas. Recorded by Osborn from *Buteo swainsoni* (Ames, Iowa), and from *Accipiter velox* (locality?).

These specimens combine characters of *fuscus*, *rufus*, *et al.* of Nitzsch, so as to lead us to doubt the distinctness of these various species of Nitzsch. We have with *Nirmus fuscus*, *sens latus*, of the hawks, a repetition of the condition shown by *Docophorus communis* of the passerine birds.

**Nirmus vulgatus** Kellogg.

New Mallophaga, II, 1896, p. 496, pl. lxxvii, fig. 5.

Many specimens from numerous species of passerine birds. This *Nirmus* must be treated like *Docophorus communis*, in that we must group together under one specific name forms rather variant (notably in length and intensity of coloration), without being able as yet to distinguish categorically these variations. Osborn's *pallidus* (Insects Affecting Domestic Animals, 1896, Bull. 5, N. S., Div. of Ent., U. S. Dept. Ag., p. 227). from *Zamelodia ludoviciana* (Ames, Iowa) is probably based on palely colored specimens of this species. The name *N. pallidus*, by the way, is preoccupied (see Piaget, Les Pediculines, 1880, p. 144).

We refer to this species specimens from the Western Blue Grosbeak, *Guiraca caerulea eurhyncha* (4 birds, California); the Western Lark Sparrow, *Chondestes grammacus strigatus* (Ontario, California); the House Finch, *Carpodacus mexicanus frontalis* (Ontario, California); the California Towhee, *Pipilo fuscus crissalis* (2 birds, Palo Alto, California); the Spurred Towhee, *Pipilo maculatus megalonyx* (Palo Alto, California); the Golden-crowned Sparrow, *Zonotrichia coronata* (Palo Alto, California); the Lazuli Bunting, *Passerina amœna* (Palo Alto, California); the Mountain Chickadee, *Parus gambeli* (El Dorado county, California); the Californian Chickadee, *Parus rufescens neglectus* (Palo Alto, California); the Western Bluebird, *Sialia mexicana occidentalis* (Palo Alto, California); the Yellow Warbler, *Dendroica aestiva* (Palo Alto, California); the Lutescent Warbler, *Helminthophila celata lutescens* (Palo Alto, California); the Black-chinned Hummingbird, *Trochilus alexandri* (Ontario, California); the Blue-fronted Jay, *Cyanocitta stelleri frontalis* (King's River

Cañon, California); the American Dipper, *Cinclus mexicanus* (Ontario, California); the Western Flycatcher, *Empidonax difficilis* (2 birds, Ontario, California), and the Ash-throated Flycatcher, *Myiarchus cinerascens* (Ontario, California). The specimens from the two last-named bird species, Flycatchers, show a common variation from the type specimens in a greater length, less angulated posterior margin of metathorax, and paler markings. Taken previously by Kellogg from eight species of passerine birds.

**Nirmus fœdus** n. sp. (Plate VI, fig. 7).

Specimens from the Ash-throated Flycatcher, *Myiarchus cinerascens* (Ontario, California), the Long-tailed Chat, *Icteria virens longicauda* (Ontario, California), Say's Phoebe, *Sayornis saya* (Ontario, California), the Arkansas King-bird, *Tyrannus verticalis* (Ontario, California), the California Shrike, *Lanius ludovicianus gambeli* (Ontario, California) and the Phainopepla, *Phainopepla nitens* (Ontario, California). This species belongs to Piaget's second group of *circumfasciati*, and resembles *platyclypeatus* P. and *frater* (Les Pediculines, p. 145, pl. xii, figs. 1 and 2) from *Motacilla alba* and *Lamprotornis amethystina*, respectively.

Description of the female. Body, length 2.21 mm., width .75 mm.; abdomen broad for *Nirmus*, pale fuscous, head darker than the thorax or abdomen, narrow dark lateral borders on the head and thorax, but no dark lateral abdominal bands; pale brown median, transverse abdominal blotches.

Head, length .56 mm., width .43 mm.; clypeal front varying from narrowly to broadly parabolic, with four short hairs on the margin, a short marginal prickle before the trabeculæ, and two long dorsal hairs

arising before the trabeculae, which are small, yet distinct; antennae short, segment 2 longer than the other segments, segment 5 longer than segments 3 or 4, a few short hairs on the segments; eye distinct, with one very long hair and a short prickle at its posterior angle; temples rounded, with two long marginal hairs and two or three short prickles; occipital margin straight; head of a general dark fulvous, clypeal front paler, clearer yellow brown; antennal bands very narrow, blackish brown, strictly marginal and not extending far anteriorly; antennae an even, pale fuscous; ocular blotches dark and extending angularly inward; temples with a narrow border of blackish brown.

Prothorax with sides rounding and slightly divergent, with a long hair in the posterior angle; three short dorsal spines near the anterior angle, two near the median line, and one nearer the lateral margin; lateral margins with irregular dark borders; intercoxal lines showing through from the under side distinctly, as sharply defined lines, directed in towards the median line, before the posterior margin. Metathorax but little wider than the prothorax, slightly constricted near the anterior angles; posterior angles broadly rounded, with one short hair and one spine; posterior margins nearly straight on the abdomen, except for the acute median angle; a series of long pustulated hairs on the posterior margin each side of the acute angle. Legs pale fuscous without definite markings.

Abdomen broadly elliptical; angles of segments not projecting, a series of long hairs on the posterior margin of the segments; transverse bands an even, pale fuscous, indistinct to wanting, without darker lateral bands; last segment broadly rounding, with slight emargination, two or three short marginal hairs and

several long dorsal hairs; ventral surface with broad median transverse bands of dark fuscous; blotches of the last segment posteriorly emarginate and laterally interrupted by the pustulations of two long hairs; these ventral blotches show through above.

**Nirmus ductilis** n. sp. (Plate VI, fig. 8).

One female from a Western Flycatcher, *Empidonax difficilis* (Ontario, California). A member of the group *interrupto-fasciati*, but well distinguished by its sharp, distinct, blackish marginal markings, without trace of median abdominal blotches.

Description of the female. Body, length 1.9 mm., width .4 mm.; long, slender, transparent white, with narrow, distinct, blackish lateral margins of head and abdomen.

Head, length .37 mm., width .28 mm.; elongate, conical, front narrow and slightly concave; a few short hairs along the margin of the front, the longest hair in front of the trabeculae, which are small but distinct and uncolored; antennæ with second segment longest, segment 5 longer than segments 3 or 4, segments 1 and 2 pale transparent whitish, segment 3 with a slight shade of brown, segments 4 and 5 dark brown; eye with a prickle; temporal margins with one long hair and two or three prickles; occipital margin slightly convex; antennal bands narrow, blackish brown, fading out along the inner margins and anteriorly, before reaching the uncolored frontal margin, the posterior extremities bending angularly in, meeting the dark ocular blotches which in turn meet the dark brown marginal borders of the temples.

Prothorax with flatly rounding lateral margins and posterior angles, dark blackish brown lateral borders, which bend in and back on the anterior and posterior

extremities, the posterior borders almost meeting on the median line. Metathorax as wide as the head, sides diverging strongly; posterior angles with three or four long hairs, a series of pustulated hairs along the outer third of the posterior margin that is rounded upon the abdomen; dark, interrupted lateral blotches narrow and marginal on the anterior angles, and large, irregular submarginal blotches, darker near the posterior angles, growing paler near the middle. Sternal markings consisting of distinct intercoxal lines and a pale brown median blotch on the metasternum. Legs translucent whitish with blackish brown marginal bands and semi-annulations.

Abdomen very long, elliptical, with subparallel sides not tapering posteriorly until after segment 7; posterior angles of the segments slightly projecting, each bearing one weak hair, till segment 7, which has two hairs in the angle; segment 8 has one lateral marginal hair besides two hairs in the posterior angle; segment 9 broadly rounding, with angular emarginations, two short hairs on the posterior margin; two dorsal hairs arising near the posterior angle of each segment except segment 8 which has a series of posterior marginal hairs; pale translucent whitish with distinct, narrow blackish brown linear bands on the lateral margins of segments 1 to 7; segment 8 with small pale brown blotches near the lateral margin and one pale brown blotch on the median line; last segment uncolored; genital blotches pale brown, linear each side of the median line on the posterior margin of segment 7, also a pale brown blotch on the median line of segment 6.

**Nirmus lautiusculus** n. sp. (Plate VI, fig. 9).

A single male from a Bell's Sparrow, *Amphispiza belli* (Ontario, California). The new species, strikingly



marked, is a member of the group *interrupto-fasciati*, in general shape like *vulgatus* K. (New Mallophaga II, p. 496, pl. lxvii, fig. 5) and with the characteristic angulated, colored internal border of the antennal fossa. In the distinctness and contrast of the markings it recalls *illustris* K. (New Mallophaga II, p. 494, pl. lxvii, fig. 4).

Description of the male. Body, length 1.65 mm., width .4 mm.; translucent whitish with sharp, black, narrow marginal bands on head and abdomen; legs with annulations and semiannulations; thorax with intercoxal lines showing through distinctly, and abdomen with median linear brown transverse blotches, two to a segment, on ventral aspect.

Head, length .34 mm., width .31 mm.; front narrow, slightly convex; two or three short hairs on the lateral margin of the front; a short prickle in front of the trabeculæ which are distinctly angular and uncolored; antennæ long; segment 2 longer than other segments, segment 5 distinctly dark brown; eye prominent, with two prickles, one on the eye itself and a second just at its posterior angle; temples rounding, with one very long hair, one short fine hair, and three short prickles; occipital margin straight and bare; antennal bands narrow, clearly defined, not fading inwardly, their anterior extremities separated by the uncolored clypeal front, interrupted just before the trabeculæ by a distinct uncolored space, posterior extremities acutely meeting the dark narrow bands that angularly margin the antennary fossæ and the eye; the temples irregularly dark on the margins; the occipital signature distinctly showing through as a narrow brown blotch on the occipital margin and in front as a triangular blotch.

Prothorax with rounding lateral margins and posterior angles; three short spines on the dorsal surface

in each anterior angle; a dark blackish brown blotch in the anterior angles, and a narrow black band along the posterior margin, widening as it reaches the angle. Metathorax longer than the prothorax, with sides diverging; a series of six long hairs on the posterior margin which is narrowly rounded upon the abdomen; anterior angles with a small blotch of dark brown. Sternal markings showing through distinctly, the intercoxal lines of the metasternum appearing as a dark transverse band across the metathorax, the lateral extremities not reaching the margin but bending irregularly backward, abruptly stopping before they reach the posterior angle. Legs translucent with dark annulations and semiannulations.

Abdomen narrowly elongate, segments 1-7 with narrow, sharply defined black lateral bands; last segment uncolored, narrowly rounding, with several long dorsal hairs; the ventral surface of segments 1-6 with two median, linear brown transverse blotches on each segment; these blotches are united on segment 6 by a brown median line; segment 7 with two longitudinal brown blotches each side of the median line approaching each other anteriorly; two very small brown blotches on the last segment near the anterior angle.

**Nirmus longus** Kellogg.

New Mallophaga, II, 1896, p. 490, pl. lxxvii, fig. 1.

A single male from the Barn Swallow, *Chelidon erythrogastra* (Palo Alto ? California). This specimen differs distinctly from the type specimens in having but three instead of six lateral metathoracic hairs, in the more elongate head, and in the distinctness of the median uncolored longitudinal line of the abdomen. It should be distinguished by a varietal name.

Var. *domesticus* Kellogg and Chapman; one male from the Barn Swallow, *Chelidon erythrogastra* (California); body, length 1.54 mm., width .41 mm.; head, length .37 mm., width .31 mm.; thus being of about same size as the species type, and twice as long as Nitzsch's *gracilis*, the common *Nirmus* of the European swallows. Characters of species with differences as noted above. Osborn (Insects Affecting Domestic Animals, 1896, p. 225) refers a specimen from the Purple Martin, *Progne subis* (Ames, Iowa), to *gracilis*. He does not give the measurements of his specimen.

### **Nirmus brachythorax** Giebel.

Insecta Epizoa, 1874, p. 134.

*Nirmus brachythorax* G., Piaget, Les Pediculines, 1880, p. 150, pl. xii, fig. 8; Osborn, Insects Affecting Domestic Animals, Bull. 5, N. S., Div. of Ent., U. S. Dept. Ag., 1896, p. 223.

Specimens from two Cedar Waxwings, *Ampelis cedrorum* (Palo Alto, California). Osborn's specimens were from same host (Ames, Iowa). Giebel's types are from same host.

### **Lipeurus.**

#### **Lipeurus laculatus** n. sp. (Plate VII, fig. 1).

Four specimens collected of this strikingly marked *Lipeurus*; an adult male and an immature individual from a Pomarine Jaeger, *Stercorarius pomarinus*, and an adult male and an immature from a Pink-footed Shearwater, *Puffinus creatopus* (Bay of Monterey, Calif.) We believe that the specimens from the Shearwaters are stragglers from the Jaeger. (We have examined so many Shearwaters that, were the species a regular parasite of *Puffinus*, we should have taken other examples.) One other individual of *Stercorarius pomarinus* was

examined, but no *Lipeurus* was found on it. The new species shows no special resemblances to any of the described *Lipeuri* of allied hosts.

Female. Body, length 4.06 mm., width .78 mm.; slender, transparent whitish with distinct black marginal markings on the head, thorax, legs, and abdomen, broad transverse bands of dark chestnut showing through the dorsal surface of the abdomen.

Head, length 1. mm., width .59 mm.; elongate, conical, sides nearly parallel, clypeal front rather narrowly rounded, with five marginal hairs, four of which arise from the anterior part of the clypeus, being about equidistant, the fifth hair is in front of the very small trabeculæ; two dorsolateral hairs, one near the first anterior marginal hair and the other between the third and fourth marginal hairs; antennæ with segment 2 longer than the other segments, segments 1, 2 and 3 uncolored, segment 4 dark brown, segment 5 lighter brown; eye distinct, with a short prickle; temporal margins nearly parallel, with one hair and four short prickles; anterior margin of the clypeus uncolored; a wide, distinct signature with convex, posterior margin; color even chestnut-brown; antennal bands broad, black, sharply defined, except at the anterior portion where they extend indistinctly toward the median line of the head; temporal margin distinctly bordered with black, narrowing posteriorly; occipital blotches black and angular.

Prothorax quadrangular, sides parallel; a short prickle in the posterior angles; pale transparent brown, with broad black lateral borders following the margins of the anterior and posterior angles. Metathorax longer than broad, widest at the posterior angles; posterior margin straight; ground color slightly darker brown

than the prothorax, with irregular, black marginal bands fading just back of the anterior angles, and with an emargination at their posterior extremity where four long pustulated hairs and one short hair arise; one short hair on the posterior angle. Legs concolorous with the pale color of the prothorax, with black annulations and marginal bands; front legs short, femora wide, with small black marginal markings; second and third pair of legs long; coxæ produced and widely separated, with dark dorsal annulations; femora long and slender, with narrow black marginal markings; tarsi and claws pale brown; several scattered hairs and spines on the legs. Sternal markings composed of intercoxal lines between pro- and mesolegs, and a large suboblong, metathoracic, median blotch with rounded angles.

Abdomen with sides of segments 1-7 parallel; segments 8 and 9 suddenly narrowed and very small; posterior angles of the segments with from one to four long hairs; segment 9 narrowly emarginate, with two long hairs on each of the posterior angles; ground color transparent whitish, with black lateral marginal bands which extend inward along the anterior and posterior margins; these lateral bands are inwardly emarginated by an uncolored space surrounding the stigmata; on the ventral aspect fulvous transverse bands, concave posteriorly; segment 7 with two longitudinal, lateral fulvous blotches; segment 8 with irregular black marginal bands; segment 9 wholly dark brown to black.

### **Lipeurus diversus** Kellogg.

New Mallophaga I, 1896, p. 123, pl. viii, figs. 3 and 4.

Many specimens from thirteen out of thirty-four individuals shot of the Black-vented Shearwater, *Puffinus*

*opisthomelas*, from twelve out of fourteen individuals shot of the Dark-bodied Shearwater, *P. griseus*, from five out of six individuals shot of the Pink-footed Shearwater, *P. creatopus*, from a single specimen shot of *P. bulleri*, from a single specimen shot of *P. tenuirostris*, and a single specimen, probably straggler, from a Short-tailed Albatross, *Diomedea albatrus* (all the birds from the Bay of Monterey, California). The species was described from *Puffinus opisthomelas* (same locality).

This species and *Lipeurus angusticeps* Piaget (Les Pediculines, p. 306, pl. xxv, fig. 4) from *Thalassidroma leachi*, and *Lipeurus abnormis* Piaget (Supplement, p. 65, pl. vii, fig. 2) from *Puffinus major*, are closely related. There is a regular sequence in size from *angusticeps* through *diversus* to *abnormis*. It may be suspected that we have to do with one species of great variation in size; but the diagnostic characters of the three species are sufficiently important to justify the separation of the forms.

### **Lipeurus densus** Kellogg.

New Mallophaga II, 1896, p. 114, pl. vii, figs. 1 and 2.

Two females and a male from a Short-tailed Albatross, *Diomedea albatrus* (Bay of Monterey, California). Types taken from *Diomedea albatrus* and *D. nigripes* (see Kellogg, Mallophaga from Birds of Panama, Baja California and Alaska, in New Mallophaga III, p. 28, pl. iii, fig. 2). These specimens fully confirm the specific identity of the female described in New Mallophaga II, p. 114, and the male described in New Mallophaga, III, p. 28. The females now taken are almost, if not quite, as large as the male, and they are also quite as fully blotched and colored.

**Lipeurus ferox** Giebel. (See Kellogg, New Mallophaga, I, 1896, p. 127, pl. ix, figs. 1 and 2).

One male from the Short-tailed Albatross, *Diomedea albatrus* (Bay of Monterey, California). Previously taken by Kellogg from same host species (same locality). The description and figure which Taschenberg (Die Mallophagen, 1882, p. 145, pl. v, fig. 1 *a*) gives for the female of *Lipeurus ferox* apply in reality, we believe, to the male of *Lipeurus densus* Kellogg (See Mallophaga from Birds of Panama, Baja California and Alaska, in New Mallophaga, III, 1899, p. 28, pl. iii, fig. 2).

**Lipeurus concinnus** n. sp. (Plate VII, fig. 2).

A male and a female from the Short-tailed Albatross, *Diomedea albatrus* (Bay of Monterey, California). A slender, graceful form of the *clypeati sutura indistincta*, not much resembling any of the *Lipeuri* hitherto taken on the Albatross.

Description of the male. Body, length 3. mm., width .53 mm.; slender, pale, with distinct black marginal markings, and brown head and transverse abdominal blotches.

Head, length .65 mm., width .4 mm.; elongate, conical, front rounded, four long marginal hairs and one short one before the antennal angle; a long hair, arising from the dorsal surface between the first and second marginal hairs, extends beyond the margin; antennæ with segment 1 nearly as long as all the other segments, segment 2 about one-third as long as segment 1, segment 3 short, with a dorsal, angular, distal appendage, segment 5 longer than segment 4, segments 4 and 5 and the tip of the appendage of segment 3 light brown, antennæ elsewhere uncolored; eyes distinct but not

protruding; temples convex, hind-head widest about half way between the eyes and the posterior angles; margin with no long hairs, but with a short curving hair and a few prickles; occipital margin straight; head all brown, except small, nearly uncolored part of clypeal front, and antennæ, of which the first three segments are uncolored, last two pale brown; narrow marginal antennal bands; small signature, widest anteriorly and extending posteriorly in a fading, acuminate point; indistinct occipital bands and temporal borders blackish; anterior horns of the prothorax showing through, producing the effect of black triangular blotches at the base of the occipital bands.

Prothorax quadrangular, straight in the middle third on the metathorax; one very short hair in the posterior angle; general color transparent whitish, with distinct, even black lateral borders. Metathorax with lateral margins slightly convex before the middle; longer than broad; posterior margin slightly angulated upon the abdomen; three long hairs and two shorter hairs in the posterior angles; general color pale transparent brownish, with irregular lateral bands of black, expanding near the anterior angles into conspicuous triangular blotches, narrower below these blotches than the lateral bands of the prothorax. Legs long, slender, transparent, with black bands on femora and tibiæ; tibiæ and tarsi brown, a few scattered hairs on the legs. Prosternum with curving intercoxal lines; a medial, metathoracic, sternal blotch oblong, darker on the posterior half.

Abdomen slender, elongate, slightly widening to segment 4, then tapering gradually to segment 9; segment 2 longer than the other segments, while segments 4 and 5 are narrow, especially in the middle; posterior angles



but slightly extending, with from one to four hairs; segment 8 with six long posterior marginal hairs; general ground color of the abdomen, after segment 1, which is transparent whitish, dark brown; lateral markings black, of segment 1 they are anterior and angular, of segments 2 to 7 broadly extending towards the median line on the anterior half of the segments, while the posterior portion is darker and more definitely angular, this lateral band is deeply emarginated interiorly by a light brown blotch; the broad transverse bands are darker on the anterior margin, and the posterior margins of these transverse bands are emarginated by a pale brown band; segment 8 an even brown with very narrow dark lateral bands; segment 9 very small, rounding, of an even brown, with two long and two short hairs on the posterior margin.

Female. Body, length 3.63 mm., width .68 mm.; head, length .68 mm., width .43 mm.; first and second segments of antennæ nearly equal and as long as the other three segments, segment 5 longer than segment 4, segments 4 and 5 slightly colored with brown; eyes larger and more prominent than in the male; segments of the abdomen more nearly equal than in the male; segments 8 and 9 suddenly narrower than segment 7; segment 8 with a strong conspicuous hair in each anterior angle; six hairs along the posterior margin and eight small hairs in a transverse curving line on the ventral aspect; segment 9 with one hair in each anterior angle and two strong hairs on each of the two obtuse points, separated by the angular emargination of the posterior margin. Abdominal markings limited to dark brown to black, lateral blotches with pale, indistinct stigmatal spots; segments 7 to 9 almost wholly brown, with a narrow, distinct, uncolored median line; lateral parts of segment 7 blackish brown.

**Lipeurus testaceus** Taschenberg. (See Kellogg, *New Mallophaga*, I, 1896, p. 130, pl. xi, figs. 2 and 4).

A few specimens, rarely more than one or two from a bird, from eight out of thirty-four individuals shot of the Black-vented Shearwater, *Puffinus opisthomelas*; not found on any one of fourteen individuals shot of *P. griseus*; found on one out of six individuals shot of *P. creatopus*; and not found on the single specimen examined of *P. bulleri*, nor of *P. tenuirostris*, all from the Bay of Monterey, Calif. Taken previously by Kellogg from *Puffinus opisthomelas*, same locality. We have no males among the few specimens collected.

**Lipeurus limitatus** Kellogg.

*New Mallophaga*, I, 1896, p. 124, pl. viii, figs. 5 and 6.

Many specimens from five out of thirty-four individuals shot of the Black-vented Shearwater, *Puffinus opisthomelas*; from five out of fourteen individuals shot of *P. griseus*; from none out of six individuals shot of *P. creatopus*; from a single individual shot of *P. bulleri*, and from a single individual shot of *P. tenuirostris*, all from the Bay of Monterey, California. Described from three females from *P. griseus*, same locality. We are unable to find any males among our rather many specimens.

**Lipeurus fuliginosus** Taschenberg. (Plate VII, fig. 3).

*Die Mallophagen*, 1882, p. 156, pl. iv, fig. 3.

Numerous examples from the Shearwaters, *Puffinus opisthomelas* and *creatopus* (Bay of Monterey, California). Taken from eight out of thirty-four birds shot of *opisthomelas*, from one out of six birds shot of *creatopus*, and not found on any one of fourteen birds shot of *griseus*. The American specimens differ from the types

of *fuliginosus*, which were collected from *Diomedea eru-*  
*lans* and *chlororhyncha* by being larger, by showing no  
difference in the clypeal front of male and female, by  
having no short hair in the eye, and in other minor  
characters. We make a variety, therefore, for them.

Var. *major* Kellogg and Chapman. (Plate VII, fig. 3).  
In the following table of dimensions the figures enclosed  
in parentheses are the measurements given by Taschen-  
berg for the type specimens. Male. Body, length 3.75  
mm. (3.32 mm.), width .9 mm. (.58 mm.); head, length  
1. mm. (.89 mm.), width .66 mm. (.55 mm.) Female.  
Body, length 3.9 mm. (3.72 mm.), width .94 mm. (.66  
mm.); head, 1.05 mm. (.9 mm.), width .7 mm. (.59  
mm.). From these measurements the head of the vari-  
ety is proportionately wider than in the type forms.  
The species is recognizable by its dark color and the  
characteristic double set of internal bands in the  
forehead.

***Lipeurus farallonii*** Kellogg. (Plate VII, fig. 4).

New Mallophaga, I, 1896, p. 193, pl. v, fig. 4.

Many specimens from two individuals of Brandt's Cor-  
morant, *Phalacrocorax penicillatus* (Bay of Monterey,  
California). Described (as a *Nirmus*) from a single  
female from a Farallon Cormorant, *Phalacrocorax dilo-*  
*phus albociliatus* (Bay of Monterey, California). The  
finding of the males of this species shows that it is a  
*Lipeurus* of the group *clypeati sutura distincta* and allied  
to Piaget's *setosus*, *sub-setosus*, *et al.* taken from various  
cormorants. The marked difference in size, outline and  
marking of the two sexes is striking, and likely to be  
confusing to students who may happen to meet but one  
sex. Is it possible that Piaget's *Nirmus dispar*, which  
the female of *farallonii* resembles, can be the female  
of some one of these *Lipeuri* of the cormorants?

Description of the male. Body, length 1.72 mm., width .36 mm.; head, length .43 mm., width .37 mm.; head like female, perhaps a little narrower, comparatively, behind; antennæ with segments 1 and 2 rather large, subequal, segments 3 and 4 very small, subequal, and segment 5 as long as 3 and 4 together, no distinct appendage; metathorax with sides nearly parallel, not plainly divergent as in female; abdomen slender, sides subparallel, ground color pale golden with wide whitish transverse sutural bands and prominent brown, shining subcircular lateral blotches not touching the narrow, inconspicuous blackish lateral bands; last segment truncate behind, with a group of four prominent hairs on each lateral half of the margin.

**Lipeurus forficulatus** Nitzsch. (See Kellogg, *New Mallophaga*, I, 1896, p. 129, pl. ix, figs. 3, 4, 5 and 6).

Specimens from a Californian Brown Pelican, *Pelecanus californicus* (Bay of Monterey, California). Taken previously by Kellogg from same host species, same locality; and from the White Pelican, *P. erythrorhynchus* (Lawrence, Kansas.)

**Lipeurus squalidus** Nitzsch. (See Kellogg, *New Mallophaga*, I, 1896, p. 132, pl. x, figs. 6 and 7.)

Six specimens from a Shoveller, *Spatula clypeata* (Palo Alto, California). These specimens resemble very much those specimens which Kellogg collected from *Merganser serrator* (see *New Mallophaga*, I, p. 130, pl. x, fig. 1). In fact, we fail to make out any good distinction between the species *temporalis* Nitzsch (found on the Mergansers) and the species *squalidus* of *Anas* and allied ducks.

**Lipeurus docophoroides** Piaget. (See Kellogg, New Mallophaga, II, 1896, pl. lxxviii, fig. 8).

Two female specimens from a Plumed Partridge, *Oreortyx pictus plumiferus* (El Dorado county, California). These specimens differ distinctly in the less pointed front from *L. docophoroides* taken by Kellogg from *Callipepla californica*, and in this form a link between *docophoroides* and *dissimilis* Piaget (see Kellogg, New Mallophaga, II, 1896, p. 507, pl. lxxviii, fig. 7). We have given these specimens a varietal name.

Var. *californicus* Kellogg and Chapman, from the Plumed Partridge, *Oreortyx pictus plumiferus* (El Dorado county, California); clypeal front not so pointed as in the species type, but approaching the rounded front of *dissimilis* P.; without signature; all the antennal segments colored, at least slightly, instead of only the last three as in the species type; the pustulated hairs of the body very long (longer than in the typical species forms).

**Lipeurus perplexus** n. sp. (Plate VII, fig. 5).

Two females from a Columbian Sharp-tailed Grouse, *Pediocates phasianellus columbianus* (Pullman, Washington), and many females, differing slightly in shape of metathorax and abdomen, from a Sooty Grouse, *Dendragapus obscurus fuliginosus* (Kings River Cañon, California). A peculiar broad, robust form of the group *circumfasciati*, with rounded front. Resembling Piaget's *L. opimus* (Supplement, p. 78, pl. viii, fig. 6) from *Turacus giganteus* (Museum of Leyden). Resembling also in general outline and characters Osborn's *Nirmus cordatus*, a specimen of which we have taken from *Limosa hemastica*. Perhaps both of these forms should be referred to the same genus. Piaget's *L. opimus*

should accompany them. Unfortunately, all of these species are represented by females only.

Description of female. Body, length 2.06 mm., width .59 mm.; short, broadly elliptical body, with short, broad head, broadly rounded in front; clear fulvous with pale golden brown lateral, transverse abdominal blotches.

Head, length .53 mm.; width .5 mm.; cordate, clypeal front broadly rounded, four short marginal hairs on the front, a short hair on the margin in front of the antennæ which are short; segment 2 of the antennæ longer than segment 1, segment 5 longer than segments 3 or 4; the anterior end of segment 3 and segments 4 and 5 pale fulvous, a few short hairs on the segments; eye prominent, a long hair rising from its dorsal surface, and with a conspicuous black fleck; temples convex, with two long hairs and two or three short prickles; occipital margin slightly concave; antennal bands slightly darker on the posterior tips and continuous as a narrow, even marginal border of pale translucent golden brown on the front; narrow, occipital blotch of pale golden brown, also a temporal border and an occipital band of the same color; mandibles dark chestnut-brown, showing through the head.

Prothorax short, lateral margins convex; one hair in the posterior angle; pale fulvous, slightly darker on the lateral margins. Metathorax with sides diverging, posterior angles rounding, with a long hair and short prickle; four hairs on the posterior margin in groups of two in small, uncolored pustulations; posterior margin with a slight angle on the abdomen; pale fulvous, slightly darker on the posterior angle; all of the thorax with a more whitish ground color than the head. Sternal markings consisting of pale intercoxal lines and a

very pale median metathoracic blotch. Legs pale fulvous with narrow dark marginal borders.

Abdomen elongate-ovate, tapering rapidly posteriorly; segments with their posterior angles slightly produced, each with from one to three hairs; a transverse series of a few long dorsal hairs near the middle of the segments; ground color pale fulvous, narrow translucent brown bands on the lateral margins; broad transverse pale brown blotches on segments 2 to 7, darker on their inner ends, separated by a broad pale median line, also a broad pale band on the posterior margin of each segment; segment 8 entirely colored, with slight median emarginations on the anterior and posterior margins of the blotch; no distinct lateral bands; last segment round, narrowly emarginate, with one short hair on the posterior margin of each rounding angle; two transverse blotches, one on each side of the emargination.

### Giebelia.

#### *Giebelia mirabilis* Kellogg.

New Mallophaga, I, 1896, p. 138, pl. xi, figs. 7 and 8.

Many specimens from twenty-seven out of thirty-four individuals shot of the Black-vented Shearwater, *Puffinus opisthomelas*; from ten out of fourteen individuals shot of the Dark-bodied Shearwater, *P. griseus*; from all out of six individuals shot of the Pink-footed Shearwater, *P. creatopus*; from a single individual shot of *P. bulleri*, and from a single individual shot of *P. tenuirostris*, all from the Bay of Monterey, California. Four specimens, probably stragglers from a Short-tailed Albatross, *Diomedea albatrus* (Bay of Monterey, California. The species was described from *P. opisthomelas*.

**Oncophorus.**

**Oncophorus bisetosus** Piaget. (Plate VII, fig. 6).

Les Pediculines, 1880, p. 217, pl. xviii, fig. 4.

Several specimens from the Californian Clapper Rail, *Rallus obsoletus* and the Virginia Rail, *Rallus virginianus* (Palo Alto, California). Piaget's specimens were taken from *Rallina plumbeiventris*, *R. tricolor* and *R. isabellina*. He also found specimens on a Yellow Rail, *Porzana noveboracensis* (from North America, in the Museum of Leyden). The specimens from this last bird are distinguished by the varietal name *porzana*, being slightly larger than the type specimens and showing certain small differences in hairs and markings. Our specimens from *Rallus obsoletus* and *R. virginianus* agree with var. *porzana* in departing in the matter of size and hairs of dorsal surface of abdominal segments from the type specimens, but go farther in differing and must be distinguished by a varietal name.

Var. *californicus* Kellogg and Chapman. (Plate VII, fig. 6). From the Californian Clapper Rail, *Rallus obsoletus* (Palo Alto, California) and the Virginia Rail *Rallus virginianus* (Palo Alto, California). (In the following list of measurements the figures in parentheses are those given by Piaget for the type specimens). Female. Body, length 1.72 mm. (1.35 mm.), width .5 mm. (.47 mm.); head, length .53 mm. (.47 mm.); width .4 mm. (.38 mm.); seven hairs on margin of forehead, of which two are longer and dorsal, instead of six with one dorsal as in the types; a prominent hair in the eye not mentioned in the description of the types; two median hairs on dorsal aspect of each abdominal segment, as in the variety *porzana* Piaget, instead of four as in the species type. The female has large



quadrangular, transverse, lateral abdominal blotches separated by a narrow median uncolored line hardly apparent on segments 6-9; a strong uncolored transverse line between segments 7 and 8; lateral bands black, distinct, segmented. In the male the transverse abdominal blotches are continuous across the segments, with widely separating, uncolored, transverse sutures, especially on posterior half of abdomen.

**Oncophorus remotus** n. sp. (Plate VII, fig. 7).

A male and female from a Great Gray Owl, *Scotioptex cinerea* (Pullman, Washington). Not at all like *O. heteroceras* Piaget (Les Pediculines, p. 222, pl. xviii, fig. 8) from *Strix bubo*, which has the head varying markedly in the sexes; and not like *O. hexophthalmos* Nitzsch (described by Nitzsch as a *Lipeurus* and referred by Giebel to *Ornithobius*, and by Piaget to *Oncophorus*) from *Strix nyctea*.

Description of the male. Body, length 2.02 mm., width .93 mm.; short, broad; pale golden brown, with slightly darker bands on the head and thorax.

Head, length .65 mm., width .59 mm., subpentagonal, broadly rounding in front; clypeus slightly convex, two hairs on each side of the uncolored clypeal front, a third marginal hair in front of the suture; a long marginal hair and short prickle in front of the trabeculæ which are long and acutely angular; antennæ with its first segment as long as all the other segments taken together, third segment with slight but appreciable distal projection, a few short spines on the segments; eye with a distinct ocular fleck and a long hair; temples with sides nearly straight, two long hairs and two prickles on the margin; occipital margin straight, without hairs or prickles; general color of the head pale

golden brown; clypeal signature very pale brown but distinct, anterior margin slightly concave; antennal bands interrupted at the suture, darker chestnut-brown at the posterior extremities, which are turned almost at a right angle with the anterior half and lie half way between the mandibles and base of the antennæ; distinct, angularly contorted, inner bands paler than the antennal bands; occipital bands pale anteriorly, growing darker and more sharply defined near the occipital margin.

Prothorax quadrangular, with rounded posterior angles, with one long hair; sternal markings showing through as dark bands near the lateral margins, bending inwardly before the posterior margin, and separated by a distinct, uncolored median line. Metathorax with convex, divergent sides, a long slender hair and a prickle on the lateral margin, near the posterior angle, three long hairs in the posterior angle; a series of hairs along the rounding, posterior margin. Legs pale brown, with a few scattered spines.

Abdomen broadly elliptical, narrowing at both extremities; a few long hairs in the posterior angles of the segments; a transverse series of hairs on the posterior margins of the segments; segments 5, 6 and 7 narrowed in the middle; last segment narrowly rounding, pointed, with two long hairs on the posterior margin; ground color very pale golden brown; transverse lateral blotches indistinct, separated by a broad uncolored median space, except on segment 5, where the transverse band extends across the entire segment; segments 6, 7 and 8 with a broad median blotch of darker golden brown; segment 9 entirely brown; there are but slight indications of defined lateral marginal bands; genitalia distinct, dark golden brown, broad and complex.

Female. Body, length 2.5 mm., width .93 mm.; head, length .71 mm., width .75 mm. The shape of the head different, the temporal margins being distinctly convex; segments 1 and 2 of the antennæ as long as segments 3, 4 and 5, but segment 2 longer than segment 1. Abdomen widely elliptical, but distinctly more elongate and less narrowed posteriorly; very pale golden brown; last segment emarginate, with rounding lateral halves.

### Eurymetopus.

**Eurymetopus taurus** Nitzsch. (See Kellogg, New Mallophaga, I, 1896, p. 135, pl. xi, figs. 3, 4, 5 and 6).

Two females from two specimens of the Short-tailed Albatross, *Diomedea albatrus* (Bay of Monterey, California). Previously taken by Kellogg from same host species (same locality). A single immature specimen, probably a straggler, from a Black-vented Shearwater, *Puffinus opisthomelas* (Bay of Monterey, California).

### Goniodes.

**Goniodes mammillatus** Rudow. (See Kellogg, New Mallophaga, II, 1896, p. 509, pl. lxxix, fig. 2).

Two immature specimens from a Columbian Sharp-tailed Grouse, *Pediocetes phasianellus columbianus* (Pullman, Washington). Previously taken by Kellogg from *Callipepla californica* (California).

### Colpocephalum.

**Colpocephalum perplanum** n. sp. (Plate VII, fig. 8).

One specimen from a Tufted Puffin, *Lunda cirrhata* (Bay of Monterey, California). This form resembles

*C. latifasciatum* Piaget (Supplement, p. 130, pl. xiv, fig. 2), from *Rhynchops flavirostris*. The difference in size, number of hairs of the temples, and character of abdominal segments, together with the unrelated host leads us to make the specimen the type of a new species.

Description of female. Body, length 1.84 mm., width .67 mm.; golden brown, with ill-defined, median, transverse abdominal bands, and small dark brown marginal abdominal blotches; head and thorax with blackish markings.

Head, length .35 mm., width .54 mm.; broadly and flatly rounded in front, with numerous, rather long, and a few short, marginal hairs; one very long marginal hair just in front of the ocular emargination, and two shorter hairs directly on the angle; ocular emargination pronounced and acutely angled interiorly; eye prominent, emarginated, with a large ocular fleck; ocular fringe distinct; antennæ with last segment broad, extending beyond the head; temples with anterior angles rounding, posterior angles angularly meeting the occipital margin; three very long and some shorter hairs on the temporal margin; the occiput slightly concave, with four rather long marginal hairs; a narrow, curving, fuscous band running parallel with the clypeal margin, ending at the lateral extremities in a dark chestnut spot; distinct, black, irregular, ocular blotch; triangular bases of occipital bands blackish brown, connected by an even, occipital border, narrowing medially.

Prothorax broad, lateral angles acute, bearing one long hair and a short spine, sides converging posteriorly, with one long hair in the posterior angles; a series of long hairs on the posterior margin. Mesothorax separated from the metathorax by a distinct,

lateral constriction, the posterior margin being distinctly marked with a dark brown band that turns in at the anterior angles along the lateral margins. Metathorax with anterior angles extending beyond the posterior margin of the mesothorax; sides divergent, posterior angles with two long hairs and two short spines; posterior margin straight on the abdomen, with a series of long hairs. Legs robust, concolorous with the metathorax.

Abdomen long, ovate; segments equal, with one or two long hairs and spines in posterior angles, and one or two short spines on lateral margins of each segment; dorsal surface with a single transverse series of hairs along the posterior margin of each segment; the ventral surface with several series of weakly pustulated hairs on each segment; last segment flatly convex, with two dorsal hairs near the lateral margins; ground color pale fuscous, with unevenly colored lateral border of darker fuscous, paling on the outer margins and darkest in posterior angles of segments and along inner margin; a longitudinal, narrow, uncolored, submarginal line parallel with the lateral margin; ill defined, transverse bands slightly darker fuscous.

### **Colpocephalum funebre** Kellogg.

New Mallophaga, I, 1896, p. 147, pl. xii, fig. 7.

One specimen from *Larus heermanni* (Bay of Monterey, California). Described from specimens from *Larus glaucescens* (Bay of Monterey, California).

### **Colpocephalum pingue** Kellogg.

New Mallophaga, I, 1896, p. 144, pl. xii, fig. 5.

One specimen, male, from a Short-tailed Albatross, *Diomedea albatrus* (Bay of Monterey, California). Described from the same host species (same locality).

**Colpocephalum spinulosum** Piaget. (Plate VII, fig. 9).

Les Pediculines, 1880, p. 563, pl. xlvii, fig. 3.

Many specimens from eight out of fifteen individuals examined of the Sanderling, *Calidris arenaria* (Pacific Grove, California). The specimens agree in all essential details of outline and markings with Piaget's description, showing the characteristic, finely pustulated, dorsal surface of the male, with the single transverse series of long pustulated hairs on each segment in the male and the two series in the female. But there is a marked difference in size, the species type being one-fourth larger than our specimens. Piaget's specimens were taken from *Limosa melanura* (Musuem of Leyden). The American specimens should be distinguished by a varietal name.

Var. *minor* Kellogg and Chapman. (Plate VII, fig. 9). In the following table of measurements the figures in brackets are the dimensions given by Piaget for his type specimens. Male. Body, length 1.72 mm. (2.1 mm.), width .5 mm. (.64 mm.); head, length .31 mm. (.38 mm), width .34 mm. (.5 mm). Female. Body, length 2.16 mm. (2.45 mm.), width .7 mm. (.86 mm.); head, length .37 mm. (.38 mm.), width .5 mm. (.5 mm.) From the Sanderling, *Calidris arenaria* (Pacific Grove, California.)

**Colpocephalum timidum** Kellogg.

New Mallophaga, I, 1896, p. 145, pl. xii, fig. 6.

One specimen from a Black-bellied Plover, *Squatarola squatarola* (Pacific Grove, California). Described from *Charadrius dominicus* (Lawrence, Kansas).

**Colpocephalum flavescens** Nitzsch. (See Kellogg, New Mallophaga, II, 1896, p. 525, pl. lxxi, fig. 4).

Specimens from the Golden Eagle, *Aquila chrysaetos* (Palo Alto, California) and from a Siberian Eagle, *Haliaeetus pelagicus* (brought alive from the Arctic Ocean to California). Taken previously by Kellogg from *Haliaeetus leucocephalus* and *Archibuteo lagopus sancti-johannis* (Kansas). Taken by Osborn from "Swallow-tailed Kite" (Ames, Iowa).

**Colpocephalum grandiculum** n. sp. (Plate VII, fig. 10).

One specimen from a California Towhee, *Pipilo fuscus crissalis* (Palo Alto, California). Also a single specimen, much smaller, (otherwise not indicating immaturity) from a Heerman's Song Sparrow, *Melospiza fasciata heermanni* (Palo Alto, California), which, because of the similarity in outline, characters of legs, and general markings, may be referred to the same species. The species resembles in general shape *C. fumidum* Kellogg (New Mallophaga, II, 1896, p. 523, pl. lxxi, fig. 5) from a California Bush-Tit, *Psaltriparus minimus californicus* (Palo Alto, California).

Description of female. Body, length 2.28 mm., width .81 mm.; head and thorax fulvous, abdomen dull fuscous; small ocular and occipital blotches, very narrow marginal, lateral, abdominal bands; temples produced angularly; a distinct V-shaped uncolored marking between the ocular emarginations, projecting backwards as a more or less distinct uncolored median line through the thorax and abdominal segments 1 to 6.

Head, length .5 mm., width .65 mm.; front broadly rounded, subsemicircular; several hairs on the strictly anterior margin, two rather long hairs on the lateral margin of the front, and two long hairs in front of the ocular emargination; eye distinct, almost if not quite

divided, the larger and anterior portion lying in the angle of the ocular emargination, while the smaller, posterior portion lies apparently on a ridge that extends back across the temples; temples prominent; anterior margin almost at right angles with the median line of the head; ocular fringe prominent, extending as far as the anterior temporal angle, a few short hairs on this angle, two long hairs and a few short spines on the lateral margins and the posterior rounding angles; occipital margin medially convex; head smoky, fulvous, distinct, with slightly darker bands extending towards the lateral margin from the base of the mandibles which are dark brown; a V-shaped uncolored marking, each branch extending from the slight swelling in front of the ocular emargination back two-thirds of the distance to the occipital margin, where the uncolored lines meet at the apex of the V; ocular blotches black, even, angular, extending forward as far as the uncolored branch of the V; temples very narrowly bordered with dark brown on the posterior angles; occipital blotches dark brown to black, sharply defined except on the anterior extremity, where they send out a sharp angular blotch; lateral extremities long and gradually narrowing, inner extremities blunt, separated by a fulvous median space.

Prothorax, lateral angles bluntly rounding, with one long hair and a short spine; lateral margin slightly concave, latero-posterior angles with no hair; posterior margin rounding on the mesothorax; two long hairs on the posterior margin near the lateral posterior angles; evenly fulvous, slightly darker on the lateral margins; chitin transverse and longitudinal bars distinct. Mesothorax with sides diverging, posterior angles slightly protruding, separated distinctly from the metathorax, a long hair on the lateral margin, a dark marginal band



on the anterior angles. Metathorax narrow, sides diverging, posterior angles rounding, posterior margin straight, with one long hair, one short hair, and a short spine; narrow dark brown marginal band on the anterior angle and lateral border; faint indications of an uncolored longitudinal median line. Legs robust; femora broad; fulvous with darker markings on the border; a series of short hairs on the outer margin of the tibia. Sternal markings consisting of intercoxal lines, a distinct shield-shaped median blotch on the prothorax, a narrow median darker longitudinal blotch between the pro- and mesothorax, a larger median blotch between the second and third pair of legs, with a distinct triangular anterior portion and a quadrangular posterior portion.

Abdomen broadly elongate; posterior angles projecting but little, with one long hair in each angle, and a series of dorsal hairs on the posterior margin of each segment; segments widely separated by uncolored sutures; transverse lateral blotches fuscous, darkening on the lateral margins into narrow bands; segments 1 to 5 with the transverse blotches separated by a narrow uncolored median line; segments 5 to 8 entirely dark fuscous; last segment with broadly rounding posterior margin, one long and one short hair each side and a series of short hairs on the posterior margin; color an even fuscous. Ventral surface a small median triangular fuscous blotch on segment 1; transverse blotches uninterrupted, but the posterior margin of the blotches on segments 2 to 6 emarginated, darker fuscous on the posterior margin; a double series of pustulated hairs and a few scattered hairs on each segment.

### Ancistrona.

**Ancistrona gigas** Piaget. (See Kellogg, New Mallophaga, I, 1896, p. 150, pl. xiii, figs. 1 and 2).

A few specimens from the Shearwaters, *Puffinus opisthomelas* and *P. griseus* (from one individual of *opisthomelas* out of thirty-four examined, and from two of *griseus* out of fourteen examined) from the Bay of Monterey, California. Taken previously by Kellogg from *Fulmarus glacialis* vars. *rodgersii* and *glupischa* (Bay of Monterey, California).

### Trinoton.

**Trinoton luridum** Nitzsch. (See Kellogg, New Mallophaga, I, 1896, p. 152, pl. xiii, fig. 4).

Specimens from the Baldpate, *Anas americana*, and the American Scaup Duck, *Aythya marila nearctica*, (Palo Alto, California) and from the Shoveller, *Spatula clypeata* (Mountain View, California). Taken previously by Kellogg from two of these hosts, and from other duck species (Kansas and California).

**Trinoton lituratum** Nitzsch. (See Kellogg, New Mallophaga, I, 1896, p. 151, pl. xiii, fig. 3).

Specimens from the Shoveller, *Spatula clypeata* (Mountain View, California) and from another individual of the same species (Palo Alto, California). Taken previously by Kellogg from *Dafila acuta* and *Merganser americanus* (Lawrence, Kansas).

### Menopon.

**Menopon tridens** Nitzsch. (See Kellogg, New Mallophaga, I, 1896, p. 165, pl. xv, figs. 3 and 4).

Specimens from an American Eared Grebe, *Colymbus nigricollis californicus* (Bay of Monterey, California); from the Western Grebe, *Aechmophorus occidentalis* (one bird from Washington, and one from California); and from the Californian Clapper Rail, *Rallus obsoletus* (three birds), and the Virginia Rail, *Rallus virginianus* (Palo Alto, California). Taken previously by Kellogg from the two hosts first named, and from *Urinator lumme* (California).

**Menopon infrequens** Kellogg.

New Mallophaga, I, 1896, p. 161, pl. xv, fig. 5.

Ten specimens from *Larus delawarensis* (Bay of Monterey, California). Described from a single female from *Larus glaucescens* (Bay of Monterey, California). The male is much smaller than the female, as shown by following measurements: body, length 1.4 mm., width .6 mm.; head, length .25 mm., width .53 mm.

**Menopon irrumpens** n. sp. (Plate VIII, fig. 1).

Four specimens from a Short-tailed Albatross, *Diomedea albatrus* (Bay of Monterey, California). No *Menopon* has been hitherto taken from an Albatross.

Description of female. Body, length 2.23 mm.; width 1.01 mm.; short, broad; dark chestnut-brown with darker blotches on the head and lateral bands on thorax and abdomen.

Head, length .4 mm., width .74 mm.; wide through the temples; clypeus broad, with a slightly angulated front; one rather long and one shorter marginal hair each side of the angular point of the clypeus, a short prickle near the suture; three long marginal hairs on the slight swelling in front of the ocular emargination, two short hairs in front of these, nearer the suture;

ocular fringe distinct, composed of stiff curving hairs which extend slightly on the temporal margin; temples with posterior angles produced; four long pustulated hairs, two shorter hairs, and one short spine on the margin; occipital margin concave, with a series of six long pustulated hairs and one spine; color of the head light chestnut-brown, with dark brown ocular blotches and black ocular fleck, and dark chestnut markings in front, near the mandibles, which show through the head distinctly; occipital margin with a narrow chestnut band, darkening into broad occipital blotches.

Prothorax broad, sides rapidly converging posteriorly; lateral angles narrowly rounding, with a short spine and a long pustulated hair in the angle, a series of fourteen strong hairs along the convex posterior margin; general color dark chestnut-brown, except the space above the conspicuous dark transverse chitin bar, which is pale fuscous; the longitudinal bars, at the ends of the transverse bar, are narrow but distinct. Metathorax short, hardly broader than the prothorax; sides divergent, with two spines on the lateral margins; two long hairs and two short spines on the posterior angles; a series of long pustulated hairs on the posterior margin not so heavy, however, as those of the prothorax; color chiefly dark chestnut-brown, transverse band darkening into a narrow black line along the lateral margin, and into a broad triangle in the posterior angles; in front of this dark band, a pale, broad, mesosutural band, and in front of this the pale brown mesothorax. Legs of the palest fuscous of the prothorax, with several short, stiff hairs on the femora and tibia.

Abdomen broadly elliptical, with several short spines on the lateral margins of the segments, and from one to five long hairs in the posterior angles; a series of

long hairs on the posterior margin of each segment; transverse blotches of dark chestnut-brown continuous across the segments, with but a very narrow, pale, posterior marginal line; the lateral marginal bands are wide and distinctly darker brown, and they do not reach the posterior margins; the last segment broadly emarginate, with two long, dorsal hairs on the rounded, posterior angles, and two very short spines on the inner margin of the emargination; the ventral surface with dark transverse bands and a series of hairs along the posterior margin of each segment.

**Menopon paululum** n. sp. (Plate VIII, fig. 2).

Specimens from three out of thirty-four individuals shot of the Black-bodied Shearwater, *Puffinus opisthomelas*, from two out of fourteen shot of *Puffinus griseus*, and from two specimens out of six shot of *Puffinus creatopus*. The first *Menopon* species recorded from *Puffinus*. The new species shows no special resemblance to forms taken from allied birds, like Fulmars.

Description of the male. Body, length 1.13 mm., width .5 mm.; small, pale yellow with distinct brown ocular blotches; abdomen with golden transverse bands and brown marginal blotches.

Head, length .26 mm., width .38 mm.; front rounding, with four short hairs on the margin, one marginal hair at the suture, three long and one short hair in front of the ocular emargination which is distinct but shallow, with an ocular fringe; maxillary palpi long, last two segments extending beyond the margin of the head; eyes inconspicuous but with a distinct ocular fleck; temples but little expanded, with four long hairs and several short spines on the angles; occipital margin but slightly concave; head pale yellow with a brown

spot just outside the mandibles connected with them by a narrow brown band; mandibles dark, showing through the head; ocular blotches small, narrowing posteriorly; occipital margin with a narrow brown band and small occipital blotches.

Prothorax with anterior angles slightly produced, a short prickle and a long hair in the angle, a series of long hairs on the rounding posterior margin; transverse and longitudinal chitin bars pale yet distinct; no blotches. Metathorax with slight lateral emargination; posterior margin nearly straight, with a series of spiny hairs; a pale golden, narrow, mesothoracic, transverse band, and similarly colored, wider, metathoracic bands. Legs pale golden; femora thick. A median prosternal blotch, shield-shaped, with a lateral process projecting backward and outward; metasternum with a pale median blotch from which short spiny hairs arise.

Abdomen elliptical, with posterior angles of the segments slightly produced, a few short spines on the lateral margins, and one or two long hairs and short spines in the posterior angles; a series of stiff hairs along the posterior margin of the segments, those on the last segments being longer; on the ventral surface two transverse series of short spiny hairs on each segment; pale golden transverse bands extending across the segments to shiny brown subcircular marginal blotches; last segment rounding behind, without marginal blotches, and with a few longish hairs.

Female. Body, length 1.74 mm., width .67 mm.; head, length .27 mm., width .45 mm., thus being much longer than the male; transverse bands of the abdomen rather more distinct than in the male, the uncolored sutural bands being thus made also more distinct, each segment with posterior series of hairs; last segment

with six stiff hairs on each rounding angular portion of the posterior margin, and the median straight portion with an uncolored border and fringe of fine hairs.

**Menopon petulans** n. sp. (Plate VIII, fig. 3).

One specimen from a Black-bodied Shearwater, *Puffinus griseus* (Bay of Monterey, California). Shorter, broader, and darker colored than *paululum* n. sp. from *Puffinus opisthomelas* (same locality).

Description of male. Body, length 1.34 mm., width .68 mm.; short, broadly elliptical; head with distinct ocular emargination and projecting temples; general color dark fuscous with distinct, large black ocular blotches; transverse abdominal bands fading in their medial portions but distinct laterally.

Head, length .28 mm., width .53 mm.; front rounded, with a very slight median angulation; a rather long median hair each side of the front angulation; a short marginal prickle in front of the suture, one rather long marginal hair just back of the suture; two pustulated hairs and one long spine in front of a distinct ocular emargination; eye distinct, filling base of ocular emargination with a black ocular fleck; temples rounding, projecting, with three long hairs and several spines; occipital margin concave, with six long hairs and two spines on the margin; front of the head with slightly darker brown triangular blotches each side of the pale front; mandibles showing through the head as a dark brown spot; ocular blotch broad and distinctly black, fading gradually along the temporal margin; occipital bands faintly showing; occipital blotches distinct, being connected by a narrow black band which fades on the temporal margins.

Prothorax with lateral angles narrowly rounding, with one long hair and a short spine, a series of long hairs on the rounding posterior margin; lateral blotches but little darker on the margins; transverse chitin bar distinct, but little darker than the fuscous ground color of the prothorax. Metathorax short, lateral margins slightly divergent, a little concave, a short prickle near the posterior angles and a long hair and one short spine in the angle; a series of hairs along the weakly convex posterior margin; lateral blotches distinct, meeting on the median line; darker brown to black on the lateral margins, a pale band on the posterior margin. Legs robust, pale fuscous with darker marginal markings. Sternal markings consisting of a distinct median blotch, with rounded anterior margins, posterior angles projecting backward, posterior margin also produced into a distinct angle.

Abdomen broadly elliptical, segments with short spines on the lateral margins and a few long hairs in the posterior angles; a series of dorsal, spiny hairs on the posterior margin of each segment; general color of the abdomen dark fuscous; lateral blotches distinct, black on the lateral margins, paler and fading out medially on the segments before segment 7; segments 7 and 8 with continuous transverse bands; segment 9 wide, with two lateral blotches meeting narrowly on the median line and a paler band on the lateral margin; the last segment flatly rounding; two short hairs on the posterior margin; ventral markings very similar to those of the dorsal surface, also a similar series of hairs on the posterior margins of the segments.



**Menopon titan** Piaget. (See Kellogg, New Mallophaga, I, 1896, p. 163, pl. xv, fig. 2).

One male from a Brandt's Cormorant, *Phalacrocorax penicillatus* (Bay of Monterey, California). This specimen differs from every other individual of this curious species that I have yet examined. It is smaller than var. *linearis*, the blotches of thorax are different, and the incomplete series of pustulated hairs along the posterior margins of the abdominal cross-bands conspicuously differ from the usual condition in *titan*. *Titan* has not before been taken from any other bird than a pelican, and this single individual from a cormorant may be a straggler. If so, it must have come from *Pelecanus californicus*, the only species of pelican found in the Bay of Monterey.

Var. *incompositum* Kellogg and Chapman. (Plate VIII, figs. 4 and 5). Male, body, length 4.6 mm., width 1.66 mm.; head, length .62 mm., width 1. mm.; the smallest variety of *titan* yet noted; mesothorax with a narrow transverse blackish band continuous across the segment; metathorax with triangular, blackish, lateral blotches, apex projecting inward; abdominal segments 1-8 with continuous, blackish, transversal bands, paler on segments 7 and 8; an incomplete series of pustules (six complete and prominent on segments 3-6) along posterior margin of each transverse band; last segment with a small transversal linear blotch on each side; genital blotch on underside of segment 8 composed of two lateral triangles partly overlapping a central shield, from which projects anteriorly a sharp, distinct, linear process; laterad of this central compound blotch there is on each side a weakly curving, blackish, diagonal, linear blotch. Found on Brandt's Cormorant, *Phalacrocorax penicillatus* (Bay of Monterey, California).

**Menopon titan** var. **linearis** Kellogg.

New Mallophaga, I, 1896, p. 163, pl. xv, fig. 2.

Many specimens from the Californian Brown Pelican, *Pelecanus californicus* (Bay of Monterey, California). Described from the same host species, same locality.

**Menopon funereum** n. sp. (Plate VIII, fig. 6).

A single male from a Gairdner's Woodpecker, *Dryobates pubescens gairdnerii* (Sunol, California), and a pale male from a Western Evening Grosbeak, *Coccothraustes vespertinus montanus* (California). This second specimen determined with doubt. Not like *M. pici* Denny (Monograph. Anoplur. Brit., p. 219, pl. xx, fig. 5; Piaget, Supplement, p. 93, pl. x, fig. 3) from *Picus viridis*; also differing distinctly from *M. praecursor* Kellogg (Mallophaga from Birds of Panama, Baja California, and Alaska, in New Mallophaga, III, 1899, p. 46, pl. iv, fig. 8) from *Melanerpes uropygialis* (Baja California).

Description of the male. Body, length 1.5 mm., width .59 mm.; mostly dark colored because of the strong, continuous, brown, transverse, abdominal bands and the blackish marking of the head, thorax and legs; thorax long, with mesothoracic sutural line distinct under magnification.

Head, length .4 mm., width .56 mm.; front convex, with two marginal hairs near the median line of the front, a short prickle midway between this hair and a long hair and short spine which are on the angle in front of a slight lateral concavity, in which are a long hair and short prickle; a long hair and shorter hair near the posterior angle of the concavity and in front of the angle before the ocular emargination on which are two long hairs; eye large, filling the inner angle of the ocular emargination, distinctly emarginate and

with a large black ocular fleck; a rather long hair on its dorsal surface near the margin; a distinct ocular fringe; temple meeting the ocular emargination angularly; fine, long, pustulated hairs and some short spines on the temporal margin; occipital margin concave, with two long hairs near the median line; ground color of the head pale fuscous with dark blackish brown blotches each side of the front; ocular blotches broad, distinct on the posterior margin but fading anteriorly till they color the angle in front of the ocular emargination; temples narrowly and irregularly bordered with dark brown; occipital margin with a defined blackish brown band, widening into angular occipital blotches; distinct occipital signature.

Prothorax short; anterior angles inconspicuous, with two spines; posterior margin with a series of long hairs; ground color dark fuscous, with distinct chitin bars. Mesothorax and metathorax long, being separated by a narrow, uncolored suture and slight lateral emargination, mesothorax dark on the anterior portion; metathorax with distinct dark chitin bars. Sternal markings consisting of dark intercoxal lines; prothorax with distinct median blotch of pale fuscous, a distinct V-shaped chitin bar longitudinally across it; dark median blotches on the meso- and metathorax. Legs large, pale fuscous with dark marginal borders and semiannulations; scattered hairs and spines.

Abdomen short, broadly elliptical, small as compared with the large head and thorax, which are together longer than the abdomen; a series of long hairs on the posterior margin of each segment and a few short spines and hairs in the posterior angles; each segment with a broad, dark, transverse band, darker on the lateral margin and covering almost all of the segment; a

longitudinal, submarginal, pale band, parallel with the lateral margins of the abdomen; last segment broadly rounded, with several long hairs near the lateral margin and some shorter hairs on the posterior portion of the segment; ventral surface with at least one series of short pustulated hairs on the posterior margin of each segment; genitalia distinct, angular, extending far forward in the body.

**Menopon distinctum** n. sp. (Plate VIII, fig. 7).

Specimens from two specimens of the Ash-throated Flycatcher, *Myiarchus cinerascens* (Palo Alto and Ontario, California), and from a Cactus Wren, *Heleodytes brunneicapillus* (Ontario, California). A well marked form.

Description of the female. Body, length 1.5 mm. width .62 mm., elongate-elliptical; pale translucent fuscous with blackish brown ocular blotches; black ocular fleck and small blackish spots on the lateral margins of the front; dark transverse blotches on the abdomen; a distinct pale submarginal longitudinal line parallel with the lateral margin of the abdomen.

Head, length .31 mm., width .46 mm.; parabolic, wide through the temples; front broadly rounding, a slight angulation in front; one hair each side of this angulation; two hairs on the lateral margin of the front; two long hairs on a slight swelling in front of a distinct ocular emargination; one long and two short hairs on the dorsal surface, in front of the ocular emargination; eye large, filling the angle of the emargination and extending on the temple, with a slight constriction; a short spine on the posterior portion, and a large black ocular fleck; ocular fringe made up of comparatively few stiff spines, more numerous on the outer

margin in front of the temples; two long hairs and several shorter hairs on the temporal margin; occipital margin nearly straight, with two long and two short hairs; pale translucent fuscous; mandibles dark, showing through the front; a dark spot on the lateral margin of the front outside the base of the mandibles; ocular blotches dark brown to black, extending forward as far as the dark lateral blotches, but paler chestnut-brown anteriorly; dark narrow border on the occiput, occipital bands pale yet distinct.

Prothorax with convex lateral margins; a short spine in the anterior angle; a few spines on the lateral margin; a series of long hairs on the rounding posterior margin; fulvous, with dark transverse and longitudinal chitin bars distinct. Mesothorax wide, with strongly divergent sides; a few spines on the lateral margin; one long hair and several spines in the posterior angle; dark inner chitin bars extending along the anterior angle and back across the segment; a second chitin bar extending from the lateral margin back across the metathorax; the posterior angle of the mesothorax dark fuscous, otherwise the segment is pale translucent fuscous. Metathorax narrow; a long hair and a short spine in the posterior angles; dark lateral triangular blotches, fading inwardly. Legs long, pale translucent fuscous, with dark fuscous borders and semiannulations; many short spines on the femora. Sternal markings consisting of distinct brown intercoxal lines and a pale but distinct wedge-shaped median blotch.

Abdomen broadly elliptical; several spines on the lateral margins of the segments; some long hairs in the posterior angles; many dorsal spines, not arranged in any definite series on the segments; lateral marginal blotches dark fuscous, separated from the median

transverse blotches by a pale submarginal band, parallel with the lateral margin of the abdomen; median transverse blotches paler fuscous; transverse bands of segments 1 to 6 widely separated by uncolored sutural bands; last segment rounding, with a fringe of hairs on the posterior margin, dark transverse blotch narrowed distinctly in the middle, ventral transverse bands distinctly fuscous; many hairs arranged nearly in two definite series in each segment.

Male. Body, length 1. mm., width .59 mm.; head, length .25 mm., width .5 mm.

**Menopon persignatum** n. sp. (Plate IX, fig. 1).

Many specimens from the California Jay, *Aphelocoma californica* (2 specimens, Mountain View, California). Resembling in general shape and characters the three or four species of *Menopon* described by Nitzsch and Piaget from the European Jays.

Description of the female. Body, length 2.03 mm., width .75 mm.; long, narrow; pale fuscous with distinct black ocular blotches, blackish lines in the thorax, and broad dark fuscous transverse abdominal bands.

Head, length .34 mm., width .56 mm.; front broadly but slightly angularly rounding; no hairs on the frontal margin, one long and two shorter hairs on the lateral margins of forehead, besides two long hairs just in front of the ocular emargination, which is nearly filled by the large eye which is slightly emarginated and bears a short prickle; ocular fringe with only a few hairs of uneven length; temples produced, rather narrowly rounded, with five long hairs and several short hairs and spines on the margin; occipital margin straight in its middle portion; one long and one short hair near

the posterior margin, and one hair on each side of the median line; ground color of the head fuscous with distinct, curving, linear blackish ocular blotches; an indistinct brown occipital signature with anterior angles produced laterally.

Prothorax large, lateral angles with one long hair and a short spine, two long hairs in the broadly rounded posterior angle and a series of six long hairs on the straight posterior margin. Mesothorax with four or five short spines on the lateral margin and two long hairs and two spines in the posterior angle; a series of stiff hairs along the posterior margin. Metathorax with a series of stiff hairs on its posterior margin, and in the posterior angle one long hair and two spines; ground color of the thorax is pale fuscous, no distinct blotches, but dark transverse and longitudinal chitin bars on the prothorax; curving chitin bars on the anterior angle of the mesothorax, and a pair of chitin bars extending from the anterior half of the lateral margin of the mesothorax back across the metathorax as far as the third pair of coxæ. Sternal markings consisting of dark intercoxal lines; on the prothorax a small median blotch with the posterior angles extended in dark chitin bars which extend forward to the anterior margin; the posterior margin of the blotch extends back in a narrow point; a large wedge-shaped blotch between the second and third pair of coxæ; this blotch has a series of short pustulated hairs on its anterior and lateral margins. Legs pale fuscous with narrow dark borders.

Abdomen elongate-elliptical; two long hairs and short spines in the posterior angles; a series of short hairs on the posterior margin of each segment, growing more stiff and spine-like near the lateral margin; broad dark

fuscous transverse bands separated by broad pale sutural bands; darkening laterally to form broad dark lateral bands, set off by rather broad pale submarginal, longitudinal bands; last segment flatly rounding, with a fringe of fine hairs; ventral surface with similar markings, but with an irregular median transverse series of hairs, besides the series on the posterior margin of the segment.

Male. Body, length 1.43 mm., width .75 mm.; head, length .28 mm., width .56 mm., thus being much smaller than the female; also of short, broad, oval shape rather than elongate and narrow; darker and more evenly fuscous; pale submarginal longitudinal bands parallel with the sides of the abdomen less distinct than in female; transverse bands narrow and less definite; lateral blotches narrow and darker on the posterior margin of the segments; last segment slightly angular, with a fringe of hairs; genitalia faintly distinguishable through the body, extending forward into segment 7.

**Menopon incertum** Kellogg.

New Mallophaga, II, 1896, p. 533, pl. lxxiii, fig. 2.

Many specimens from a Russet-backed Thrush, *Turdus ustulatus* (Palo Alto, California); a Western Lark Sparrow, *Chondestes grammacus strigatus* (Ontario, California); and a Vigor's Wren, *Thryothorus bewickii spilurus* (Palo Alto, California). Taken previously by Kellogg from *Turdus ustulatus* and from the American Goldfinch, *Spinus tristis* (same locality).

**Menopon mæstum** n. sp. (Plate IX, fig. 2). .

Two specimens from a Golden-crowned Sparrow, *Zonotrichia coronata* (Palo Alto, California), and a



Samuel's Song Sparrow, *Melospiza fasciata samuelis* (Palo Alto, California). A short, broad species, with short, wide head, and wide prothorax, approaching the *Eureum* type of Menopon (see p. 133 this paper).

Description. Body, length 1.37 mm.; width .81 mm.; short, broad; head very short and wide, not of the usual evenly crescentic type; occipital margin straight and dark; general color dark fuscous, the dark markings of the head making the posterior portion appear quadrangular.

Head, length .28 mm., width .59 mm.; front broad, flatly rounded; six hairs on the front, one each side of the angulation and three (one long and two shorter) hairs on the lateral margins of the front; two hairs on the angle in front of the ocular emargination; lateral margin of the forehead almost at right angles with the lateral margins of the front; eye large, prominent, with a large black ocular fleck and a short spine; ocular fringe sparsely spined; temples projecting strongly, and narrowly convex, with three long hairs and several shorter hairs and spines: occipital margin straight; a narrow broad submarginal band across the front, its posterior ends bending in so as to leave clear pale brown the anterior portion of the angle in front of the ocular emargination; from this angle a distinct dark fuscous quadrangular blotch extends back to the occipital margin, cutting off the rounding temples which are very pale fuscous; ocular blotches narrow and dark, extending forward along the ocular emargination, meeting the anterior margin of the dark fuscous blotch interrupting the arms of the narrow uncolored V-shaped marking, which has its branches rising from the inner angle of the ocular emargination and its vertex on the occipital margin; occipital blotches blackish

brown, connected by a narrow even line on the occipital margin; a dark broad occipital signature showing through the head.

Prothorax short and wide; two short spines in the anterior margin and a series of four long pustulated hairs and one short spine on each rounding lateral and posterior margin; transverse and longitudinal chitin bars distinct; median portion of the prothorax pale anteriorly, but darker fuscous towards the posterior margin; lateral portions, beyond the longitudinal chitin bars, dark fuscous. Mesothorax narrow; posterior angles distinctly angular, with a long hair and spine; dark transverse band on the posterior margin, dark longitudinal chitin bars extending from the anterior angles across the mesothorax; a second pair of chitin bars extending from the anterior, lateral margins back across the metathorax. Metathorax narrow, appearing like the first abdominal segment; a long hair and two spines in the posterior angle; a dark brown transverse band across the lateral margin. Sternal markings consisting of dark intercoxal lines, a median blotch on the prothorax, with the posterior angles produced laterally, meeting narrow dark chitin bars which extend forward to the anterior margin; the posterior margin of the blotch also produced in an angle; a broad brown median band between the second and third pair of legs, also extending onto the first abdominal segments; a few scattered pustulated hairs on this band. Legs large, pale fuscous, with narrow dark borders and scattered hairs.

Abdomen broadly ovate, the poles broadly truncate; posterior angles projecting, with one or two long hairs and a short spine; segments narrower on the anterior half of the abdomen; a few hairs on the posterior margin of the segments; entire abdomen a dark rich

fuscous, darker on the posterior margins of the segments; last segment broad, narrow, with a fringe of hairs along the rounding posterior margin.

**Menopon malleus** Nitzsch (Plate IX, fig. 3).

Germer's Mag. Ent., 1818, vol. iii, p. 301.

*Eureum malleus* Nitzsch, Burmeister, Handb. d. Ent., 1840, vol. ii, p. 441; Denny, Monograph. Anoplur. Brit., 1842, p. 288; Giebel, Insecta Epizoa, 1874, p. 249; Piaget, Les Pediculines, 1880, p. 608, Supplement, 1885, p. 139, pl. xv, fig. 3.

A single immature specimen from a Cliff Swallow, *Petrochelidon lunifrons* (Ontario, California), and an adult female and an immature specimen from a Cactus Wren, *Heleodytes brunneicapillus* (Ontario, California). The single specimen of this species previously known was collected by Nitzsch in 1814 from *Hirundo rustica*. As the above named Cliff Swallow and Cactus Wren were collected by the same person on the same day *it may be* that the two individuals taken from the wren are stragglers from the swallow.

This species has heretofore been attributed to the genus *Eureum* Nitzsch, the genus being based upon the single specimen (which, though heretofore apparently not so considered, is immature) of this species and a very few specimens of another very different species, *cimicoides* Nitzsch from the European Swift *Cypselus apus*. Piaget has suspected that both these species are merely rather aberrant members of the genus *Menopon*, which position, as regards the species *malleus*, at least, we take unqualifiedly. The two species have been held together partly through the usual conception of the near relationship of the hosts; as Nitzsch says, "*habitatio in chelidonum familia*" (Germer's Mag. Ent., vol. iii, p. 301, 1818). Now, in fact, the swallows and the swifts are not nearly related at all, the swifts finding

their near relations among the night-hawks and hummingbirds. The finding of an immature and an adult female together on the wren, in addition to a single immature specimen on the swallow, allows us to present new evidence of the agreement of the species in generic characters with *Menopon*. The *Menopon* species, *maestum*, described in this paper, serves as an easy step from the more typical *Menopon* type to this peculiar *Eureum* type with its short, broad head, its short, broad prothorax, and long, heavy legs. *Menopon robustum* Kellogg (New Mallophaga, II, 1896, p. 528, pl. lxxii, fig. 3) is of this gradatory type, and presents "a mingling of characters of *Menopon*, *Ancistrana*, and *Eureum*; a short, broad head with strongly chitinized, backward-projecting processes on the ventral surface like *Ancistrana*; a thorax like *Eureum*; and the habitus and general body characters of *Menopon*" (Kellogg, l. c.). Osborn's *M. expansum* (Insects Affecting Domestic Animals, U. S. Dept. Ag., Div. Ent., Bull. N. S., No. 5, 1896, p. 245, pl. ii, fig. j.) from *Dolichonyx oryzivorus* must also be of this general type.

Our immature forms correspond with the description and figure (Piaget, Supplement, p. 139, pl. xv, fig. 3) of the species. Our adult female (figured herewith) shows the following characters not referred to, or unconformable to those in Piaget's description. Body, length 2.25 mm., width 1.15 mm.; head, length .34 mm., width .9 mm.; head less flatly rounded in front than in the young, and with a slight median angulation; on each side of this angulation a conspicuous marginal hair, and farther to the side a longer hair not marginal, but rising from just in front of the base of the antenna. Metathorax with two long hairs and three spines in the posterior angles, the three spines ranged along the

posterior margin. Dorsal surface of the abdomen with a few scattered, longish hairs; ventral surface with groups of short, strong spines and some longish hairs on the lateral part of the posterior margins of segments; last segment broadly rounded behind, with fringe of weak hairs of different lengths.

**Menopon ridulosum** n. sp. (Plate IX, fig. 4).

Specimens from two Yellow Warblers, *Dendroica aestiva* (Palo Alto, California). A small, heavy-bodied form.

Description. Body, length 1. mm., width .53 mm.; being thus a very small species; head large compared with the rest of the body; head almost as wide as long; abdomen with narrow transverse abdominal bands.

Head, length .46 mm., width .51 mm.; large, nearly as broad as the abdomen; front broadly parabolic, with a slight median angulation; two short hairs in front each side of the angle, several shorter hairs in the frontal margin, two longer hairs on the lateral margin, and two long hairs on the angle before the shallow ocular emargination; eye with a black ocular fleck; ocular fringe distinct; two very long hairs on the narrowly rounding temples and several short spines; occipital margin concave, with four long hairs on the margin; two small angular blackish spots on the lateral margin of the front outside the mandibles, which are also dark, showing through the head; ocular blotches curving, blackish brown, fading on the anterior portion of the ocular emargination; a narrow band of dark blackish brown on the occipital margin.

Prothorax wide; a long hair and short spine on the anterior angle; a series of long hairs on the rounding posterior margin; dark transverse and longitudinal

chitin bars distinct, dark brown, while the ground color of the prothorax is even pale fulvous. Mesothorax long, with strongly diverging sides; posterior angles sharp, with several long hairs and broad heavy spines; a series of hairs on the posterior margin; ground color pale fulvous with distinct, narrow chitin bars extending from the anterior angles across the mesothorax, a second pair of chitin bars extending from the lateral margins across the meso- and metathorax. Metathorax narrow; posterior angles with a few long hairs and heavy spines; posterior margin with a series of hairs; intercoxal lines showing through the thorax. Legs pale fulvous with darker marginal markings.

Abdomen broadly elliptical, short; posterior angles with one or two long hairs and some heavy spines; a series of hairs on the posterior margin of the segments, which give place to heavy spines near the lateral margin; a few scattered dorsal spines; last segment flatly rounded, with a few short marginal spines; narrow dark fuscous transverse bands, separated by broad pale transverse bands.

### Physostomum.

We have representatives of this genus from a dozen species of passerine birds, but we do not feel able to make satisfactory specific determination of our material except in a few instances. We do not believe that under the present knowledge of the group much can be done toward distinguishing any but peculiar and obviously characterized species, forms readily separable by marked peculiarity of shape. We have specimens of this genus from the following birds, all from California: Western Wood Pewee, *Contopus richardsonii* (two specimens); Say's Phoebe, *Sayornis saya*; Western

Flycatcher, *Empidonax difficilis*; Ash-throated Flycatcher, *Myiarchus cinerascens*; Spurred Towhee, *Pipilo maculatus megalonyx*; California Towhee, *Pipilo fuscus crissalis*; Cedar Waxwing, *Ampelis cedrorum*; Samuel's Song Sparrow, *Melospiza fasciata samuelis*; Least Vireo, *Vireo bellii pusillus*. In addition, we distinguish the three following species of the genus.

**Physostomum sucinaceum** Kellogg.

New Mallophaga, II, 1896, p. 514, pl. lxx, fig. 2.

Three specimens from a Western Flycatcher, *Empidonax difficilis* (Palo Alto, California). Previously taken by Kellogg from the same host (same locality).

**Physostomum diffusum** Kellogg.

New Mallophaga, II, 1896, p. 518, pl. lxx, fig. 3.

One specimen, var. *pallidum* Kellogg from an Oregon Junco, *Junco hyemalis oregonus* (Pullman, Washington). Taken previously by Kellogg from *Junco* sp. (Lawrence, Kansas).

**Physostomum prominens** n. sp. (Plate IX, fig. 5).

Two specimens from a Costa's Hummingbird, *Calypte costae* (Ontario, California). This strange form with its lateral head margins deeply sinuate and its unique prothorax is very different from any other *Physostomum* described. The specimens are probably not fully mature, one distinctly immature, the other lacking probably only coloration intensity.

Description. Body, length 2 mm., width .85 mm.; transparent whitish; head short and broad, with deeply sinuous lateral margins; eyes in the posterior angles.

Head, length .5 mm., width .53 mm.; broad, short; front broad, straight; conspicuous projecting lateral

palettes; the lateral margins of the head deeply concave before the middle; temples swollen, the margins convex; head widest across the posterior angles which are not produced backwards, but rounding rectangular; the inconspicuous eyes with conspicuous black flecks are situated in the very apex of these angles; each angle bears two longish hairs and one shorter one; posterior margin nearly straight, feebly angulated in the middle; whole head transparent whitish with faint brownish tinge here and there.

Prothorax large, lateral margins with lateral angles broadly and bluntly rounded; posterior margin almost semicircular, with four rather short hairs on each lateral half; pale transparent whitish with faint brownish at margins. Metathorax with rapidly diverging lateral margins, straight posterior margin with two hairs and a spine in region of posterior angles, three hairs near posterior margin just inside of this region, and two hairs and a spine anterior to these submarginal hairs.

Abdomen broadly elliptical; posterior angles not projecting and without conspicuous hairs; on the lateral portion of each segment a group of three hairs near the posterior margin, and a hair and a spine near the lateral margin and more anterior; pale transparent whitish with a pale brown narrow submarginal longitudinal band fading posteriorly.



## LIST OF HOSTS WITH PARASITES.

- Echmophorus occidentalis*.  
     *Menopon tridens*.  
*Colymbus nigricollis californicus*.  
     *Nirmus fusco-marginatus* var.  
         *americanus*.  
     *Menopon tridens*.  
*Lunda cirrhata*.  
     *Nirmus pacificus*.  
     *Colpocephalum perplanum*.  
*Cerorhinca monocerata*.  
     *Nirmus maritimus*.  
*Ptychoramphus aleuticus*.  
     *Nirmus maritimus*.  
*Synthliboramphus antiquus*.  
     *Nirmus maritimus*.  
*Cephus columba*.  
     *Docophorus procax*.  
     *Nirmus pacificus*.  
         *fusco-marginatus* var.  
         *americanus*.  
*Stercorarius pomarinus*.  
     *Docophorus melanocephalus*.  
     *Nirmus triangulatus*.  
     *Lipeurus laculatus*.  
*Rissa tridactyla pollicaris*.  
     *Nirmus lineolatus* var. *atri-*  
         *marginatus*.  
*Larus occidentalis*.  
     *Docophorus lari*.  
*Larus argentatus smithsonianus*.  
     *Nirmus fusco-marginatus* var.  
         *americanus*.  
*Larus vegæ*.  
     *Nirmus lineolatus* var. *atri-*  
         *marginatus*.  
*Larus delewarensis*.  
     *Docophorus lari*.  
     *Nirmus punctatus*.  
     *Menopon infrequens*.  
*Larus brachyrhynchus*.  
     *Nirmus lineolatus* var. *atri-*  
         *marginatus*.  
*Larus canus*.  
     *Nirmus lineolatus* var. *atri-*  
         *marginatus*.
- Larus heermanni*.  
     *Docophorus lari*.  
     *Colpocephalum funebre*.  
*Sterna maxima*.  
     *Docophorus melanocephalus*.  
*Diomedea albatrus*.  
     *Nirmus giganticola*.  
     *Lipeurus diversus*.  
         *densus*.  
         *concinuus*.  
         *ferox*.  
     *Giebelia mirabilis*.  
     *Eurymetopus taurus*.  
     *Colpocephalum pingue*.  
     *Menopon irrumpens*.  
*Fulmarus glacialis glupischa*.  
     *Nirmus maritimus*.  
*Puffinus creatopus*.  
     *Lipeurus diversus*.  
         *testaceus*.  
         *fuliginosus* var. *ma-*  
         *jor*.  
         *laculatus*.  
     *Giebelia mirabilis*.  
     *Menopon paululum*.  
*Puffinus opisthomelas*.  
     *Docophorus validus*.  
     *Lipeurus diversus*.  
         *testaceus*.  
         *limitatus*.  
         *fuliginosus* var. *ma-*  
         *jor*.  
     *Ancistrona gigas*.  
     *Giebelia mirabilis*.  
     *Menopon paululum*.  
*Puffinus grisens*.  
     *Nirmus giganticola*.  
         *pacificus*.  
     *Lipeurus diversus*.  
         *limitatus*.  
     *Giebelia mirabilis*.  
     *Ancistrona gigas*.  
     *Menopon paululum*.  
         *petulans*.

- Puffinus tenuirostris*.  
     *Lipeurus diversus*.  
         *limitatus*.  
     *Giebelia mirabilis*.  
*Puffinus bulleri*.  
     *Lipeurus diversus*.  
         *limitatus*.  
     *Giebelia mirabilis*.  
*Phalacrocorax penicillatus*.  
     *Lipeurus farallonii*.  
     *Menopon titan* var. *incompositum*.  
*Pelecanus californicus*.  
     *Lipeurus forficulatus*.  
     *Menopon titan* var. *linearis*.  
*Anas americana*.  
     *Trinoton luridum*.  
*Spatula clypeata*.  
     *Lipeurus squalidus*.  
     *Trinoton lituratum*.  
         *luridum*.  
  
*Aythya marila nearctica*.  
     *Docophorus icterodes*.  
     *Trinoton luridum*.  
*Aythya affinis*.  
     *Docophorus icterodes*.  
*Rallus obsoletus*.  
     *Oncophorus bisetosus* var. *californicus*.  
     *Menopon tridens*.  
*Rallus virginianus*.  
     *Oncophorus bisetosus* var. *californicus*.  
     *Menopon tridens*.  
*Tringa minutilla*.  
     *Docophorus fusiformis*.  
     *Nirmus complexivus*.  
*Calidris arenaria*.  
     *Nirmus actophilus*.  
         *complexivus*.  
     *Colpocephalum spinulosum* var. *minor*.  
*Limosa fedoa*.  
     *Nirmus cordatus*.
- Squatarola squatarola*.  
     *Docophorus fuliginosus*.  
     *Nirmus incœnis*.  
     *Colpocephalum timidum*.  
*Ægialitis semipalmata*.  
     *Docophorus fuliginosus*.  
     *Nirmus opacus*.  
*Oreortyx pictus plumiferus*.  
     *Lipeurus docophoroides* var. *californicus*.  
*Dendragapus obscurus fuliginosus*.  
     *Lipeurus perplexus*.  
*Pediocætes phasianellus columbianus*.  
     *Lipeurus perplexus*.  
     *Goniodes mammillatus*.  
*Elanus leucurus*.  
     *Nirmus fuscus*.  
*Accipiter atricapillus striatulus*.  
     *Nirmus fuscus*.  
*Buteo borealis calurus*.  
     *Nirmus fuscus*.  
*Aquila chrysaëtos*.  
     *Docophorus pictus*.  
     *Colpocephalum flavescens*.  
*Haliaëtus pelagicus*.  
     *Colpocephalum flavescens*.  
*Falco sparverius deserticolus*.  
     *Nirmus fuscus*.  
*Asio wilsonianus*.  
     *Docophorus cursor*.  
*Syrnium nebulosum*.  
     *Docophorus speotyti*.  
*Scotiaptex cinerea*.  
     *Oncophorus remotus*.  
*Nyctea nyctea*.  
     *Docophorus ceblebrachys*.  
*Dryobates pubescens gairdnerii*.  
     *Menopon funereum*.  
*Dryobates nuttallii*.  
     *Docophorus singularis*.  
*Xenopicus albolarvatus*.  
     *Docophorus californiensis*.  
*Sphyrapicus thyroideus*.  
     *Docophorus californiensis*.

- Melanerpes formicivorus bairdi*.  
     *Docophorus californiensis*.  
*Trochilus alexandri*.  
     *Nirmus vulgatus*.  
*Calypte costæ*.  
     *Physostomum prominens*.  
*Tyrannus verticalis*.  
     *Nirmus fœdus*.  
*Myiarchus cinerascens*.  
     *Docophorus communis*.  
         *rufus*.  
         *fusco-ventralis*.  
     *Nirmus vulgatus*.  
         *fœdus*.  
     *Physostomum sp.*  
     *Menopon distinctum*.  
*Sayornis saya*.  
     *Nirmus fœdus*.  
     *Physostomum sp.*  
*Contopus richardsonii*.  
     *Physostomum sp.*  
*Empidonax difficilis*.  
     *Docophorus communis*.  
     *Nirmus vulgatus*.  
         *ductilis*.  
     *Physostomum sp. sucinaceum*.  
*Otocoris alpestris chrysolæma*.  
     *Docophorus communis*.  
*Cyanocitta stelleri frontalis*.  
     *Docophorus communis*.  
     *Nirmus vulgatus*.  
*Aphelocoma californica*.  
     *Docophorus communis*.  
     *Menopona persignatum*.  
*Sturnella magna neglecta*.  
     *Docophorus communis*.  
*Scolecophagus cyanocephalus*.  
     *Docophorus communis*.  
*Coccothraustes vespertinus montanus*.  
     *Menopon funereum*.  
*Carpodacus mexicanus frontalis*.  
     *Nirmus vulgatus*.
- Spinus pinus*.  
     *Docophorus communis*.  
*Chondestes grammacus strigatus*.  
     *Docophorus communis*.  
     *Nirmus vulgatus*.  
     *Menopon incertum*.  
*Zonotrichia leucophrys intermedia*.  
     *Docophorus communis*.  
*Zonotrichia leucophrys gambelii*.  
     *Docophorus communis*.  
*Zonotrichia coronata*.  
     *Docophorus communis*.  
     *Nirmus vulgatus*.  
     *Menopon mæstum*.  
*Spizella sp.*  
     *Docophorus communis*.  
*Spizella socialis arizonæ*.  
     *Docophorus communis*.  
*Junco hyemalis oregonus*.  
     *Physostomum diffusum*.  
*Junco hyemalis thurberi*.  
     *Docophorus mirinotatus*.  
*Amphispiza belli*.  
     *Docophorus communis*.  
     *Nirmus lautiusculus*.  
*Melospiza fasciata heermanni*.  
     *Colpocephalum grandiculum*.  
*Melospiza fasciata samuelis*.  
     *Docophorus communis*.  
     *Physostomum sp.*  
     *Menopon mæstum*.  
*Pipilo maculatus megalonyx*.  
     *Nirmus vulgatus*.  
     *Physostomum sp.*  
*Pipilo fuscus crissalis*.  
     *Docophorus communis*.  
     *Nirmus vulgatus*.  
     *Colpocephalum grandiculum*.  
     *Physostomum sp.*  
*Zamelodia melanocephala*.  
     *Docophorus communis*.  
*Guiraca cærulea eurhyncha*.  
     *Docophorus communis*.  
     *Nirmus vulgatus*.

- Passerina amœna.*  
     *Nirmus vulgatus.*  
*Piranga ludoviciana.*  
     *Docophorus communis.*  
*Petrochelidon lunifrons.*  
     *Menopon malleus.*  
*Chelidon erythrogastra.*  
     *Nirmus longus* var. *domesticus.*  
*Ampelis cedrorum.*  
     *Docophorus communis.*  
     *Nirmus brachythorax.*  
     *Physostomum* sp.  
*Phainopepla nitens.*  
     *Nirmus fœdus.*  
*Lanius borealis.*  
     *Docophorus communis.*  
*Lanius ludovicianus gambeli.*  
     *Docophorus communis.*  
     *Nirmus fœdus.*  
*Vireo solitarius plumbeus.*  
     *Docophorus communis.*  
*Vireo bellii pusillus.*  
     *Physostomum* sp.  
*Helminthophila celata lutescens.*  
     *Nirmus vulgatus.*  
*Dendroica æstiva.*  
     *Docophorus communis.*
- Dendroica æstiva.*  
     *Nirmus vulgatus.*  
     *Menopon ridulosum.*  
*Icteria virens longicauda.*  
     *Nirmus fœdus.*  
*Cinclus mexicanus.*  
     *Nirmus vulgatus.*  
*Heleodytes brunneicapillus.*  
     *Menopon malleus.*  
         *distinctum.*  
*Thryothorus bewickii spilurus.*  
     *Docophorus communis.*  
         *mirus.*  
     *Menopon incertum.*  
*Parus inornatus.*  
     *Docophorus communis.*  
*Parus gambeli.*  
     *Nirmus vulgatus.*  
*Parus rufescens neglectus.*  
     *Nirmus vulgatus.*  
*Turdus ustulatus.*  
     *Menopon incertum.*  
*Turdus aonalaschkæ auduboni.*  
     *Docophorus communis.*  
*Sialia mexicana occidentalis.*  
     *Docophorus communis.*  
     *Nirmus vulgatus.*

## EXPLANATION OF PLATES.

PLATE V.—Fig. 1, *Docophorus procax* Kellogg and Chapman, ♀. Fig. 2, *D. validus* Kellogg and Chapman, ♀. Fig. 3, *D. fusiformis* Denny, ♂. Fig. 4, *D. pictus* Giebel, ♀. Fig. 5, *D. singularis* Kellogg and Chapman, ♀. Fig. 6, *D. mirinotatus* Kellogg and Chapman, ♀. Fig. 7, *D. mirus* Kellogg and Chapman, ♀. Fig. 8, *Nirmus pacificus* Kellogg and Chapman, ♀. Fig. 9, *N. fusco-marginatus* Denny, var. *americanus* Kellogg and Chapman, ♀.

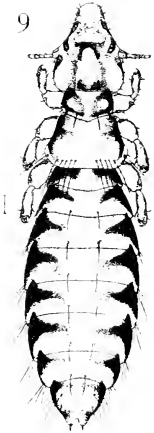
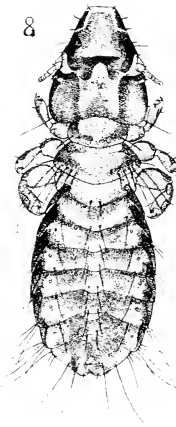
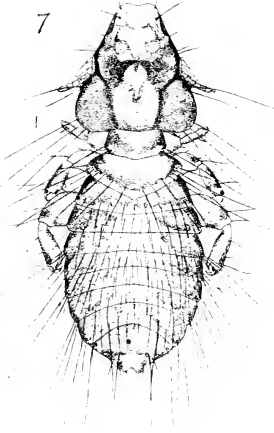
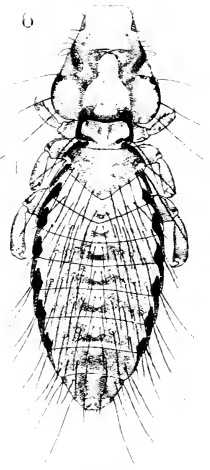
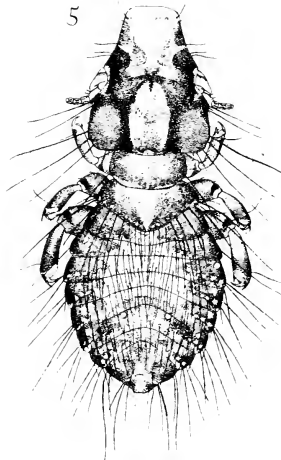
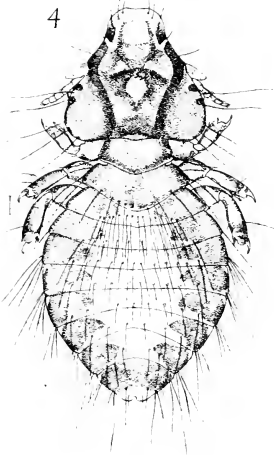
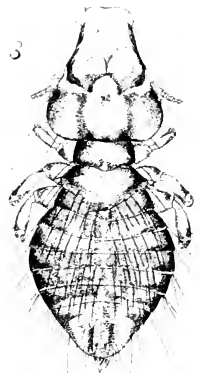
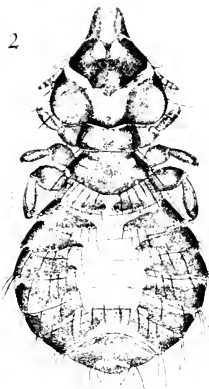
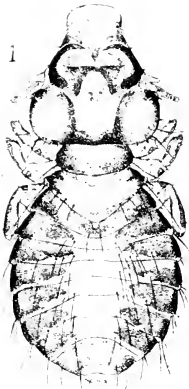
PLATE VI.—Fig. 1, *Nirmus maritimus* Kellogg and Chapman, ♀. Fig. 2, *N. triangulatus* Nitzsch, ♀. Fig. 3, *N. complexivus* Kellogg and Chapman, ♀. Fig. 4, *N. actophilus* Kellogg and Chapman, ♀. Fig. 5, *N. incensis* Kellogg and Chapman, ♀. Fig. 6, *N. opacus* Kellogg and Chapman, ♀. Fig. 7, *N. fedus* Kellogg and Chapman, ♀. Fig. 8, *N. ductilis* Kellogg and Chapman, ♀. Fig. 9, *N. lautiusculus* Kellogg and Chapman, ♂.

PLATE VII.—Fig. 1, *Lipeurus laculatus* Kellogg and Chapman, ♂. Fig. 2, *L. concinnus* Kellogg and Chapman, ♂. Fig. 3, *L. fuliginosus* Taschenberg, var. *major* Kellogg and Chapman, ♂. Fig. 4, *L. farallonii* Kellogg, ♂. Fig. 5, *L. perplexus* Kellogg and Chapman, ♀. Fig. 6, *Oncophorus bisetosus* Piaget, var. *californicus* Kellogg and Chapman, ♀. Fig. 7, *O. remotus* Kellogg and Chapman, ♂. Fig. 8, *Colpocephalum perplanum* Kellogg and Chapman, ♀. Fig. 9, *C. spinulosum* Piaget, var. *minor* Kellogg and Chapman, ♂. Fig. 10, *C. grandiculum* Kellogg and Chapman, ♀.

PLATE VIII.—Fig. 1, *Menopon irrumpens* Kellogg and Chapman, ♀. Fig. 2, *M. paululum* Kellogg and Chapman, ♀. Fig. 3, *M. petulans* Kellogg and Chapman, ♂. Fig. 4, *M. titan* Piaget, var. *incompositum* Kellogg and Chapman, dorsal aspect of one abdominal segment. Fig. 5, *M. titan* Piaget, var. *incompositum* Kellogg and Chapman, ventral aspect of last segments of abdomen of ♂. Fig. 6, *M. funereum* Kellogg and Chapman, ♂. Fig. 7, *M. distinctum* Kellogg and Chapman, ♀.

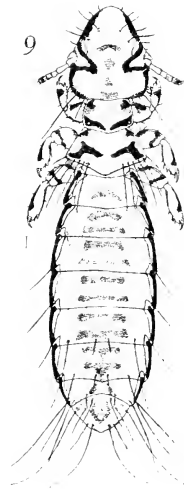
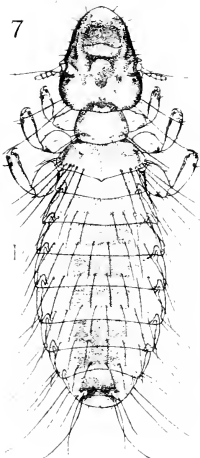
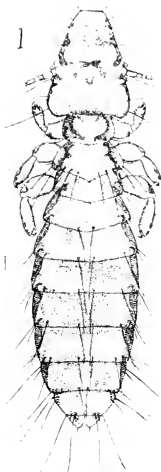
PLATE IX.—Fig. 1, *Menopon persignatum* Kellogg and Chapman, ♀. Fig. 2, *M. mæstum* Kellogg and Chapman, ♀. Fig. 3, *M. malleus* Nitzsch, ♀. Fig. 4, *M. ridulosum* Kellogg and Chapman, ♀. Fig. 5, *Physostomum promiuens* Kellogg and Chapman.



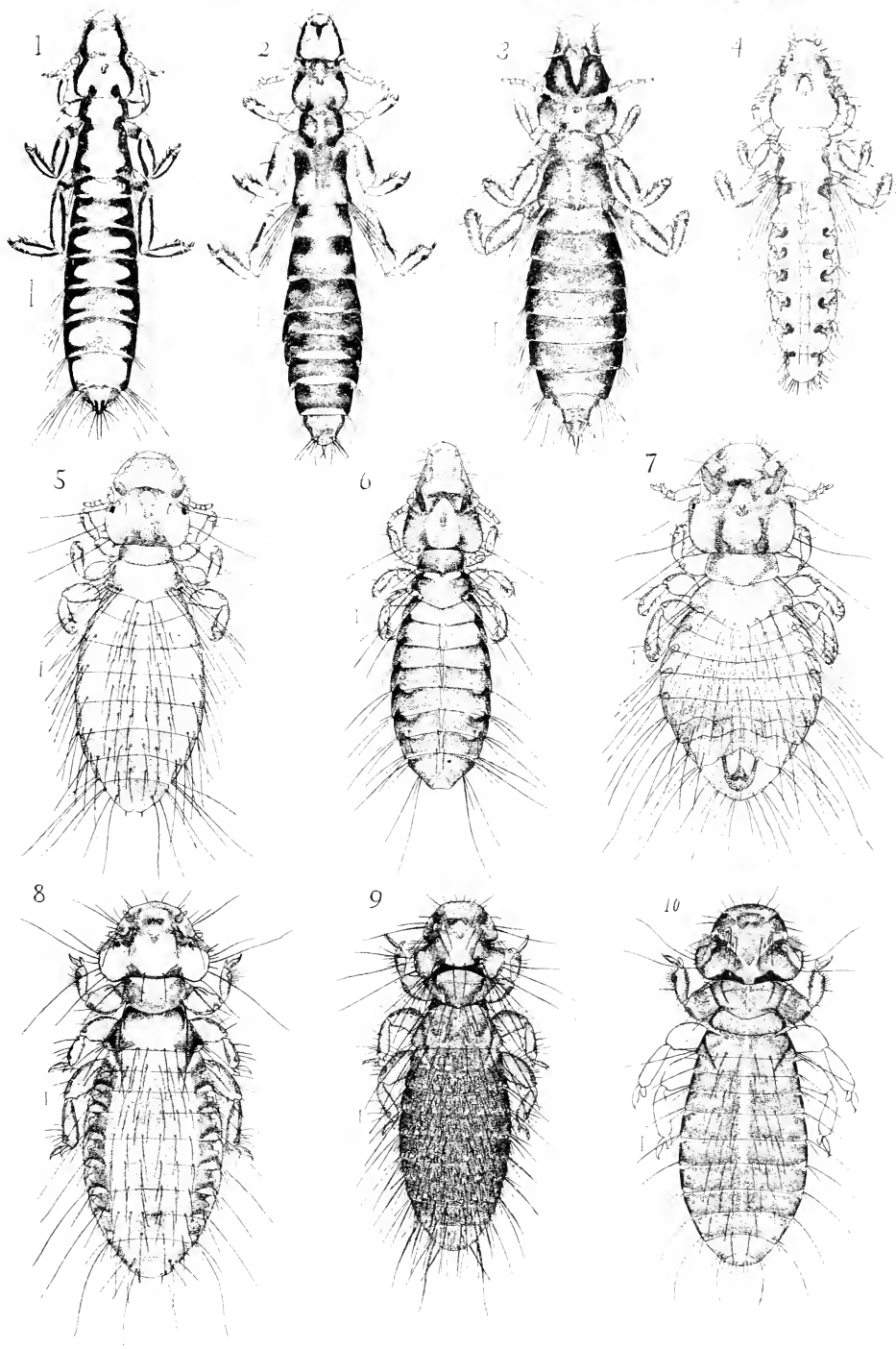




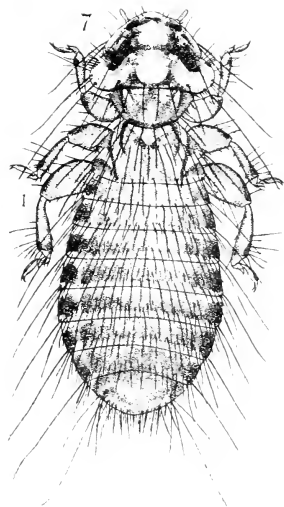
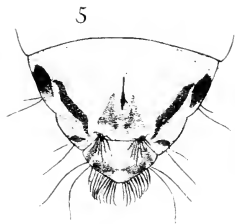
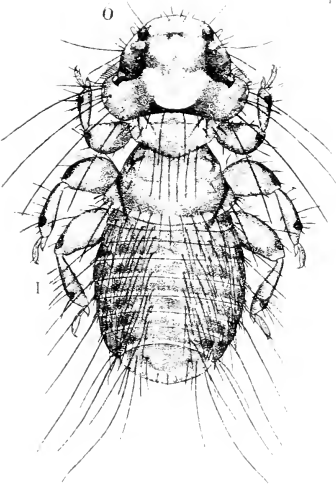
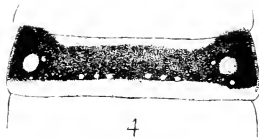
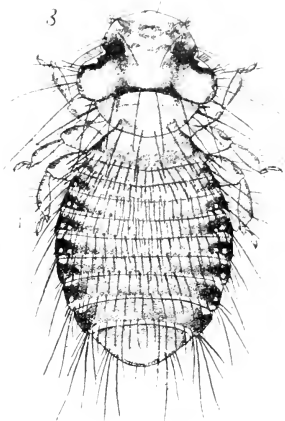
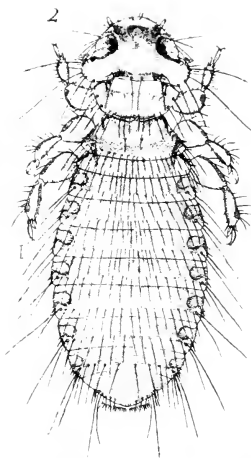
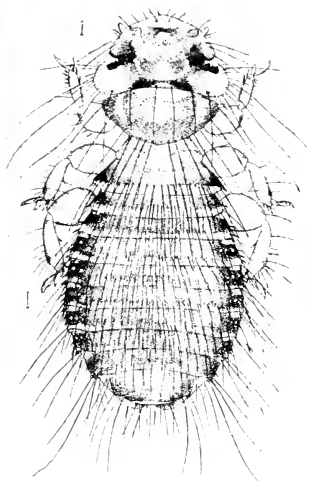




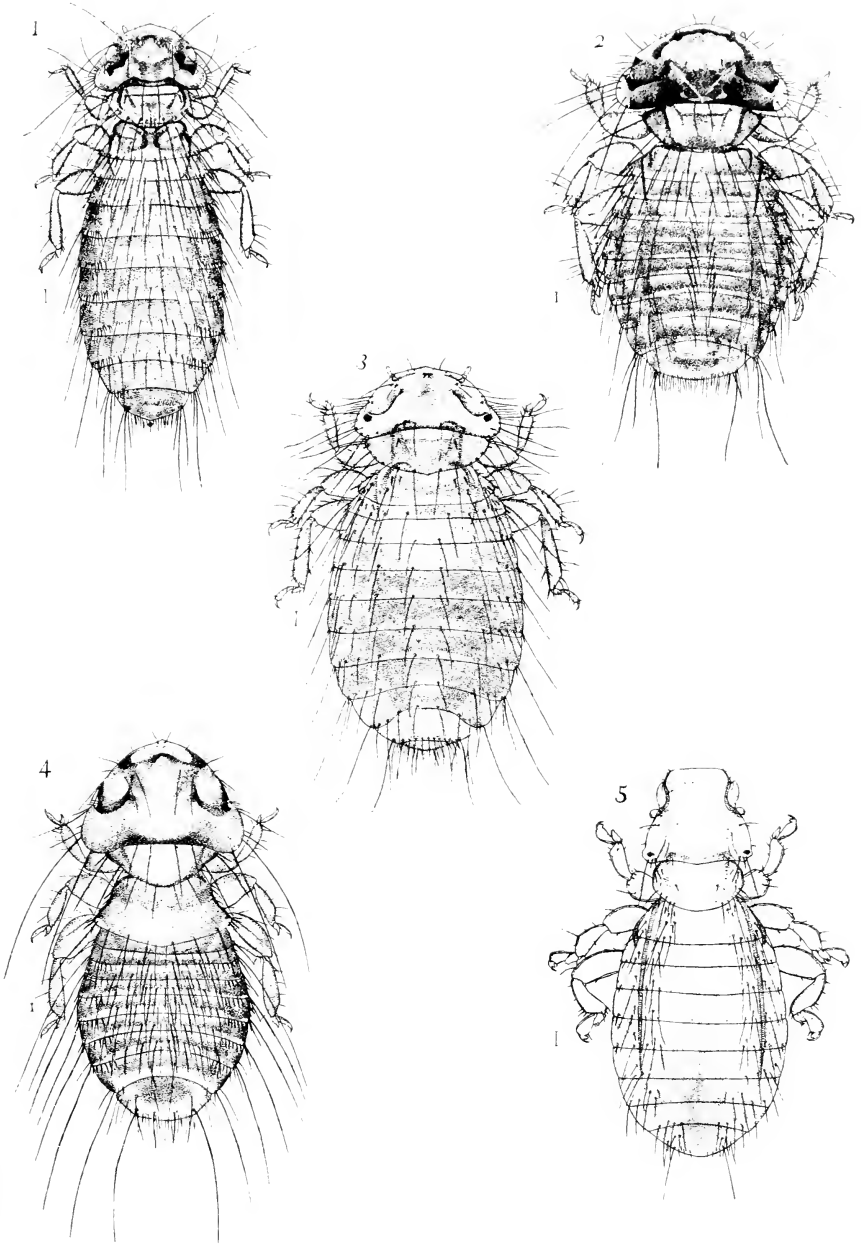
















# THE ANATOMY OF THE MALLOPHAGA.

(With Plates X to XVII.)

BY ROBERT E. SNODGRASS.

The earliest work on the anatomy of the Mallophaga is that of Nitzsch. His results are comprised in his own announcement of his work, "Darstellung der Familien und Gattungen der Thierinsekten (insecta epizoica) als Prodomus einer Naturgeschichte derselben," published in the third volume of Germar and Zinken's "Magazin für die Entomologie," 1818, and in Giebel's "Insecta Epizoa, die auf Säugethieren und Vögeln schmarotzenden Insecten, nach Chr. L. Nitzsch's Nachlass bearbeitet," published in 1874. Both of these works are chiefly systematic, but the larger groups are separated on anatomical characters. The first purely anatomical paper is one by Wedl in 1855, "Ueber das Herz von *Menopon pallidum*." This paper is limited to a single organ. The next, by Kramer, "Beiträge zur Anatomie und Physiologie der Gattung *Phlopterus* (Nitzsch)," published in Zeitschrift für Zoologie in 1869, includes all the organs of a single species (*Lipeurus jejunus*). The third and latest purely anatomical paper is Grosse's "Beiträge zur Kenntnis der Mallophagen," published in the same journal as the last, in 1885. *Menopon titan* (*Tetrophthalmus chilensis* Grosse), is made the basis for detailed descriptions, but the work is comparative, since more general descriptions of other forms are given, and the anatomical characters of the two main groups are pointed out. In 1869 Rudow published a paper, "Beobachtungen über die Lebensweise und der Bau der Mallophagen oder Pelzfresser, sowie Beschreibung neuer Arten," in which the

principal anatomical characters are tabulated, and a long description of the mouth-parts given. The latter, however, is almost entirely incorrect. The mouth-parts were described wrongly at first by Nitzsch, then by Kramer, and finally by Rudow. Their correct explanation is due to Grosse. Rudow's paper contains an important statement concerning the number of egg-tubules in *Amblyceran* females. He says that there are five present of which two are rudimentary. Nitzsch could find but three, and Grosse apparently made no determination of the number present. In 1869, also, Melnikow published in *Archiv für Naturgeschichte*, vol. xxxv, an embryological paper, "Beiträge zur Embryonal-entwicklung der Insekten" in which the embryology of the Mallophaga is described. Nusbaum in his paper, "Zur Entwicklungsgeschichte der Ausführungsgänge der Sexualdrüsen bei den Insekten," in *Zoologischer Anzeiger* for 1882, describes mainly two Mallophagan species, *Lipeurus bacillus* and *Goniocotes hologaster*.

#### I. GENERAL EXTERNAL ANATOMY.

*External Form and Body-wall.*—The body is generally very much flattened dorsoventrally. The segments of the thorax are often apparently only two, the mesonotum and metanotum being united. In others, however, the two are distinct although the former is narrow. In longitudinal sections of *Menopon titan* (plate x, fig. 1), the mesonotum ( $T_2$ ) is seen to be separated from the metanotum ( $T_3$ ) by a non-chitinized space, and is depressed below the level of the latter. The number of abdominal segments varies, but the largest is ten. The number in some cases varies with the sex. The head is flat, horizontal, situated closely

upon the prothorax, and often excavated behind to receive the latter. In *Menopon persignatum*, as shown by transverse sections (plate xii), the head is very flat and comparatively wide. The side walls are very far from being perpendicular, and are scarcely distinguishable from the dorsal walls. They meet the floor of the cranium at a sharp angle. The top of the head is flat in front, somewhat concave behind. The prothorax is triangular in cross-section, having one angle median and ventral. The tergum is a little rounded. The mesothorax is more convex above and flatter beneath. The lateral edges are sharp and project over the bases of the legs. The metathorax is wider but otherwise similar to the mesothorax except in length. In the females of some species the abdomen is little or not at all flattened.

The body-wall of most species is well chitinized. In the abdomen the chitin is deposited in several areas around each segment (plate xv, figs. 3, 4, and 5, and plate xvii, figs. 1-5). On the dorsal side is a wide continuous plate reaching on each side to a short distance from the lateral margin of the segment. Likewise on the ventral side is a similar chitinization, and the two plates form respectively the tergum and sternum of the segment. Laterally, between the outer ends of these, are angular plates, one on each side, forming the lateral walls or pleura of the segment. The four are separated from one another by non-chitinized spaces. The intersegmental spaces are generally, especially on the dorsum, thrown into S-shaped folds, so that the posterior end of one segment overlaps the anterior end of the one in front. In some cases the chitinous tergum or sternum of a segment occupies only a small part of its length. In some the chitin is mostly accumulated

at one place. An extreme example is shown in the terga of the anterior abdominal segments of *Eurymetopus taurus*. Here the chitin shows in longitudinal sections a large oval thickening near the anterior end of the segment, back of which it forms only a thin superficial plate reaching to near the posterior end. Anteriorly it terminates in a deeper but very short prolongation. The non-chitinized part in front is folded into a strong S-shaped band, the upper loop of which, forming the posterior border of the segment in front, projects over the anterior end of the chitinous thickening. Processes of the chitinous wall often extend into the body-cavity, especially in the thorax, giving attachment to various muscles. The antennary fossæ of the Amblycera are formed by chitinous processes from the lateral ventral margins of the head extending outward beneath the antennæ, and by a prolongation of the outer dorsal aspects of the head outward and downward (plate xii, figs. 1 and 2). Chitinous genital parts will be described under the head of the Reproductive Organs.

*The Appendages.*—The antennæ are three to five-jointed. In the Amblycera they are concealed in deep fossæ on the lateral ventral aspects of the head, and generally have the terminal segment enlarged. In the Ischnocera they are simple, filiform and exposed.

The mouth-parts have already been described in detail in Kellogg's "New Mallophaga, II,"\* and merely a general account of their structure will be given here. They are of the biting type and consist of mandibles, maxillæ, and labium. The maxillæ (plate x, figs. 5, 6, 11 and 12) are large, strong, triangular, two-toothed

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\* Proc. Cal. Acad. Sci., 2nd Ser., Vol. VI, 1896.

structures, attached to the head by a condyle on one side and a socket on the opposite side of the outer basal angle. From the inner angle of the base a prolongation extends inward. The two teeth project from the inner edge, generally one distal to the other. The mandibles present two modifications, one found in the Amblycera and the other in the Ischnocera. In the former they lie parallel with the ventral surface of the head, so that the condyle is ventral and the socket dorsal. In this form one tooth lies in front of the other in a horizontal line in the same plane as the long axis of the mandible. In the Ischnocera the mandibles hang vertical to the head, so that the condyle is posterior and the socket anterior. In this form the distal tooth is typically ventral to the other in a vertical line in the same plane as the long axis of the mandible. The more proximal tooth, however, may be moved toward the tip and come to lie by the other and in front of it (plate x, fig. 6). In this case the two lie in the same horizontal line, but this is perpendicular to the long axis of the mandible. Starting with either type, the other may be produced from it by revolving the mandible on an axis passing from its outer to its inner basal angles. The degree of revolution varies in different Ischnoceran species, but the angle is always large and may reach  $90^{\circ}$ . In many cases there is a chitinous plate or rod attached to the inner angle of the base of the mandible, and a smaller one attached to the outer. These serve for attachment of muscles (plate x, fig. 12, *ch. pls.*) extending backward or upward into the head cavity. When they are absent muscle fibers are attached directly to the mandibles.

The maxillæ are generally simple, small, non-chitinized lobes, often provided with teeth on their inner

edges. They lack palpi and distinct divisions into the ordinary parts (plate x, figs. 3 and 10).

The labium presents two forms, one in the Amblycera the other in the Ischnocera. In the former (plate x, fig. 9), there are present a submentum, mentum with two four-segmented palpi, and a ligula with two glossæ and two paraglossæ. The ligula is the only part that varies much, since it may have more or fewer than the four lobes named. In the Ischnocera a submentum, mentum, and ligula are present. The latter two are not well separated, but the paraglossæ are distinct (plate x, fig. 13) and very constant in form, being short, thick, cylindrical, and rather more chitinized than the rest of the labium. The glossæ are present between the paraglossæ as two small lobes.

In front of the mouth is the labrum, a large lobe situated on the ventral aspect of the head, generally some distance back of the anterior border of the clypeus.

The three pairs of legs are very similar throughout the group. The tarsi are two-jointed, and, with the exception of two genera, *Trichodectes* and *Gyropus*, that inhabit mammals, are provided with two claws, the others having only one. In some specimens of *Docophorus cursor* examined, the legs when at rest generally assumed the following positions. The femur (fig. 1) of the metathoracic leg extends outward and is inclined slightly forward

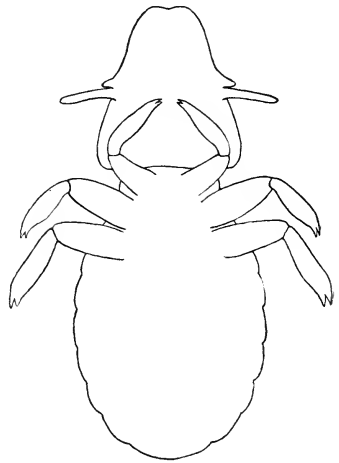


Fig. 1.

from the body. The femur of the mesothoracic leg extends outward also but a little more forward than the other. That of the prothoracic leg is inclined forward at an angle of about  $45^{\circ}$  with the body. Hence the fore legs are held mostly beneath the head and anterior part of the prothorax. The meta- and mesotibiae extend backward, outward, and downward from the distal ends of the corresponding femora. The protibiae extend backward, inward, and downward from the distal ends of the profemora, and their distal ends lie internal to the coxal ends of the femora.

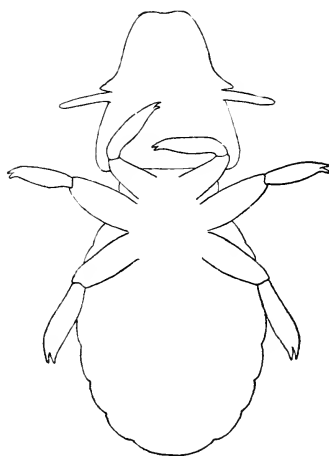


Fig. 2

When the insect is walking undisturbed in forward longitudinal progression, the two legs of the mesothorax and of the metathorax move respectively together, but the two pairs move in opposite directions. That is (figs. 2 and 3), the two mesothoracic legs move forward or backward at the same time and the metathoracic legs move in the same

manner, but while the mesothoracic legs are moving forward, the metathoracic legs are moving backward, and *vice versa*. Thus, while one pair of legs is pushing the body forward the other pair is reaching forward for a new grasp, and this is obtained just as the active pair has finished its work. The pair previously being carried forward then takes hold and continues the motion of the body, the two being themselves brought relatively backward. In this way the two pairs are

always either approaching each other or are receding from each other.

The prothoracic legs do not move synchronously with either of the other pairs nor with each other. Generally (fig. 3) one moves backwards while the other is reaching forward. They appear mainly to guide the body. The femoro-tibial joint is most of the time in front of the tarsal claws, so that their power as propellers cannot be great. The parasite thus progresses along the

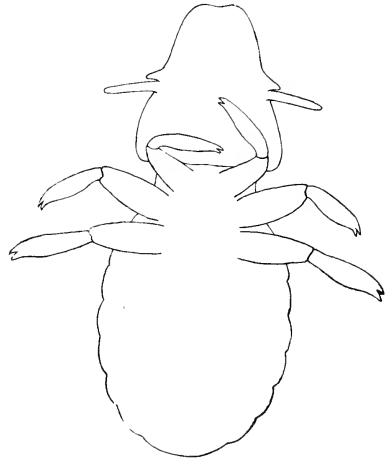


Fig. 3.

feather with a hand over hand movement of the prothoracic legs, as of a man climbing a rope, while the other legs, a pair at a time, are continually pushing the body forward.

This is the typical movement of the legs and the one which prevails when the insects are walking quietly and regularly, but at times it becomes very much obscured by irregular movements and is generally more or less so, so that almost any relative position of the legs may be seen. The outer end of the metathoracic femur is seldom brought much farther forward than its coxa. The mesothoracic femur forms a smaller angle with the body in front, but not such a small one behind as the metathoracic leg. The femoro-tibial joints of the prothoracic legs are during progression brought forward, and the tibia also independently turns forward on the femur, so that the angle between the two increases and the tarsal claws are carried forward



by a double motion. They then grasp the feather and by their own motion backward and by the motion of the body forward on the hind legs the femoro-tibial angle is again decreased and the leg assumes its former position. The insects run along on the feathers very easily, generally preferring the shaft. Those experimented with were kept on a few bits of feather on a glass slide. They ran along the shaft of a feather until they came to the end, then backed up a short distance, turned around, and ran back to the other end to go through the same performance there. They generally move with the head forward but can apparently go backwards or at any lateral angle just as easily; they nearly always, however, turn around when they wish to reverse the direction of movement. When several were placed on some guinea-pig hairs they appeared to be at no loss at all as to how to get along, and traveled just as well as on the feathers, although perhaps a little slower. Some Pediculids, however, from the guinea-pig, when placed on some feathers, appeared to be somewhat hindered by the network of barbs and barbules. The Mallophaga were entirely unable to progress upon the glass slide when they got off of the feathers, but the lice showed no difficulty at all in this respect; the latter could also right themselves when placed on their backs while the former could not.

## II. THE ALIMENTARY CANAL AND ITS APPENDAGES.

*The Alimentary Canal.*—The alimentary canal presents two types of structure. One form is simple, having no special development at any part, the other is complicated by a lateral and backward prolongation of the crop, so that the latter forms a large expanded diverticulum of the œsophagus. The first form is confined to

the Amblycera, the second to the Ischnocera. Of the first, the alimentary canal of *Menopon titan* (plate xi, fig. 13, plate x, fig. 1, and plate xvii, fig. 6) may be taken as an example. It has the form of an almost straight tube separable into six distinct parts. The first of these is a narrow elongated buccal cavity (plate x, fig. 1, *bc*) extending upward and backward from the oval aperture, by which it opens anteriorly, to the second part of the alimentary canal, the pharynx (*p*). This is a large cavity, oval in longitudinal sections, having its long axis extending backward and upward, but not so much in the latter direction as that of the buccal cavity, so that the two form an angle with each other. The pharynx lies mostly in front of the brain (*b*) and subœsophageal ganglion (*s.œ. g.*), the commissures lying laterad of its posterior end. Between the latter the pharynx contracts and passes into the œsophagus. This is rather long, narrow, gradually expands posteriorly, passes uninterruptedly into the crop, and forms with the latter the third division of the alimentary canal (*œ* and *cr*). The crop is of variable size according to the contents, but is rather large when distended.

The fourth part, the ventriculus, is long, wide in front and narrow behind, and connected with the crop in front by a short, very narrow neck. On each side of this it is produced into a large cæcum, the two embracing the posterior end of the crop. Back of the stomach is the intestine forming the fifth and sixth divisions of the alimentary tract. The first of these two consists of the prerectal part of the intestine and the second of rectum. The former is a short, straight, narrow tube, a little enlarged toward the middle and separated from the ventriculus in front and the rectum

behind by slight constrictions. From its anterior end four Malpighian tubules arise. The rectum is very large (plate xi, fig. 13, and plate xvii, fig. 6, *v*). Its anterior part is much dilated, the enlargement being rather suddenly narrowed in front, but posteriorly gradually passes into the more tubular posterior part. Its anterior end is provided with six oval rectal glands. These vary in size in different specimens. In the male the anal opening is in the upper posterior part of the genital chamber, in the female it is in the end of the last abdominal segment (plate xv, figs. 1 and 2, *a*, and plate xvii, fig. 6, *a*).

Sections show the following histological features of the alimentary canal. The preventricular part is lined with a chitinous intima continuous with the body-covering at the mouth. The ventriculus lacks an intima, but possesses a thick inner cellular epithelium (plate x, fig. 1, *v*). The intestine has a thin chitinous lining continuous with the body-covering at the anus. The prerectal part possesses a thin cellular epithelium covered by an outer membrane, surrounding which are small muscle fibers. The rectum lacks the epithelium and has larger muscle fibers (plate xvii, fig. 6, *rtm*). The rectal glands project inwardly and are covered by the chitinous lining of this part of the alimentary tract.

In the Ischnocera, as before stated, the alimentary canal is complicated by a very remarkable condition of the crop. This in the genus *Trichodectes* has the form of a large sac connected with the lower end of the œsophagus by a long, narrow neck; in the other genera it forms a large transverse dilatation of the œsophagus, some distance above where the latter opens into the ventriculus. The crop is always produced much

more to one side of the œsophagus than to the other.

The alimentary canal of *Eurymetopus taurus* may be taken as a type of this latter form (plate xi, fig. 11). The œsophagus is a long, slender tube reaching from the head to the mesothorax. Here it enters the anterior dorsal aspect of the crop. The latter lies dorsal and to the left of the other organs of the body-cavity except the heart, and extends from the middle line backwards and to the left, reaching the sixth abdominal segment when considerably distended. Its size and shape vary according to its contents, but it is generally much longer than wide, rounded in front, swollen toward the middle, and tapering behind. Its upper end extends a short distance beyond the opening of the œsophagus into it. About opposite the latter point, on the ventral aspect of the crop, the subingluvial part of the œsophagus begins and runs backwards to the ventriculus, forming a short, narrow tube. The ventriculus is smaller than the crop when the latter is fully distended. Anteriorly it bears two large, lobular cæca, each being rather flat and expanded beyond its base. The stomach lies with most of its long axis in an antero-posterior direction. It is widest through the middle; in front of this it is slightly constricted, while in the opposite direction it becomes very much narrowed, and, assuming a tubular form, makes a bend to the left. It goes a short distance in this direction and then meets the hind-gut. The latter turns immediately backward and runs in a straight line to the exterior. It is divided into an anterior, narrow, prerectal part and a posterior, enlarged rectum. The former bears at its anterior end the four Malpighian tubules, becomes enlarged toward its middle, and is separated posteriorly from the rectum by a slight constriction. The latter is much distended

in front, where six large, oval, rectal glands are situated, but becomes narrowed posteriorly, the hind half being a straight, narrow tube opening into the upper part of the genital cavity. The relative size and shape of each of these parts vary greatly with their contents. The crop is provided with very prominent longitudinal and transverse muscles, which form a network of fibers over it.

It is evident that in such an alimentary canal as that just described there are two distinct divisions in addition to those of the alimentary canal of an Amblyceran species. The crop of *Eurymetopus* forms a part distinct and sharply separated from the œsophagus in front, and also sets off that portion of the œsophagus between itself and the stomach as a distinct division of the alimentary tract. The bits of feathers that form the food of the insect are generally almost as long as the crop and always lie in it in a longitudinal direction.

The alimentary canals of all other Philopterids in which this organ is known are similar in all essential respects to that of *Eurymetopus taurus* just described. In *Docophorus lari* the crop is very much like that of *Eurymetopus taurus* in shape (plate xi, fig. 8). It extends from the anterior left part of the body-cavity backwards and to the right. The œsophagus is narrow, lies in the middle line, and enters the crop some distance to the right of the anterior end of the latter. Arising from the ventral surface of the crop, at a point some distance to the left of the opening of the anterior part of the œsophagus into the same, is the subingluvial part of the œsophagus, which passes backwards a short distance and enters the ventriculus. This is rather long and tapers very much posteriorly. Its anterior end is provided with a large, lobe-like cæcum on

each side. Its posterior end is a little bent just before it enters the hind-gut. The latter is short and narrow. The rectum is very much expanded anteriorly, having six prominent rectal glands surrounding the posterior end of the anterior smaller part of the intestine.

In *Goniodes cervinicornis* the crop is relatively very long and tapering (plate xi, fig. 12). It lies in an almost antero-posterior direction to the left of the rest of the alimentary canal. Its anterior end is large and rounded; posteriorly it tapers to a rather pointed extremity which reaches a little farther back than the posterior end of the ventriculus. When in the natural position its hind end is bent to the right and lies close to the stomach. The œsophagus enters the crop on its dorsal surface back of the anterior end. The part of the œsophagus between the crop and the stomach arises from the former in front of the point at which the anterior portion of the œsophagus opens into it. The stomach is rather long, but when it is distended it does not taper very much posteriorly, passing into the intestine by a rather sudden constriction. The two cæca at its anterior ends are relatively smaller than in the other forms described, and are merely blunt diverticula of the ventriculus without constricted bases. The pre-rectal part of the intestine is very short and narrow. The rectum on the other hand is unusually large, having its anterior end very greatly dilated and provided with six very large and much elongated rectal glands.

In *Lipeurus fuliginosus major* the crop lies to the left side of the body-cavity, the rest of the canal lying along the right. The ventriculus simply contracts posteriorly, passing gradually into the intestine, the two being separated by only a slight constriction. The rectum is comparatively rather long but otherwise both it

and the rest of the intestine are very similar to the others described.

Nitzsch (1874) figures the alimentary canals of the following Philopterid species: *Docophorus fuscicollis*, *D. ocellatus*, and *Lipeurus jejunus*. That of *Docophorus fuscicollis* differs in no essential respect from those forms already described. In *D. ocellatus* the openings of the pre- and postingluvial divisions of the œsophagus are rather far removed from the nearer end of the crop. The ventriculus is very long and bent upon itself, forming a loop.

The genus *Trichodectes* (family Trichodectidæ) presents a rather remarkable deviation from the other Ischnoceran forms in the shape and position of the crop. As already mentioned, it is of the form of a sack connected with the œsophagus some distance in front of the ventriculus by a narrow, more or less elongated neck. In *Trichodectes geomydis* (plate xi, fig. 10), the crop is rather smaller comparatively than in most of the Philopterid forms, being about two-thirds the length of the stomach. The neck is long and slender, extending laterally from the œsophagus. The ventriculus is large anteriorly, where it is produced into two large cæca which are not constricted at their bases. Posteriorly the stomach becomes narrowed and makes an abrupt bend in the direction of the crop. After running a short distance in this direction as a narrow tube it passes into the intestine. This division of the alimentary canal goes backward from the midgut, forming a right angle with the posterior tubular part of the latter. The rectum is wide anteriorly, where it presents six glands as in the other families. In a *Trichodectes* from a horse the crop (plate xi, fig. 9) is the same as in *T. geomydis*, but is comparatively even a little smaller;

also, the neck is shorter. The ventriculus with its large gastric cæca is about the same. Nitzsch (1874) figures the alimentary canal of *T. climax*. Here the crop differs somewhat from the two just described in that the neck is very much shorter, the crop forming a pear-shaped diverticulum from the side of the œsophagus and separated from it by a narrow constriction. In this form the distal end of the crop is the larger, while in the Philopterid forms the proximal end is the larger, the distal end being generally more or less tapering and pointed. No intermediate form of a crop between the Philopterid and Trichodectid types has been found, and it is impossible to say which is the more primitive.

*Pharyngeal Sclerite.*—In many genera, including all of those of the Ischnocera, and one and part of another genus in the Amblycera, there is present a curiously formed sclerite in the walls of the pharynx. It has already been described in Kellogg's "New Mallophaga, II," under the term "œsophageal sclerite." As shown there, it is a prominent, cup-shaped thickening of the chitinous lining of the ventral wall of the pharynx, forming a depression in the latter. From its sides (plate x, fig. 7) chitinous bands (*bs*) run upward around the pharynx and are connected by muscles with the dorsal wall of the head. From the anterior corners a large expansion (*ant. h*) on each side reaches forward and upward in the walls of the pharynx. Into the anterior end of its cavity a duct from two ventrally situated glands opens. The latter (plate x, fig. 2, *l.g.*) are oval, covered with a chitinous envelope, and supported by chitinous pedicles. From the anterior end of each a duct runs forward, after traversing the ventral surface, and then turns inward and backward to unite with the duct



from the other side. The common duct thus formed then goes straight back to the sclerite. The shape of both these organs is very remarkably constant. In one or two genera they present deviations, and also in a few scattered cases, but these will be described farther on.

As was pointed out by Kellogg (1896), these organs are not peculiar to the Mallophaga but occur also in the Psocidæ, having been described for these insects by Burgess (1878). Outside of these two groups, however, they are not known to occur. Among the Mallophaga they are not of universal occurrence, but are for the most part confined to one suborder. Specimens of the following genera were had for examination: *Ancistrona*, *Colpocephalum*, *Docophorus*, *Eurymetopus*, *Giebelia*, *Goniocotes*, *Goniodes*, *Lamobothrium*, *Lipeurus*, *Menopon*, *Nirmus*, *Nitzschia*, *Oncophorus*, *Physostomum*, *Trichodectes*, *Trinoton*. The following table shows the distribution of the sclerite and glands among these genera:

Genera with Sclerite and Glands Present.	Genera with Sclerite and Glands Absent.	Genera with Sclerite and Glands Present or Absent.
<i>Colpocephalum</i> .	<i>Ancistrona</i> .	<i>Docophorus</i> .
<i>Eurymetopus</i> .	<i>Lamobothrium</i> .	<i>Lipeurus</i> .
<i>Giebelia</i> .	<i>Nitzschia</i> .	<i>Menopon</i> .
<i>Goniocotes</i> .	<i>Physostomum</i> .	<i>Nirmus</i> .
<i>Goniodes</i> .	<i>Trinoton</i> .	
<i>Oncophorus</i> .		
<i>Trichodectes</i> .		

The above table shows that those genera with the structures present belong, with the exception of *Colpocephalum*, to the suborder Ischnocera; while those in which they are absent belong, without exception, to the suborder Amblycera. Hence there are no Ischnoceran genera in which the sclerite and glands are absent in all

species, although in three genera they are absent in a few cases. On the other hand, in the Amblycera they are absent in all but two genera, and of these one has them present in all species, but in the other they may be present or may be absent. Of thirty-eight species of *Docophorus*, twenty-six species of *Lipeurus*, and twenty-nine species of *Nirmus* examined—all that were accessible—only in *Docophorus icterodes*, *Lipeurus picturatus*, *L. longipilus*, and *Nirmus signatus* are the structures absent. From this it is evident that the exceptions to the occurrence of the œsophageal sclerite and glands in North American Ischnocera are few. It is worthy of notice also that the species of this suborder lacking them occur in the three largest genera,—the species of *Docophorus*, *Lipeurus*, and *Nirmus* being far more numerous than those of all the other genera of the same suborder together.

The following genera have been found so far only on European birds, *Akidoproctus*, *Boopia*, *Bothriometopus*, *Eureum*, and *Ornithobius*. Taschenberg (1882) and Piaget (1880), however, give good figures of all these genera, and in their figures the presence or absence of the sclerite is apparently intended to be shown, although whether it is or is not present is not stated in the description of each species. The figures can probably be relied on to show at least in what species it is present. According to them the structure is present only in *Akidoproctus*. This genus and also *Bothriometopus* and *Ornithobius* belong to the Ischnocera, so that it appears that there are two genera of this suborder in which the sclerite is absent; but this is without proof. If it is absent in the two Amblyceran genera, *Boopia* and *Eureum*, they agree with most of the other forms of their suborder. The sclerite appears to be absent

also in *Gyropus*, an Amblyceran mammal-infesting genus\*

In some species of several genera the sclerite is not of the typical form described. In *Docophorus pertusus* it is very much modified in form. The body is comparatively very small and the anterior processes are not present at all. On the other hand, the lateral circum-oesophageal bands are greatly enlarged, forming a thick chitinous band passing upward around the pharynx. The body of the structure is so small that it appears merely as a median, backward-projecting enlargement of the rest. The dorsal cavity is present, its anterior wall and the anterior margins of the lateral wings are transparent and continuous with one another. The wings are expanded near their bases but distally each becomes narrowed and passes upward and somewhat forward as a slender curved rod. The structure is of about the same shape in a young specimen but the wings are proportionally smaller. In *Docophorus atricolor* the sclerite is small and weakly chitinized but the anterior processes are comparatively large and much expanded. In *Lipeurus diversus* the body is elongated, and in *L. squalidus* it is similar but with the anterior processes enlarged. In several other Ischnoceran genera the sclerite is variously modified, but the species in which modification occurs are scattered and not closely related to one another.

In the Amblycera only two genera possess the pharyngeal sclerite, and in these two the characteristic form is not that of the Ischnocera. It is, however, typically the

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\*Taschenberg figures *Bothriometopus macrocnemis*, ♂ and head of ♀, and *Ornithobius hexophthalmus*, ♀ and head of ♂, in which the sclerite is not shown. But in *Akidoproctus rostratus* and *A. stenopygos* it is plainly present. Piaget figures *Boopia longitarsus*, *B. grandis*, *Eureum cimicoides*, *E. malleus*, *Gyropus ovalis*, *G. gracilis*, and *G. turbinatis*, in all of which the sclerite is not shown.

same. In *Menopon* and *Colpocephalum* the anterior processes of the sclerite are very much prolonged forward and are only slightly divergent. In some cases the sclerite is extremely reduced in size. In *Menopon fædus* the anterior processes are not prolonged but are wide and bifid. These two genera are in other respects also very similar, and it is of significance that in the only genera of the Amblycera that possess the sclerite it has the same structure, different from that prevailing amongst the Ischnoceran genera, in each.

The following table gives the species of *Menopon* examined that have and do not have the sclerite and glands:

Genus <i>Menopon</i> .	
Species with Sclerite and Glands Present.	Species with Sclerite and Glands Absent.
<i>auro-fasciatum</i>	<i>distinctum</i>
<i>decoratum</i>	<i>malleus</i>
<i>dissimile</i>	<i>persignatum</i>
<i>fædus</i>	<i>præcursor</i>
<i>funereum</i>	<i>rediculosum</i>
<i>incertum</i>	<i>robustum</i>
<i>indistinctum</i>	<i>titan</i>
<i>infrequens</i>	<i>tridens</i>
<i>irrupens</i>	
<i>longicephalum</i>	
<i>loomisii</i>	
<i>melanorum</i>	
<i>mesoleucum</i>	
<i>monostachum</i>	
<i>navigans</i>	
<i>numerosum</i>	
<i>paululum</i>	
<i>petulans</i>	
<i>striatum</i>	

It is evident that the œsophageal sclerite and connected glands might be made use of in determining the relations of *Menopon* and *Colpocephalum* to the other genera, and also of the Mallophaga to other orders of Insects, since they occur also in the Psocidæ. But the probable number of yet unknown species is too great to allow of these structures being used to determine relationships of genera within the order.

*The Salivary Organs.*—In 1869 Kramer described the salivary glands of *Lipeurus jejunus*. In 1874 they were mentioned by Giebel in "Insecta Epizoa" from Nitzsch's notes. He gives no description of them. Finally, in 1885, Grosse gave a general account of their structure in the whole order, and a special description of those of *Tetrophthalmus chilensis* (*Menopon titan*). As far as is known, all species of Mallophaga possess two pairs of salivary organs; in some cases there is evidence that only one of each pair is a gland, the other being a reservoir. In any case either one gland and a reservoir or two glands are situated on each side of the crop or œsophagus. From the anterior end of each organ a duct arises and passes forward. The two ducts on each side unite with each other, forming a right and left common salivary duct. These run forward a varying distance and then approach each other and unite in the middle line. This final duct formed of the four primary ducts runs forward beneath the œsophagus and enters the head where it opens into the pharynx.

In the suborder Amblycera the salivary organs appear to have no constant form characteristic of the subgroup. Grosse describes those of *Menopon titan* (plate xi, fig. 2) as consisting of a gland (*a*) and reservoir (*b*) on each side. The glands are elongate-oval, and each has a furrow on the inner side, from the middle

of which the duct arises. The reservoirs are long and club-shaped, having the ducts passing forward from the anterior ends. He describes also the glands of a *Lembothrium* as being composed of twenty small tubes situated upon the salivary duct like the teeth of a comb.

Nitzsch gives several figures showing the salivary glands. In *Menopon mesoleucum* two pairs of glands are shown of which the inner ones are very long and comparatively narrow. They extend in a straight course backwards along the sides of the alimentary canal as far as the rectal glands. In front they become narrowed and pass gradually into the ducts. External to each of these is a shorter gland. This one is also rather elongated and tapers in front and behind. The posterior end is coiled, while the anterior end passes into the duct. Grosse makes the general statement that the salivary organs consist of a salivary gland and a saliva reservoir, and that the latter are filled with a viscous substance.

In the Ischnocera the organs have a more definite shape, being much less variable among the different species. They consist of two pairs of glands and their ducts. Each pair lies on one side of the alimentary canal in the region of the anterior end of the crop and is composed of an outer, generally larger gland, and an inner, smaller one (plate xi, fig. 11, *r* and *g*). In *Trichodectes geomylis* (plate xi, fig. 1) the two are of about the same size. The inner one (*b*) has its long axis transverse and its larger end turned inwardly; while the outer is oval. The outer organ generally has the appearance of being a reservoir rather than a gland. Kramer studied the histology of the two and described the cells of the inner, smaller one as being remarkably distinct, while those of the outer he says are only with

the greatest difficulty made out to be cells. He found the outer organs mostly filled with fat-like drops.

Both Kramer and Grosse describe a second set of salivary glands found only in the Ischnocera. Kramer described those of *Lipeurus jejunus* as consisting of a group of fourteen cells attached to the smaller of the two glands just described. He could find no ducts connected with them, but, since they were always present and constant in position and arrangement, he still regarded them as having a saliva-secreting function. Grosse observed them in the genera *Nirmus*, *Trichodectes*, and *Lipeurus*. He found, however, that they occurred not only on the crop but also in groups of two, six, and eight, connected with the fat body. On this account, and since he also could discover no duct in connection with them, he concluded that their function as salivary organs was very doubtful.

In *Trichodectes geomydis* there can be no doubt of this glandular nature, for here ducts can be very easily observed. If the alimentary canal be removed from the body and transferred to a glass slide, two sets of large cells may be seen attached to the anterior end of the crop. Each set consists of seven cells, each provided with two large, internal bodies, apparently nuclei. The cells are polygonal and situated close together. By detaching the mass from the crop and floating it out in water it may be seen to be connected by a very distinct duct with the upper end of the neck of the crop, close to where it joins the œsophagus (plate xi, fig. 10, *g*). This is long enough to allow the glands to lie on the upper end of the crop. On passing the glands under a cover-glass the loosely united cells spread apart and there may be seen very clearly a ramification of the main duct passing to each one of them

(plate xi, figs. 3 and 4). It hence appears that in this species these cells form a compound gland of seven cells, each cell being provided with a duct of its own, the ducts of the several cells uniting and finally forming a common duct which opens into the alimentary canal at the mouth of the neck of the crop. In other Ischnoceran genera examined, including *Eurymetopus*, *Docophorus*, and *Goniodes*, these glands are present but the cells in each are more numerous. In *Eurymetopus taurus* (plate xi, fig. 5), each gland is composed of about twenty-four cells arranged mostly in two rows, although in some specimens, at the posterior end, they are three and four rows wide, so that the gland is posteriorly expanded. Each possesses two nuclear-like bodies, (one of these may be a hollow space into which the duct opens, such spaces being present in salivary cells of insects), and they are all closely pressed together so that they assume polygonal shapes. The presence of a duct is much more difficult to determine than in *Trichodectes geomydis*, but by removing the œsophagus and crop to a drop of water on a glass slide, as before, and pushing the glands away from the crop, they may be seen to be connected with the latter by a number of fine fibers. Upon focussing down on these with the microscope, one may be seen larger than the rest, possessing a double-bordered appearance characteristic of ducts when viewed with transmitted light. It is attached to the upper end of the crop at one extremity and at the other to the anterior end of the gland, where it divides close to the latter and becomes lost in the cells. By tearing the cells apart there may be seen attached to and ramifying between them, minute, delicate processes, apparently tubules.

A third set of glands opening into the anterior part



of the alimentary canal are those of the head, already described in connection with the oesophageal sclerite.

With regard to the salivary glands, then, not considering those glands of the head, the two suborders differ as follows: The Amblycera possess simply two pairs of salivary organs—a gland and reservoir on each side of the alimentary canal. These are of variable shape, since they may be simple and relatively small or very large, or they may be compound, consisting of as many as twenty separate, secreting tubules. The Ischnocera possess a pair of simple, small, only slightly variable, salivary organs on each side of the alimentary canal. These are evidently the homologs of the salivary organs of the other suborders, since their ducts unite with one another in the same manner, and since their general position is the same. In addition, they have a pair of small compound glands each element of which consists of a single cell provided with a separate ductule. The species of the Amblycera are specialized individually, those of the Ischnocera as a group.

*The Malpighian Tubules.*—In all cases known there are four and only four Malpighian tubules. They are simple tubes generally variously dilated near their bases. This dilatation may form a short oval enlargement of the vessels as in *Docophorus lari* (plate xi, fig. 8), or it may be long, and even occupy half the length of the tube as in *Menopon titan* (plate xi, fig. 13). These enlarged parts of the tubes are very variable in size, and according to the specimen may be present and large or entirely absent in the same species. In *Colpocephalum osborni* the basal parts of the two tubes on each side are united for a short distance (plate xi, fig 7). The vessels are generally very much convoluted and form a tangled mass of tubes about the lower part

of the alimentary canal. In others, however, they are straight. In *Menopon titan* they form V-shaped tubes with the bend forward and the inner arm joining the intestines. Each tube consists of an apparently structureless investing membrane (plate xi, fig. 6), of a single layer of large granular epithelium cells within this, and finally of a thin intima lining the epithelium. The lumen is narrow and irregular since the inner ends of the cells are angular, and a convexity on one side of the lumen fits into a concavity of the epithelium on the opposite side.

### III. THE RESPIRATORY SYSTEM.

The tracheæ are disposed in two main trunks, one on each side of the body, reaching from the posterior end of the abdomen into the head. Spiracles are situated laterally on the dorsal side of the abdominal segments, and in some species, as *Menopon titan*, there is a spiracle on each side of the prothorax (See Kellogg, 1896). A short branch connects each spiracle with the main longitudinal trunk of the same side. Opposite the union are given off several branches to the various organs of the body. In the head the lateral trunks end by dividing into numerous branches. No dilatation of the tracheæ occurs at any point. In *Menopon titan* a large transverse trunk connects the two lateral trunks in the fourth abdominal segment.

### IV. THE NERVOUS SYSTEM.

The nervous system consists of a brain and sub-oesophageal ganglion in the head and a large ganglion in each of the thoracic segments. From the two head

ganglia are given off branches to the mouth-parts and sense-organs. Each thoracic ganglion sends laterally a large branch to the corresponding legs. The last one gives off, in addition to these, branches that go backwards into the abdomen, supplying the organs there situated. In *Eurymetopus taurus* (plate xvi, fig. 7) the brain is large, much wider than long, and consists of two lobes united in the middle line. Each lobe expands greatly laterally. The posterior border of the brain is convex, notched in the middle line. The anterior border is very concave. The brain, therefore, presents from above the appearance of being composed of two large lateral masses connected in the middle line by a narrow commissure. From each anterior outer angle a trunk passes downward and backward to the anterior end of the subœsophageal ganglion. These form the circumœsophageal commissures, and from each a small trunk runs forward to a very large frontal ganglion situated in the median line between the anterior ends of the two cerebral lobes. The subœsophageal ganglion is larger than the brain and is situated in the lower part of the head beneath the œsophagus near the occipital margin. It is somewhat triangular in shape, with one side turned forward.

The brain and subœsophageal ganglion of *Menopontitan* (plate xvi, fig. 8) are very similar to those of *Eurymetopus taurus*. Dorsoventral longitudinal sections show that the brain is rather thick and that the lateral lobes are expanded posteriorly as well as laterally. The circumœsophageal commissures are inclined at an angle of about forty-five degrees. The frontal ganglion is smaller than in *Eurymetopus taurus* and is connected by a short trunk with the upper end of each circumœsophageal commissure. From it a branch runs forward to the labium. The

subœsophageal ganglion is oval in longitudinal sections. The peripheral part of each is composed of rather large cells. Fibers pass from the lower ganglion through the commissures to the outer anterior angles of the brain, where they radiate in all directions to the peripheral cells. Transverse sections of the brain of *Menopon* sp. (plate xii, figs. 1-4, *br*), followed from before backwards, show in front the small, disunited sections which farther back (fig. 1) become enlarged in an inner and ventral direction and connected with the subœsophageal ganglion (*sg*) by two short, straight trunks. The latter ganglion is very flat in front. Back of the commissures (fig. 2) the lobes of the brain enlarge and become ovoid in sections, with the large end turned inward. The subœsophageal ganglion is still flattened and slightly constricted in the middle. Sections passing through the eyes (fig. 3) show a narrow commissure passing over the pharynx connecting the previously separated cerebral lobes which are now oval in shape. The subœsophageal ganglion is still flat but slightly enlarged laterally. Still farther back (fig. 4) the transverse commissure of the brain has increased in thickness, and the subœsophageal ganglion greatly enlarged, especially laterally.

The three thoracic ganglia are large, situated close together, and each is generally larger than the one in front. In *Eurymetopus taurus* each ganglion is hexagonal viewed dorsoventrally (plate xvi, fig. 7), with two sides transverse, one in front and the other behind. The most posterior ganglion is large and joined to the mesothoracic ganglion by its anterior side. From the lateral angles, which are a little back of the middle, large trunks are given off to the legs, and from the posterior angles larger branches, one on each side, go backwards

into the abdomen. The mesothoracic ganglion is smaller than the last one, but, except that the lateral edges are more nearly equal, is very similar to it. Its anterior side joins the posterior side of the one in front, and from its lateral angles trunks arise that supply the mesothoracic legs. The prothoracic ganglion is more elongated than the others and the lateral angles are relatively farther back, but as before, the leg branches arise from them. There are no interganglionic commissures between the thoracic ganglia but the prothoracic ganglion is connected with the subœsophageal ganglion by two short, longitudinal trunks. In other forms the thoracic ganglia are a little more separated, but in all cases known, the nervous system is much concentrated and ganglia never occur in the abdomen. Longitudinal sections of *Menopon titan* (plate x, fig. 1) show that the thoracic ganglia ( $g_1$ ,  $g_2$ , and  $g_3$ ) are oval longitudinally and have an outer layer of large cells like those in the head. Transverse sections of *Menopon* sp. (plate xii, figs. 5-7) show that each ganglion ( $g_1$  and  $g_2$ ) is double and very large. In *Eurymetopus taurus* (plate xvi, fig. 7) each ganglion is supplied with tracheæ from a large, transverse commissure ( $t r$ ) passing transversely from one main, lateral, tracheal trunk to the other. Each of these transverse trunks is applied very closely to the posterior part of the corresponding ganglion, and gives off into the latter numerous ramifying branches.

#### V. THE DORSAL VESSEL.

The heart was first described by Wedl in 1855. Nitzsch says nothing about it. Kramer in 1869, briefly described that of *Lipeurus jejunus*. Grosse

adds little to the descriptions given by Wedl and Kramer. Wedl found that it could be studied successfully only in living animals. According to him the heart proper of *Menopon pallidum* is one-chambered and is situated in the next to the last abdominal segment just below the dorsal wall. The inner cavity is provided in front and behind with an opening. It consists of a molecular parenchymous part on each side, and a median membranous part. From the lateral, thickened part there arise ragged prolongations reminding one of the papillary muscles of the vertebrate heart, and which terminate in fine thread-like fibers attached to the median membranous walls of the heart. To the outer side of the parenchymous part are attached on each side a bundle of tense fibers, which may be termed the right and left suspensory fibers of the heart. The dorsal aorta has a swelling at its base forming a bulbus arteriosus. This has on each side a bundle of fibers, the right and left suspensory fibers of the bulbus arteriosus. Likewise at the opposite end of the heart is a swelling forming the bulbus venosus. This has two prolongations at its posterior end which appear to be inlet tubes allowing the entrance of the blood into the bulbus venosus. At the posterior end is a median row of fibers.

Kramer describes the heart of *Lipeurus jejunus* as a long narrow tube enlarged at its posterior end. Here are attached the very much reduced wing-muscles. Wedl does not mention these but very probably refers to them when he describes the "suspensory fibers". At the posterior end, according to Kramer, are four openings to admit the blood. Wedl states that the heart-beats amount to 112-120 per minute in specimens just taken from the living host, but sink to 56-52 in specimens taken from a host that has been dead a day or so.

He further describes the manner in which the different parts of the heart and aorta contract, and also gives an account of the methods he used in making his observations. Finally he states that he examined several representatives of the Philopteridæ, such as *Lipeurus variabilis*, *Goniodes colchici*, and *Docophorus atratus*, but apparently he determined merely that the heart is present in these forms.

## VI. THE REPRODUCTIVE ORGANS.

The reproductive organs of both the male and the female may be divided ontogenetically into (1) parts derived from the interior of the body, including the testes or ovaries, the vasa deferentia or oviducts, and the vesicula seminalis, ejaculatory duct or vagina and spermathæca; and (2) into parts derived from the exterior of the body, including a genital cavity in both sexes, and an eversible penis with variously developed accessory chitinous parts in the male. According to Nusbaum (1882) the embryological origin of the internal organs of *Lipeurus bacillus* and *Goniocotes hologaster* is as follows: The parts arise from four fundaments. Two of these are derived from the mesoderm and give rise to the testes or ovaries and the vasa deferentia or oviducts; the others are derived from the epiblast of the ventral side of the fourth abdominal segment, and give rise to the vesicula seminalis and ductus ejaculatorius of the male or the vagina and spermathæca of the female. The second pair subsequently unite forming the unpaired organs of the adult. The latter are hence strictly external since they originate from the epiblast of the embryo. For convenience of description, however, the parts are classified better as internal and

external genitalia, in which the terms *internal* and *external* are used relatively with regard to the adult structure.

### 1. THE MALE ORGANS.

*The Internal Male Genitalia.*—The testes are either six or four in number in adults, the former number being confined to the Amblycera and the latter to the Ischnocera. In the Amblycera they are variously-shaped organs lying in the lateral parts of the adominal cavity, three on each side, one in front of the other. Each opens by a short vas deferens into a common sperm duct. In the Ischnocera the testes are two in number on each side. They are generally pyriform, having the pointed ends turned away from each other and each terminated by one or two fine threads, and having the blunt ends approximated and connected by a short, narrow commissure from which the common vas deferens arises. The other internal reproductive organs of the male are essentially alike in the two suborders. The vas deferens on each side runs generally first backward from the testis and then turns forward to enter the sperm vesicle. The latter organ is usually single, but is composed of right and left lobes which in many cases are easily separated and which are sometimes normally disconnected. In all cases their lower ends open into a common ejaculatory duct. This goes to the exterior and may be either straight or variously bent. The two halves of the sperm vesicle when not entirely separated externally are essentially distinct, since each half possesses its own lumen, into which the vas deferens of the same side opens. Figure 4, then, may be taken to represent diagrammatically the typical condition of the internal male genitalia of the whole order. The figure as it is



represents more exactly the Amblyceran structure, but the Ischnoceran may be produced from it by suppressing one testis on each side and drawing the other two toward each other while their distal ends are turned in opposite directions. Nusbaum states that in *Lipeurus bacillus* and in *Goniocotes hologaster*, two Ischnoceran species, the fundamentals of the testes in the embryos form each three lobes, of which the posterior two develop into testes, while the anterior one atrophies. This anterior lobe, if it represents a third testis, establishes three on each side as the typical number of testes in the whole order.

In *Physostomum diffusum* (plate xiii, fig. 9) the testes are rather small. The most anterior is situated relatively rather far in front of the others, and is triangular in outline, having the base turned forward. Its posterior end becomes rather gradually narrowed, passing into the vas deferens. The middle and posterior testes are enlarged toward their bases and pointed at their distal ends. Each is connected with the vas deferens by a short vas efferens. The sperm duct runs a short distance back of the last testis and then turns forward to the seminal vesicle. This organ lies in the third abdominal segment. It is rather small, being about the length of the segment in which it is situated.

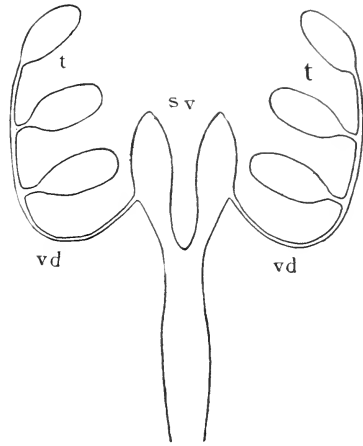


Fig. 4.—Diagram of the internal reproductive organs of the male Mallophaga; *t*, testes; *vd*, vasa deferentia; *sv*, vesicula seminalis.

It is bilobed, being divided by median dorsal and ventral furrows into a right and left half. Each half is again partially divided by a longitudinal furrow into two secondary lobes, the outer of which is thinner than the other. From the posterior end of the vesicle a wide, almost straight ejaculatory duct passes to the exterior. Its lower half is provided with a strong, transverse musculature. The vasa deferentia appear to open into the ejaculatory duct at a point above its middle. They, however, merely become attached to this duct here, since they run forward along its sides, closely bound to it, and enter the sperm vesicle.

The vesicula seminalis of *Trinoton luridum* is elongated antero-posteriorly, tapers anteriorly, and is enlarged and rounded posteriorly. From it the ejaculatory duct runs forward and to the left. Soon it makes an abrupt bend backward and toward the middle line again, where it enters a greatly enlarged and very muscular division which opens to the exterior.

The whole reproductive system of *Menopon titan* is very greatly modified by an extreme complication of the different parts. They are all essentially the same, however, as in other species, and the modification is mostly confined to the parts developed from the exterior and to the muscles attached to these parts. These will be described farther on. The main modification of the inner organs is a great increase in the length of the ductus ejaculatorius. The testes (plate xiii, fig. 10, *t*) are oval, elongated tubes situated along the sides of the body. The most anterior on each side is connected with the anterior end of the vas deferens of the same side. The second and third are connected with the same duct at points farther back by rather long vasa efferentia. The part of the vas deferens between the first

and second testes (beginning with the one in front) is longer than that between the second and third. The anterior end of each testis reaches some distance anterior to the posterior end of the one in front. Each vas deferens proceeds a short distance back of the last testis and then turns toward the median line of the body, the two are here connected by a transverse duct (*c d*) and enter the large mass of muscles surrounding the invaginated penis (this structure together with the muscles will be described under the head of the External Genitalia; see *postea*). They pass between the fibers and enter the cavity surrounded by them; turning then forward they run in this direction along the upper part of the cavity to the anterior end of the latter. Here they emerge from the muscles and go forward to the vesicula seminalis (*sv*), each entering the side of this organ toward the set of testes with which it is in connection.

The seminal vesicle is very large, composed of two only slightly united lobes. It is elongated antero-posteriorly, tapering at both ends, and connected with the ductus ejaculatorius at its posterior ends. The latter is, as stated, a very long tube, and is consequently very much coiled. It begins at the posterior completely united end of the vesicula seminalis as a rather wide tube. It runs backwards from here only a short distance and then makes a turn toward the median line, the seminal vesicle being situated a little to the left. Here it makes a small loop upon itself and then runs forward to near the anterior end of the seminal vesicle, which reaches forward into the metathorax, making during this course a second loop upon itself. At the anterior end of the vesicula it makes a sharp bend backward, dorsal to the vesicula, and runs in a straight

line to its posterior end, where it becomes narrower and turns toward the middle line. It reaches the transverse muscles of the penis and becomes here thrown into several loops, and then runs forward among the longitudinal muscles of the penis to the anterior end of the innermost (*int*) tube of the latter, with which it becomes continuous.

Nitzsch does not describe extensively the reproductive organs, merely giving a general description of them for the different suborders. He figures, however, the male organs of *Colpocephalum flavescens* and of *Menopon pallidum*. In the former (plate xiii, fig. 7) the six testes (*t*) are pear-shaped, situated with their broad ends upon the vasa deferentia (*vd*), with which they are connected by very short secondary ducts. Their pointed ends are terminated each by a short fiber. The vasa deferentia run backward and inward, uniting with the basal portion of the ductus ejaculatorius (*ej*) far from the vesicula seminalis (*sv*). The latter is somewhat elongated divided longitudinally to near its base by a median and two lateral grooves. The ejaculatory duct is very long. Immediately after leaving the vesicula seminalis it turns forward lateral of this organ and runs forward to some distance beyond its anterior end; the duct then turns backward and slightly inward, ending in a somewhat enlarged basal part to which is attached an internal chitin rod (*v*). In this form and in *Physostomum diffusum* the ductus ejaculatorius is very wide compared with this duct in *Menopon titan* and *Menopon pallidum*. In *Physostomum* it is provided with very prominent transverse muscle fibers.

In *Menopon pallidum*, as figured by Nitzsch, the testes are small, oval, and connected with the vasa deferentia by rather long ducts. The vasa deferentia are much

convoluted in the portion lying between the testes and their proximal ends. The vesicula seminalis is expanded and four-lobed at its distal end, two lobes being situated on each side of the median line. From each of the two inner lobes a short twisted blind tube runs forward. The posterior end is rather pointed and passes into the ejaculatory duct. This duct is long and narrow, and is thrown into numerous convolutions, which, however, all lie between the vesicula seminalis and the external genital opening. The vasa deferentia open into the base of the ductus ejaculatorius.

The following are examples of the male organs of the Ischnocera. In *Eurymetopus taurus* (plate xiii, fig. 8) the testes (*t*) are four in number, two on each side. Each is a small pear-shaped organ having the tapering end terminated by a fine thread. The two on each side are closely connected by a rather wide commissure. They lie in the lateral part of the body cavity in the third and fourth abdominal segments close to the dorsal wall, with their long axes in an antero-posterior direction. From the inner side of the commissure connecting the testicles the vas deferens (*vd*) arises. It is a narrow tube passing first backward and inward and then forward and inward till it reaches the seminal vesicle (*sv*). Each duct enters the base of this organ on its own side. The vesicula is much the same as in *Physostomum* and *Colpocephalum*, it being partially divided into a right and left lobe by a median furrow. Each half is then again divided by median dorsal and ventral furrows on its surface. The two middle lobes of the four thus produced project farther forward than the lateral ones. Near the posterior end of the organ the four furrows cease and the ductus ejaculatorius (*ej*) takes its origin from a very short, undivided portion.

The ductus is separated from the vesicula by a constriction just in front of which the vasa deferentia terminate. The ejaculatory duct is divided into a wide, anteriorly and outwardly running, proximal part, and a narrower, longer, and posteriorly running, distal part. The two meet in front at an acute angle. The proximal dilated part is well provided with transverse circular muscles; the distal portion is also provided with muscles but not so prominently as the other. The ductus opens into the penis, but this will be described under the next heading.

The testes (*t*) of *Goniodes cervinicornis* (plate xiii, fig. 3) are rather more elongated than those of the last species described, but otherwise very similar. Their larger ends are approximated, and connected by a commissure narrower and longer than in *Eurymetopus*. The vasa deferentia (*vd*) are simple tubes passing from the commissure backwards and then forwards to the seminal vesicle (*sv*). They enter the latter, however, far up, almost at the midlateral points. In this form the vesicle is completely divided to its base into a right and a left lobe. Each lobe is elongated, tapering in front and behind. It is enlarged in its anterior half, and joined a little below its middle point by the vas deferens of the same side. The two lobes are connected with the upper end of the ductus ejaculatorius, whose lumen is formed by the union of the cavities of the seminal vesicle. A short, backward-running, proximal part of the ductus is comparatively very narrow. It soon, however, enters on the right a greatly enlarged division of the duct, which extends anteriorly and to the right of the vesicula. It is longer than the latter, wide through the middle, and narrowed at each end. Anteriorly it gradually contracts into the comparatively

narrow, backward-running part of the duct. This proceeds to the penis, and in its course makes a bend to the left back of the seminal vesicle, then, after reaching the middle line of the body, goes straight to the exterior. The upper enlarged part of the duct is strongly muscular.

Nitzsch figures the male organs of two Ischnoceran species, *Goniocotes compar* and *Lipeurus jejunus*. In the former the pear-shaped testes abut closely upon each other by their large ends, and from between them the vas deferens passes by a convoluted course to the upper end of a posterior enlarged part of the ejaculatory duct. The latter is long and rather slender for most of its length. It makes a large bend forward as in the other species described, the inner arm of the loop likewise is considerably dilated; but a narrow neck intervenes between this part and the vesicula. The latter is partially divided anteriorly into two lobes.

Kramer (1869) describes very fully the male reproductive organs of *Lipeurus jejunus*. According to him the two testes on each side are acorn-shaped, having their pointed ends terminating in a fine-branched fiber. They are formed by a continuation of the outer homogeneous covering of the testes. Just where they leave the testes they contain three or four nucleated cells beyond which they become solid threads. Each divides into two main branches which are attached to the dorsal tube, but also by side branches to the Malpighian vessels and to other organs, so that they are simply members of the connective fibers that bind all the organs together. The slender vas deferens arises from the united larger ends of the testes. It consists of an outer structureless covering and an inner cellular epithelium. He describes the vesicula seminalis as an

accessory secreting gland, stating that the vasa deferentia enter it and continue through it as an integral part, and then pass out as its duct forming the ductus ejaculatorius. Exception to this view will be taken farther on. According to Kramer the vesicula consists of a rather long duct and of the gland proper, the former widening itself suddenly into the latter. The walls of the duct are composed of several superimposed parts; surrounding all is a loose mass of fibers which are partly nerves and partly connective threads. Within this is a fine structureless coat only here and there provided with distinct nuclei, which is continuous over the whole gland. Below this is a thick coat of cells in several layers. Lining the duct is a two-layered intima; where the duct passes into the gland the two layers diverge, the outer passing over the outside of the gland just beneath the outermost structureless membrane of the duct, which, as stated, passes over the whole gland also, and the inner continuing into the cavities of the gland as their intima. The cells of the cellular layer of the duct are contractile and appear to be muscle-cells corresponding with the muscular cells of the œsophagus and crop. At the lower end of the gland the vasa deferentia penetrate the two outer membranes and run forward beneath a series of wide cell-like plates, with which, however, they do not unite. They proceed forward thus, surrounded by the plates as by a sheath, along the middle of the flat surface of the gland to near its upper end, where they first enter its interior and then within traverse again its whole length. Within the gland they are surrounded by its secreting cells; at its lower end they unite to form the ductus ejaculatorius. It is to be noted that the muscle-cell layer of the duct continues for only a short distance



over the base of the gland, the latter being situated within the cells as a flower in its calyx. Kramer further describes the penis and its muscles, and also the origin of the sperm and formation of the spermatophores.

Transverse sections through the testes of *Menopon titan* show that each is surrounded by a structureless outer tunica. Within this is an epithelium of high narrow cells projecting irregularly with ragged edges into the lumen of the organ. They are all more or less curved and together present somewhat the appearance of an iris diaphragm (plate xiii, fig. 1). An intima is apparently absent. The lumen of the testes is not very large and is filled, in prepared specimens, with a granular substance which is probably a coagulated fluid. The vasa deferentia have an outer tunica resembling that of the testes, within this a single-layered cellular epithelium. The cells are much smaller and relatively a great deal shorter than those of the testes (plate xiii, fig. 2). The lumen is small and lined by a thin structureless intima covering the inner ends of the epithelium cells. The seminal vesicle is composed of the same elements as the vasa deferentia. The epithelium cells are columnar but comparatively short (plate xiii, figs. 5 and 6). The lumen on the other hand is very large and filled with an apparently coagulated (in mounted specimens) non-cellular substance. The organ in sections is clearly seen to be a double structure, for the two halves are almost entirely separate. The two cavities communicate only through the upper end of the ejaculatory duct. The main connection between the two lobes is by an apparently outer layer of the tunica, which in the groove between the two sides passes across from one to the other, and an inner layer continuing around its respective lobe. In some places,

however, in the basal half of the organ, the inner layers of the tunicas are absent and the opposing cells fused. The ejaculatory duct (plate xiii, fig. 4) has the same structure as the seminal vesicle and vasa deferentia. Outside of its tunica, however, is a layer of circular muscle fibers. These continue a short distance over the base of the seminal vesicle (plate xiii, fig. 5) and unite the lower ends of its lobes more firmly, but they soon cease.

From the preceding descriptions it is evident that figure 4, on page 177, represents the typical development of the internal genital organs of the males for the whole order. The only constant difference between the two orders in respect to these organs is the number and relative position of the testes. The latter organs have no constant form in the Amblycera although the variation is small, while on the other hand, in the Ischnocera the form is almost entirely constant. Thus, with respect to the sperm glands, as was found to be the case also with the salivary glands, the Ischnocera are specialized as a group, while the Amblycera are specialized among themselves on a less evolved type.

It now remains to consider the nature of the structure referred to as the vesicula seminalis. As stated, Kramer regarded it as an accessory gland, but he did not show what its function as a gland is. He found, further, that the spermatophores are not formed in the male ducts, but in the female spermathæca. That it is composed of united right and left organs is very evident. This is indicated by the fact that it is actually entirely divided into two lateral lobes in at least one form, and in others it is more or less deeply cleft, while in none known is it without a median groove. Further, according to Nusbaum (1882), it actually

arises from two separated fundaments in the embryo, which subsequently unite. Kramer states that since the secreting cells are arranged around two tubes, the vasa deferentia, the organ has the appearance of being composed of two closely united glands, and that a separating wall is actually present. Grosse (1885) disagrees with Kramer and regards the structure as consisting of two bladder-like enlargements of the ductus ejaculatorius, which serve to retain the spermatozoa as they come from the testes until sent to the exterior by the contraction of the vesicle. According to him, accumulations of spermatozoa are to be found in the upper part of the organ. He states also that a secreting power cannot be denied to the cells forming the wall. The walls are thick and have a glandular appearance, but, other than this, proof of their secreting function appears to be absent.

The embryological investigations of Nusbaum, if correct, show clearly the relation of the vesicula seminalis to the adjacent parts. As has been shown, the vesicula generally presents a four-lobed appearance, being divided by three longitudinal constrictions of which the median one is the most constant and the best marked. According to Nusbaum the vasa deferentia unite with the fundaments of the reproductive organs derived from the epiblast. The latter then become each produced into two lobes at their anterior ends before they fuse with each other. Then, when they unite, there is produced a structure having a four-lobed anterior end to which the vasa deferentia are attached, and an undivided posterior part. The former becomes the vesicula seminalis and the latter by elongation the ductus ejaculatorius.

*The External Male Genitalia.*—The outer accessory structures connected with the inner reproductive organs have never been very carefully studied. Nitzsch (1818), Piaget (1880, 1885), and Taschenberg (1882) described them mostly as they appeared through the body-wall. Piaget made a few dissections. The external organs consist of two parts: (1) a simple or compound invagination of the body-wall of the last abdominal segment, and (2) chitinous parts developed in the walls of the invagination. In addition, however, there are muscles attached to these parts, situated within the body, and which are very important and sometimes very complicated adjuncts of the copulatory organs. The following descriptions represent all the genera of which males could be obtained.

**Eurymetopus taurus** (Plate XIV, fig. 5, plate XV, fig. 1).

The male has nine abdominal segments. The last tergum is very much narrowed from side to side, forming a triangular terminal dorsal plate with the apex, which is a little invaginated, projecting backwards. The sternum of the last segment, on the other hand, is much enlarged, projecting much beyond the corresponding tergum both posteriorly and laterally as a large plate with slightly upcurved lateral edges. Above this plate the top of the copulatory organ may be seen projecting a little beyond the end of the tergum. By separating these two plates a terminal cavity of the abdomen is exposed, having the chitinous penis lying along the middle line of its floor, and the anus opening into the upper posterior part. This space will be spoken of as the *genital cavity*, since it is evidently formed to accommodate the reproductive function, and since it contains the external part of the copulatory

organ. The opening of the alimentary canal into it is apparently a secondary result, since the anus is terminal and exposed in the female when the genital cavity is in front of the last sternum.

Longitudinal sections through the male show that the genital cavity is formed by a wide invagination of the hind end of the abdomen (plate xv, fig. 1). The cavity is almost as wide as the body itself, and extends from the posterior border of the last segment far into the eighth. In its upper wall near the posterior margin is the anal opening (*a*). From its inner end an evagination of much smaller diameter than the primary invagination takes place, forming a long, rather slender, distally tapering tube in whose walls a thick deposit of chitin is present. This is the penis (*p*). From its base a large, wide chitinous plate extends forward *within* the body-cavity (*pl*). The part of the penis lying within the genital cavity will be spoken of as the *external* part of the penis, and the plate extending forward within the body cavity as the *internal* part. It is to be noted, however, that the plate is strictly external, since it is simply a part of the chitinous covering of the body, and that it is internal only in the sense that an inward-running process of the body-wall is internal. The genital chamber reaches much farther forward below the penis than above it. At the point where the internal and external parts of the penis are continuous, the ductus ejaculatorius (*ej*) enters into the evagination of which the outer part is formed, and opens by a terminal orifice to the exterior. The internal plate extends forward beneath the ductus ejaculatorius and close to the ventral wall of the body to the anterior border of the second abdominal segment. To it the muscles (*em*) of the penis are attached.

The penis (plate xiv, fig. 5) as a whole is a dorsoventrally flattened structure. Its anterior three-fourths is wide, forming the internal plate, while the posterior one-fourth is wide at its base but rapidly tapers beyond this. The posterior fourth is the external part formed by the chitinous thickening of the evagination described. Where the two meet, a large, square area is taken out of the penis. The margins at the side of and behind this are very thick. From the former arise two wide processes, one on each side, which rapidly contract and curve dorsally and inwards, almost meeting each other in the middle line. In front of these, two other processes arise from the anterior margin of the non-chitinated space, as two backward prolongations from the inner edges of the thickened lateral margins of the plate in front. They extend backward, outward, and slightly ventrally, terminating beyond the posterior edges of the lateral processes, and almost reaching across the unchitinated space. They are narrower than the lateral processes and taper but slightly. From the posterior thickened margin of the unchitinated area a third pair of processes arises. These are short, rapidly tapering, and continuous with the ventral edge of the transverse part behind the unchitinated area, this part being, as before stated, tubular. These processes lie close together, each just to one side of the median line. Their inner edges are slightly divergent and their outer edges strongly convergent and concave. Their tips reach about as far forward as the posterior ends of the processes in front. There are thus six processes—two in front, two behind, and one on each side—arching over the unchitinated space of the chitinous penis. They surround the terminal portion of the ejaculatory duct, since the latter passes beneath the arch formed by the dorsal processes on its way to the external tubular

part of the penis. The several processes serve, however, partly for the attachment of muscles. The anterior half of the internal plate is comparatively very thin and tapers to a blunt termination in front. Back of the middle, also, the plate contracts somewhat toward its base. The external penis has a large, thick, basal part, which rapidly contracts to a slender, tubular, distal part, terminating by an arrowhead-shaped enlargement, the posterior angles of which are very sharp. This terminal tube curves downward a little toward its tip (plate xv, fig. 1), where its inner cavity opens to the exterior.

To the anterior end of the chitinous penis on its ventral side are attached two wide sets of muscle fibers. These pass backward, outward, and a little ventrally to the ventral wall of the abdomen. Each set is parallel-sided and arises from the penis just to one side of the middle line, and as the two diverge backwards they form only a very small angle with each other. To the other end of the penis are attached four sets of muscles, two dorsal and one on each side. Each lateral bundle is attached to one side of the enlarged subterminal part of the penis. It passes forward and outward, forming an angle of about  $45^{\circ}$  with the penis, to the lateral wall of the body-cavity. The dorsal muscles are near the middle line, and extend anteriorly, outward, and dorsally. These posterior sets are shorter than the anterior ones, ending on the body walls in the fourth and fifth segments.

The mechanism of the chitinous parts, invaginated tube, and muscles is self-apparent. The anterior muscles contracting push the chitinous penis backward, and it carries outward the partly evaginated inner tube of the genital cavity, the flexible walls of which become

erected. In this way the external part of the penis can be protruded from the genital cavity, which during the operation becomes itself more or less erected. The posterior sets of muscles contracting reverse these movements, resulting in a withdrawal of the penis into the genital chamber.

***Docophorus lari*** (Plate XIV, fig. 8).

The chitinous genitalia in this species consist of a large, thin, flat chitinous plate situated within the abdomen close to the ventral wall, and an external, conical tube with two articulated lateral arms. The plate is rather short, being less than twice as long as wide. Its greatest breadth is near its posterior end; it tapers somewhat forward but has a wide rounded anterior termination. The external part is tubular and represents an inner tube evaginated from the anterior end of the genital cavity. Its walls are very thick and entirely chitinous. In general shape it is, as stated, conical, having the internal plate passing forward from the ventral part of the anterior end. Its lateral outlines are slightly convex. Posteriorly it terminates in a slender median prolongation, at the extremity of which is the external genital opening. Into the anterior end of this part, dorsal to the internal plate, the ductus ejaculatorius enters. Five processes surround the slender, parallel-sided terminal tube. Two of them are dorsal, two lateral—one on each side, and one ventral. The latter is triangular in shape, rather elongated antero-posteriorly, and has the more pointed apex pointed backwards in the median line. The dorsal processes are much longer than the ventral one. Each is a flat plate reaching almost to the posterior end of the central tube. It expands toward its middle and then tapers off again



beyond this point. The approximated edges are straight and lie each just to one side of the middle line, while the outer edges are very angularly convex. The lateral processes are short and thick, somewhat hook-shaped, with the ends turned outward. They reach a little beyond the ventral plate.

Two long curved rods are attached externally to the lateral aspects of the base of the outer part of the penis. Their anterior ends, by which they are movably articulated, are considerably enlarged. Each is curved throughout its length, so that the outer margin is convex and the tips, which extend a little farther backward than the median parts, converge. The part of the penis between these processes is very strongly chitinous. The lateral margins of the internal plate are much more strongly chitinized than the median part, so that in a cleared and mounted specimen the former alone show through the body wall. Consequently there is the appearance of an internal pair of rods extending forward from the bases of the external pair; and in many of the figures of Nitzsch, Piaget, and Taschenberg the chitinous genitalia of the males are represented as if this were the case. The plates serve, as in *Eurymetopus taurus*, for the attachment of muscles. One specimen was found with the penis protruded. The lateral external rods were turned forward, over the back of the insect, so that the median conical part was left projecting backward and upward alone. It is not very clear what the function of the rods is, since there are numerous forms, as will be shown, in which they are absent. The turned-forward position is probably not abnormal, since they were found thus in several specimens of other species, and some of the drawings of Piaget show them the same. They have the appearance

of acting as a guard to the penis, or they may also serve as levers to prevent the latter from being pushed back into the genital cavity. The penis, however, is otherwise very much the same as in those forms where movable rods are absent.

### **Nirmus pacificus.**

The penis is very similar to that of *Docophorus lari*. The internal part is a wide plate which tapers slightly forward and ends anteriorly with a wide rounded outline. The proximal half of each lateral margin is slightly convex and very thickly chitinized, so that the two give the appearance of a pair of curved prongs reaching forward into the body cavity, since the median part of the plate is comparatively very thin and transparent. Between the internal plate and the outer parts is a thickened portion common to both. The external penis consists of two lateral curved rods articulated to the base of the median external part. When the penis is retracted within the genital chamber, these two rods extend backward with their tips approximated and their concave edges turned toward each other. When, however, the penis is protruded, the rods turn forward over the back of the insect and become rotated outwards, so that their convex edges are toward each other and their tips divergent. The median external part is prolonged terminally into a slender, tapering, chitinous tube, which appears to bear at its end the genital opening. Surrounding this are five processes which arise near its base and are much the same as those of *Docophorus lari*. On the dorsal side is a pair of rather long slender plates, on the ventral side a slender median rod, and on each side a rather large, outward-turned process reaching a little beyond the extremity of

the ventral rod. Ventrad of these last are two small cusps. The dorsal laminae are much longer than the others, but the central tube projects a little beyond them. The last abdominal sternum is a wide, rounded plate which projects backwards so as to lie beneath the penis when this organ is protruded.

**Giebelia mirabilis.** (Plate XIV, fig. 4).

In this species the penis consists of the same parts as the two last described, there being present an internal plate, an external conical median part, and two lateral processes. The plate is wide and comparatively very short, its length being only a little greater than its breadth. It lies within the body close to the ventral wall, and to its dorsal surface muscles are attached. The sides are a little concave, its anterior border straight with corners rounded. The lateral basal parts are thicker than the rest. The external intromittent part of the penis is short, wide, with convex lateral edges, rapidly contracting distally, and ending in the middle line with a short, narrower prolongation. This is not entirely chitinized as in the other forms described for its distal half is almost membranous. At the base of the internal plate on its dorsal side the ductus ejaculatorius enters the external penis. The two lateral processes are short and thick, each being only a little longer than half the internal plate. They are curved, having the convex edges turned outward. They converge posteriorly but the tips are turned straight backwards forming an angle with the rest, so that the terminal parts lie parallel with each other. Their bases are enlarged and movably articulated to the rest of the penis as in the other forms described. The articulation is the same as that

between the segments of the body and the joints of the legs; i. e., the parts are continuous but non-chitinized where the articulation occurs.

**Goniodes cervinicornis.** (Plate XIV, fig. 2).

The penis can be protruded for a distance about equal to three segments of the abdomen. The outer part consists of a delicate membranous tube evaginated from the inner end of the genital chamber. It is protected by three chitinous processes arising from a circular chitinization surrounding the base of the membranous penis. Two of the processes are lateral, long, slender, tapering, and somewhat convergent, with the outer edges convex and the inner concave. The third is ventral and median. It is a narrow chitinous rod having the distal end triangularly expanded, terminating some distance in front of the posterior ends of the lateral processes. These parts are free from the wall of the membranous penis but closely surround it. Lying within the dorsal wall of the latter is a thin, wide, chitinous plate arising also from the circular chitinous base of the penis. It is shorter than the ventral process, and has its edges a little concave. From the anterior ventral margin of the basal part of the external penis a large, thin, parallel-sided, chitinous plate, having a rounded anterior edge and slightly concave lateral edges, arises and passes forward within the body-cavity, giving attachment to protrusor and retractor muscles. It lies close to the ventral wall of the body-cavity, and at its base the ejaculatory duct enters the external penis. The opening into the latter is overhung by a wide tapering plate. The membranous penis extends beyond the ends of all the chitinous parts. When the chitinous structure is pushed outwards the outer processes

and the common chitinous base are entirely exposed. It is to be noted that in this species the lateral processes of the external penis are not, as in *Docophorus*, *Nirmus*, and *Giebelia*, movably articulated to the base, and also that the median part is much less extensively chitinized.

***Lipeurus fuliginosus major*.** (Plate XIV, fig. 1).

In this species the chitinous genital parts form a fork-shaped structure. A long, narrow plate lies within the body, representing the handle, while the external part consists of two prongs. The internal plate is comparatively much narrower than in any of the species so far described. It is a little contracted from side to side toward its base. Distally it gradually tapers to a blunt termination. Its posterior end expands suddenly and becomes bifid. Each arm is very short and extends backwards and outward, forming an angle of about  $45^{\circ}$  with the plate. The posterior borders of the two form a concavely rounded edge to their end of the plate. Attached to the posterior end of each of these prongs is a lengthened knife-like piece which extends backwards into the genital cavity. The two are dissimilar. The one on the left is larger, being both longer and wider, but they differ in still other respects. The left one has its outer edge convex proximally and concave distally; the inner edge of the same shows similar curves but in opposite order. The end tapers down to a point directed somewhat outwards. The outer edge of the right smaller prong has an outline corresponding with that of the inner edge of the left prong. That is, it is concave toward its base and convex toward its tip. The inner edge is convex at the middle, decidedly concave proximally and slightly so distally. Hence its point is

turned inward—relatively opposite to that of the left prong.

The bifid posterior end of the internal plate is imbedded in the base of the chitinous penis. The outer prongs are attached to the arms of the bifurcation in a manner much different from that in other forms. The base of each prong is a little expanded and bears two tapering processes projecting inwardly and anteriorly, one lying dorsal to the other. The dorsal process is the larger; it is curved so that the posterior margin is concave and the anterior convex. The tips of the dorsal processes of the two sides are directed toward and lie close to each other. Each is connected by a delicate dorsoventrally flattened chitinous bar, which passes outward to the arm on the same side of the bifid base of the internal plate, and fuses with it very near its posterior ends. The ventral process is smaller than the dorsal one; its posterior edge is convex and its anterior edge concave. The end of each arm of the plate abuts upon the corresponding prong between the bases of the two processes of the latter, the transverse slender bar of chitin serving to connect the two otherwise separated parts. Lying in the dorsal wall of the membranous penis is a thin chitinous plate. It extends from near the bases of the lateral prongs to a short distance from the distal end of the smaller one. It also is symmetrical. The right edge is about straight and distinctly marked; it lies nearer the side of the penis than does the left edge, so that the plate is not median. The left edge is much less sharply defined and extends obliquely from the left side of the base of the penis posteriorly and toward the middle line. To the dorsal side of the internal plate is attached a large mass of muscle fibers, and on the same side of the plate the ductus ejaculatorius enters the penis.

**Oncophorus bisetosus californicus.**

There is nothing in the genitalia of this form different from those already described. The chitinous parts consist of a rather wide internal plate with thickened margins and transparent central part, and of an outer median tapering chitinous intromittent organ with articulated lateral processes. Piaget figures *Oncophorus unguiculatus* in which the genitalia are apparently the same as in the form just described.

**Goniocotes creber.** (Plate XIV, fig. 9).

In this form the chitinous genitalia are extremely reduced. Within the body is a long narrow plate reaching almost to the anterior end of the abdomen. It is very thin and transparent except laterally, where it is weakly chitinized, giving the appearance of two long, very delicate, slightly curved rods lying within the body. Each of these is continuous externally in the wall of the penis. Their outer parts are more chitinized, the tips sharp and convergent. Muscles are attached to the internal part. Piaget figures several species of *Goniocotes* in which the chitinous genital parts are about the same as in *G. creber*, consisting of an internal plate with external prongs. In some the plate is evidently more chitinized than in this form.

The species whose genitalia have been described are all Ischnoceran forms; the following belong to the Amblycera and it will be seen that the genitalia are more simple than in the others, though essentially the same.

**Trinoton luridum.** (Plate XIV, fig. 7).

A genital chamber is present with a membranous penis arising from its inner end. The chitinous parts consist of a long, slender, tapering rod running forward

within the body cavity from the base of the penis. Its posterior end is expanded and bifid, the prongs being external and imbedded in the wall of the penis. They extend posteriorly and a little outwards, each being a little longer than half the length of the internal rod. Each prong ends bluntly posteriorly, but some distance in front of its posterior end it gives off a process wide at its base but soon narrowing very much, which runs dorsally a short distance and then turns posteriorly, extending in this direction parallel with the main prong from which it arises past the posterior end of the latter, and then turns inward to meet and fuse with the corresponding process of the other side. This median part is very weakly chitinized. The arc thus formed lies in the dorsal wall of the membranous penis, while the two prongs are lateral. The penis extends some distance beyond all the chitinous parts. The ductus ejaculatorius enters it above the internal rod, which latter serves for the attachment of muscles. The intromittent organ in this form, then, consists of a membranous tube evaginated from the inner end of the genital chamber, in whose walls chitinous rods are developed which unite anteriorly to the ventral wall of the tube and send forward a chitinous rod into the body cavity.

**Colpocephalum osborni.** (Plate XIV, fig. 6).

The genitalia of this species are very similar to those of *Trinoton luridum* just described. The only difference is that the processes arising from near the posterior ends of the prongs of the fork-shaped structure do not meet each other. In addition to these, however, there is present in the dorsal wall of the membranous penis a chitinous arrowhead-shaped plate, which reaches about half way to the ends of the lateral prongs and is



connected with the latter by wings from its base, which reach the prongs a short distance back of their divergence. There are also developed in the walls of the penis numerous small, granular chitinizations.

**Physostomum diffusum.** (Plate XIV, fig. 3).

The chitinous genital parts of this species are very simple. There are present in the walls of the penis two diverging lateral rods which meet in front. Here they send forward into the body cavity a very small rod, it being about a third of the length of each outer prong, to which muscle fibers are attached. The posterior ends of the prongs are connected by a transverse, angular bar.

**Menopon mesoleucum.** (Plate XIV, fig. 10).

A long, rather thick internal rod is present. This arises from the united anterior ends of two thick bars in the walls of the penis. These bars are very short and do not nearly reach the end of the penis. To the end of each is articulated a longer tapering rod free from the penis and reaching to its posterior end. These have the appearance of being homologs of the articulated lateral prongs in some of the Ischnoceran forms.

RÉSUMÉ.

From the preceding descriptions it is clear that the outer genitalia of the male may be generalized as follows. The posterior end of the last abdominal segment is invaginated to a varying extent, forming a genital chamber surrounded by the walls of the body, possessing a chitinous lining continuous with the body-wall, and opening posteriorly to the exterior. Into its anterior end the ductus ejaculatorius opens, and the

part in which the operation occurs is carried backward

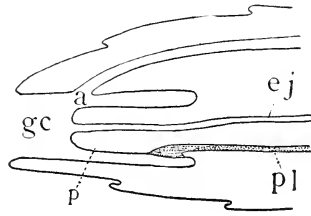
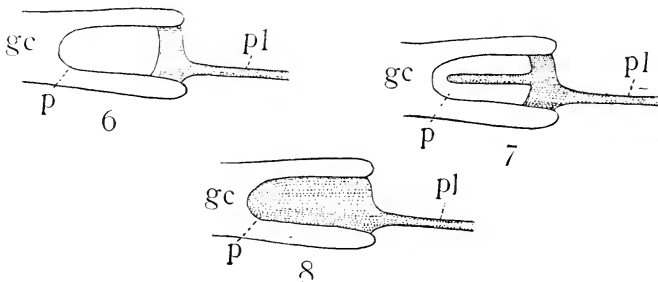


Fig. 5.—Diagram of external genitalia of male Mallophaga; *a*, anus; *gc*, genital chamber; *ej*, ejaculatory duct; *p*, penis; *pl*, internal plate arising from chitinous thickening in base of penis.

as an invagination forming an internal tube arising from the anterior wall of the genital chamber. This tube is the penis. Figure 5 represents diagrammatically what has just been described. It is evident that if the inner walls of the genital chamber are flexible the penis could be entirely protruded from the cavity containing it. Specimens killed in alcohol are often found with the penis projecting in this manner. The anal segment is lacking, so that the rectum opens into the genital chamber.

The chitinous genitalia are formed as chitinizations in the walls of the inner tube. The object of this is double, (1) to strengthen the walls of the penis, (2) to give attachment to muscles for protruding and retracting the penis. The latter function is apparently the more important, since a contrivance for its accommodation is never absent, while chitinous parts strengthening the penis are in some cases very slightly developed and in a few, such as in *Menopon titan*, yet to be described, and in some species of *Colpocephalum*, are entirely absent. The structure which gives attachment to the muscles is always of the form of a chitinous prolongation into the body cavity from a chitinization in

the ventral part of the base of the penis. It may, therefore, be represented as in figure 5, *pl*. This internal structure may be short or long and either narrow or broad, but it is always essentially the same and lies ventral to the ductus ejaculatorius. The external parts are developed as various degrees of chitinization radiating through the walls of the penis from the ventral basal chitinous deposit. The simplest and most usual form consists of a rod given off backward on each side (fig. 6) such as in *Menopon mesoleucum*, *Trinoton luridum*, *Colpocephalum osborni*, and others.



Figs. 6-8.—Diagram showing successive degrees of chitinization in walls of penis; *p*, penis; *gc*, genital chambers; *pl*, internal plate.

Secondary processes may be developed from these. In others the basal chitin may completely surround the penis (fig. 7) and, besides lateral processes, may give off dorsal and ventral ones as in *Goniodes cervinicornis*. Further, this circular basal chitinization may extend continuously backward (fig. 8) and transform the penis into a chitinous tube, as in *Docophorus lari* and in *Eurymetopus taurus*. Independent chitinizations may also be developed in the penis, taking the form of plates and granulations in its walls, as in *Lipeurus fuliginosus major*. It cannot be stated whether the articulated lateral processes are homologous with the non-articulated

lateral pieces or not—embryology must decide this. However, since the two are not known to be present in the same form, and since in *Goniodes cervinicornis*, at least there are non-articulated processes free from the lateral walls of the penis, it might be inferred that the two may be homologous.

Comparison shows that the simplest forms of external genitalia occur in the Amblycera, and that in none of these are the parts much complicated. On the other hand, the genitalia in nearly all the Ischnocera are very much more developed, and are characterized by a much wider spreading of the chitin in the walls of the penis, and of a relatively much larger development of the internal process. The condition of the external reproductive organs in the two suborders hence agrees with that of the internal organs, for it was before shown that the latter are the more specialized in the Ischnocera.

The structure of the intromittent apparatus of *Menopon titan* will now be described (plate xiii, fig. 10, and plate xv, figs. 2-5). It is so very highly developed and so complicated, being much more so than in any other form known, that it is more easily understood after a study of the more typical structure found in other species. Grosse has described it but apparently not very correctly. He says that the last abdominal segment of the male is invaginated and runs forward in the body to the border of the last and penultimate segments, and then goes again backwards in order to continue anew anteriorly, tube-like, to the sixth segment. Surrounding this are transverse muscles, and attached to its anterior end longitudinal muscles. He next states that within the invaginated segment is a tube open at both ends, which anteriorly passes into a gradually decreasing

chitinous rod reaching to the third abdominal segment, and that within this tube is still another which continues anteriorly into a whip-lash beset with numerous spines or bristles. It is rather hard to imagine how structures such as these could exist in the manner described; and dissected specimens, entire specimens cleared with *Eau de Labarraque* and stained, and sections cut in longitudinal and transverse directions, indicate that Grosse's description is not entirely correct. The structure of the various parts which Grosse has mentioned is apparently as described in the following account.

When the abdomen of the male is opened from above there is to be seen in it, lying along the middle line and ventral to the alimentary canal, a large, compact mass of muscles reaching from the last segment into the fourth. The posterior three-fourths of this mass is composed of transverse fibers, and the anterior one-fourth of longitudinal fibers which converge to a point in the fourth segment. This structure forms the most prominent organ in the abdomen and is easily taken entire from the body by detaching it from the body-wall at the posterior end. Under a low-power lens it can easily be seen that the transverse muscles of the posterior three-fourths are much curved, but are a little less than semicircular. Their dorsal ends are attached to a vertical sheet of membrane which extends down between them from above as a fold from a thin membrane surrounding the whole mass. Their lower ends are attached to a thin, transverse, ventral plate. By dissecting the fibers apart it is found that they, together with the ventral plate to which their lower ends are attached, surround a cylindrical cavity. Within this is a thin-walled, membranous tube open in front. This

latter contains a second thicker and more chitinous tube and a chitin rod. The rod arises posteriorly from the inner tube. Between the outer tube and the muscles on the dorsal side of the former lie the forward-running parts of the vasa deferentia. These enter the muscles posteriorly and then pass into the upper part of the cavity within them, run forward to the anterior end of this, and then emerge to join soon the seminal vesicle. The inner tube and rod pass forward some distance beyond the anterior end of the outer tube, and the former is thrown into several convolutions which vary in different specimens. The anterior longitudinal muscles arise from the anterior end of the mass of transverse muscles and converge upon the tip of the chitin rod. From these a small band of fibers continues into the thorax, where it is attached to the floor of the metathorax in the middle line. The transverse muscles, when detached from the ventral plate, but left with their upper ends still joined to the vertical membrane, have very much the appearance of a bunch of fire-crackers, the fold of membrane representing the axial fuse.

The inner tube on account of its being more strongly chitinous than the other appears dark, while the outer is transparent. The interior of the inner tube is beset with numerous chitinous projections. In the posterior part these are of the form of small conical processes closely distributed over the walls. Somewhat farther forward they increase in length and form sharp backward-pointing teeth. Still farther in front they become much more elongated, and anterior to these they take the form of large backward-projecting, spike-shaped appendages having sharp points, and they almost obstruct the lumen of the tube. Beyond these a decrease in size of the processes takes place, and in the walls of the

anterior part of the tube they are entirely lacking, the tube being here transparent. Beginning at the posterior end the tube runs straight forward to near the anterior end of the transverse muscles. In the longitudinal muscles it becomes folded and a loop may project from the latter. It is here of greatest diameter. It becomes narrowed in the part that has no internal processes and gradually passes into the comparatively narrow ejaculatory duct. To its posterior end the chitin rod is attached. This is circular in transverse sections, rather long since it reaches into the fourth segment, and tapering anteriorly. It is curved, having the convexity to the right and dorsally.

The relationships of these different parts is very clearly shown by transverse and longitudinal sections (plate xv, figs. 2-5). The posterior end of the last (the ninth) abdominal segment is deeply invaginated, the invagination running forward into the fifth segment. The walls of the tube thus formed (plate xv, figs. 2, 3, 4, 4<sub>1</sub>) are very thin and transparent, being entirely non-chitinized. In the anterior part of the sixth segment, however, they begin to increase in thickness and continue to become thicker from here forward to their anterior ends in the fifth segment. Here they turn away from the axis of the tube they form and then curve backwards a short distance. Then they become thin again and turn sharply forward and inward, closely following the inner face of the first bend. This is the beginning of an evagination which extends backwards almost to the beginning of the first. The walls of this are likewise very thin and transparent, and are closely applied, except posteriorly, to the inner surface of the first tube. There is thus formed a double-walled tube open in front and having a recurved anterior edge.

This is the outer of the two tubular structures to be observed by dissection alone and it is surrounded by the transverse muscle-fibers (plate xv, figs. 2, 3, 4,  $t_1$  and  $t_2$ ). This is probably what Grosse referred to as a tube open at both ends.

In the anterior part of the eighth segment the walls of the inner tube diverge from those of the outer one, leaving a free space between them connected with the exterior. A short distance back of where the two diverge the walls of the inner tube are bent backward and then again forward, forming a free cylindrical fold projecting backward. This extends posteriorly to the middle of the last segment and then ends by being invaginated and forming within itself a third tube (plate xv, figs. 2, 3, 4,  $t_3$ ). The posterior part of the walls of these two are fused for a short distance and closely united as far forward as the fold in the second. Here the innermost tube becomes entirely free and lies as within a sheath surrounded by the first and second tubes. This is the inner tube so easily determined by dissection; it runs forward as before described, passing out of the cavity between the other tubes and entering the longitudinal muscles (plate xv, figs. 2 and 5  $t_3$ , and plate xiii, fig. 10 *int*). The chitinous rod (plate xv, figs. 2-5,  $r$ , and plate xiii, fig. 10,  $r$ ) is attached to the fused part of the second and third tubes back of the posterior fold of the former. Only its anterior end is shown in median longitudinal sections. It is the homolog of the internal rods or plates of the chitinous genitalia already described.

It is readily seen that the intromittent organ of *Menopon titan* is simply an exaggeration of the type of that found in other species. It consists first of a deep invagination of the body-wall, extending from the



posterior end of the last abdominal segment forward into the fifth. (Grosse states that this is the turned-in tenth segment of the male. Beyond the fact that the male has one segment less in the abdomen than the female, he gives no evidence for this conclusion). The cavity thus formed corresponds exactly with the genital chamber of other species. Into the posterior part of it the rectum opens from above. Its anterior end is evaginated, and the tube thus formed is homologous with the membranous penis of other forms. It is almost destitute of chitinization, however; the rod arising in other species from the base of the penis is here situated near the tip. It appears from this that the elongation of the parts has been brought about, not by a deepening of the genital cavity with a corresponding lengthening of the penis in a posterior direction, but by a deepening of the genital cavity with a lengthening of the penis in front of its base. The innermost tube is produced by an invagination of the posterior end of the penis and is either unrepresented in other forms or is comparatively extremely short. Figure 9 represents diagrammatically

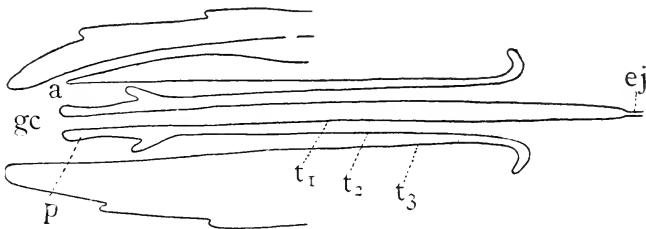


Fig. 9.—Diagram of Intromittent organ of *Menopon titan*, male; *a*, anus; *gc*, genital chamber; *ej*, ejaculatory duct; *p*, penis; *t*<sub>1</sub>, innermost invaginated tube; *t*<sub>2</sub>, middle invaginated tube; *t*<sub>3</sub>, outermost invaginated tube or wall of genital chamber (cf. fig. 5).

the relation of the several tubes, and a comparison of this figure with fig. 5 shows the similarity of structure. (cf. also plate xv, fig. 2 with fig. 1).

The muscles surrounding the tubular structures are also very complex, as has been shown. The plate to which the ventral ends of the transverse fibers are attached arises from the body-wall between the sterna of the eighth and ninth segments of the abdomen (plate xv, figs. 2 and 4, *p*). The proximal end of this plate is non-chitinized but farther forward it becomes darker. It ends in the ventral part of the groove formed by the recurved ends of the first and second tubes. Its lateral edges curve somewhat dorsally. The muscles are surrounded by a very thin, delicate membrane (plate xv, fig. 2, *m*) which along the median dorsal line sends a fold downward a short distance to which the upper ends of the transverse muscles are attached. In the middle the muscles are seven or eight fibers deep but the number lessens toward each end. They curve laterally around the tubes and each layer is attached to the ventral plate internal to the layer just outside it.

The longitudinal muscles, as stated, form a conical mass of fibers converging upon the anterior end of the rod, from which a few run forward to the sternum of the metathorax. There are a few transverse muscles within the others, especially close around the contained tube (plate xv, figs. 2 and 5, *lm*). It is rather difficult to determine how the longitudinal muscles are attached posteriorly. It appears clear, however, that they are not attached to any of the tubes but to the ventral plate, and in the following manner: The anterior end of the plate curves laterally very much upward around the outermost tube. The upper lateral and dorsal fibers posteriorly, in front of the recurved anterior ends of the first and second tubes, curve downward and inward, crossing each other in the middle line. They then turn backward, passing over the rim of the tubes, and

are attached mostly to the lateral ventral aspects of the anterior end of the ventral plate, but a few are attached on the dorsal side. The lower lateral and ventral muscles likewise cross each other in the middle line in front of the tubes and are attached to the lateral aspects of the dorsal side of the anterior end of the ventral plate. The mechanism of this complex structure is rather hard to understand. It is evident that the contraction of the longitudinal muscles must push the rod outwards, carrying with it the innermost tube. The posterior fold in the second tube appears also, as if present to accommodate such an action. Grosse states that during copulation the whole inner tube is everted. It is difficult to understand what it is for if it is not made use of in this way, but it is much more difficult to see by what means it is turned out, since in front of the attachment of the rod at its posterior end it is entirely free from everything except the ejaculatory duct. Those specimens examined in which the inner tube was most everted had this protruded only as far as the base of the rod, the longest length apparently possible, judging from the structure of the parts. There can be little doubt that the band of muscles connecting the anterior end of the rod with the floor of the metathorax serves to draw the rod back. The transverse muscles may serve to prevent the lateral bending of the rod while the longitudinal muscles are contracting.

## 2. THE FEMALE ORGANS.

The reproductive organs of the female consist, like those of the male, of internal and external parts. The external part consists merely of the genital cavity, with the abdominal sternum forming its floor produced into a variously modified plate. The genital cavity differs

from that of the male in not being situated in the terminal segment of the body, but by being found as an invagination of the ventral body-wall several segments forward. It also does not contain the anal opening, this being situated terminally in the last segment.

The external parts of the female are much the same in all forms and the female *Menopon titan* may be described as a type of the whole order. Grosse describes the female organs of this form, but only very briefly, and he says nothing at all of the external parts. The sternum of the eighth abdominal segment is considerably modified. It consists mostly of a large depressed plate (plate xvii, fig. 7, *pl*) produced on each side into two ventrally projecting ridges divergent behind. The posterior border is free, above it is the external genital opening (*gc*), a narrow transversely elongated aperture. It opens into a cavity, the genital chamber, situated above the plate. The structure is best studied by means of transverse and longitudinal sections. Longitudinal sections (plate xvii, fig. 6) show that the genital chamber (*gc*) is formed as an invagination of the sternum of the eighth abdominal segment, a short distance in front of the posterior border of the latter. The vagina (*v*) opens into the upper part of its anterior end by a terminal downward curvature. It is lined by a continuation of the chitinous wall of the body. Transverse sections (plate xvii, figs. 1-3) show that the depressed plate of the eighth abdominal sternum is W-shaped. The tergum of the segment forms a large, continuous, arched plate extending on each side to the lateral edge of the body. Here a non-chitinized line occurs, separating the tergum from a pleural chitinization situated laterally on the ventral aspect. The inner edges of these are united by unchitinized spaces

with the outer arms of the W-shaped sternum. Each angle of this, again, is free from chitin. The lateral walls are thick and especially so at their bases, where they are produced into a large, inward-projecting ridge (*b*). The non-chitinization of the angles of the sternum and of its union with the pleural sclerites makes it evident that it is formed to enlarge by a diverging of the sides of the lower angles when an egg passes into the genital chamber. The inner lining (*ci*) of the latter is thin but mostly chitinized. A large mass of transverse muscles (*tm*) surround the inner wall, being attached latterly to the walls of the sternum and their enlarged bases. Back of the vaginal opening their inner ends are attached to a longitudinal dorsal crest of the inner wall of the cavity. A few longitudinal muscles (*lm*) also are present.

The genital cavity is wide posteriorly but becomes narrower in front. It is almost divided into two longitudinal chambers by the dorsal ridge of the ventral groove of the sternum. The vagina opens into its anterior end somewhat to the right. This is a large tube and must be regarded as a part of the exterior since it possesses a chitinous intima continuous through that of the genital cavity with the exterior covering of the body. From the genital chamber the vagina (plate xvii, figs. 2-5, *vo*, *av*, *pv*, and *cv*) runs a short distance dorsally and then turns forward. It forms a large U-shaped tube (plate xvi, fig. 3, *va*) lying in the ventral part of the abdominal cavity, with the closed end reaching far forward. Sometimes it is somewhat spirally twisted upon itself. The anteriorly running arm begins at the anterior end of the genital cavity to the right of the other backward running arm (plate xvii, figs. 2, 3, 4, *vo*, *av*, *pv*). The latter is

generally expanded near its middle but becomes narrower posteriorly, reaching back of the opening of the other arm into the genital chamber. Here it makes a bend to the right (plate xvii, fig. 1, *pv*) and becomes continuous with the oviduct (*od*).

The muscles surrounding the genital cavity are continuous over the vagina, forming circular muscles around it which continue throughout its whole length. Outside of these are a few transverse muscles. Grosse states that the muscles begin near the opening. Within the muscles is a structureless membrane which forms the true outer covering of the vagina. Within this is a cellular epithelium lined by a chitinous intima thrown into large folds projecting into the lumen.

The oviduct (plate xvii, figs. 1-6, *od*) is very long and somewhat coiled. It varies greatly in different specimens, but always runs forward from the anterior end of the vagina as an apparent continuation of it. It is first closely or openly bent upon itself, and then runs again forward to near the anterior end of the vagina, where it bifurcates, each tube running outward and backward, bearing at its end the egg-tubes of the same side. According to the specimen the oviduct may be very narrow or greatly distended. It is formed of the same elements as the vagina except that it lacks the chitinous intima. The inner ends of the epithelium cells (plate xvi, fig. 4, *ep*) project irregularly into the lumen, and the latter is generally almost obliterated by the approximation of the cells, which are much larger than those of the vagina. The muscle layers, on the other hand, are not so thick.

The egg-tubes are five in number on each side. They arise from the distal ends of the oviducts and have the same structure that they show except that the

outer covering of muscles is lacking. Each is a long slender tube dilated where it contains ova into chambers which decrease in size distally. The five tubes on each side are united at their anterior ends and form a tangled mass on each side of the body. Each tube (plate xvi, fig. 6) is surrounded by a close, outer, structureless *membrana propria* (*mp*). Within this is an epithelium composed of a single layer of cells. When there is no egg present in the ovary these cells are all very large (plate xvii, figs. 3-5, *o*) and almost fill the lumen of each tube. They appear triangular in transverse sections, while their bases on the *membrana propria* are polygonal. A large, radially elongated nucleus is present in each. When ova are present in the ovaries the egg-tubes present a very different appearance (plate xvi, fig. 6). Each egg is surrounded by a follicle formed by an enlargement of the tubule. In the lower chambers (*a*) are to be found fully formed eggs (*o*). They are surrounded by a thick egg-covering filled with granular yolk. In form they are elongated and flattened at each end. The epithelium (*ep*) of the walls of a lowermost egg-chamber is composed mostly of small cubical cells. Posteriorly they are elongated, forming a transverse posterior wall for the chamber in the middle of which is the opening into the proximal part of the tubule connecting the egg-chambers with the oviduct. In front the epithelial cells become successively longer, until the most anterior are very long and slender, those from opposite sides almost meeting one another. In front of these are four immensely enlarged cells (*ac*) entirely filling the lumen of the tubule and thus closing the anterior end of the egg-chamber. These retain the form of the cells of an inactive tubule. The small epithelial cells are

lined by a distinct intima, which is apparently absent when there is no egg present and the cells are large.

The smaller egg-chambers (*b*) contain a granular mass of yolk (*g*) which is not surrounded by a covering of its own. The epithelium is the same as in the lower chamber, except that the anterior cells are not elongated. Filling the anterior end of the enlargement of the tubule are six large cells. The part of the tubules connecting two egg-chambers is slender, with small epithelial cells.

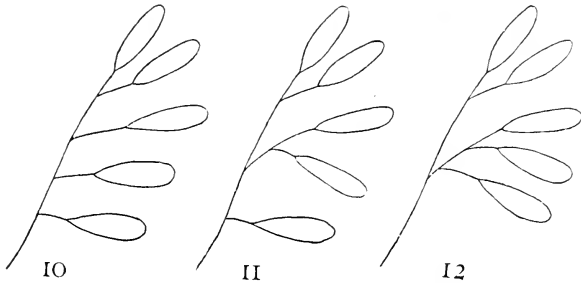
Grosse states that there is present on each side of the vagina a club-shaped spermathæca. In the specimens of *Menopon titan* examined, however, there was no organ of this kind present.

In *Eurymetopus taurus* (plate xvi, fig. 1) the vagina (*va*) consists of a large, wide, straight, invaginated tube reaching forward to the fifth abdominal segment. Into its anterior end open two oviducts, one from each side. Into the posterior end on the dorsal side a duct opens, connected at its distal end with a large, dorsoventrally flattened, glandular organ (*g*). The cells of this are very large and distinct (plate xvi, fig. 2). The duct is divided into a wide distal and narrower proximal part. The posterior end of the first is invaginated and the second part arises from the inner end of this. Numerous muscle-fibers (*m*) are attached to the upper part around its middle. Spermatozoa were not found in the gland. This appendage is constant, but the pouch referred to varies a great deal.

The oviducts are simple tubes extending outward, anteriorly and dorsally into the fourth segment. They are sometimes narrow tubes with enlarged bases and are sometimes wide throughout their whole length. Each bears at its distal end five egg-tubules. These



sometimes join the oviduct serially as in fig. 10, or two or more may be united at their bases as shown in figs. 11 and 12.



Figs. 10-12.—Variations in attachment of egg-tubules to the oviduct in *Eurymelopus taurus*.

Nitzsch states that in the Ischnocera there are five egg-tubes present in the females, while in the Amblycera there are but three. He expresses a doubt though whether this second statement holds for the suborder. Rudow (1870) states that in both groups five are present but that in the Amblycera (*Liotheum*) two remain rudimentary. Even this statement is not entirely true, for there are five well developed in the adult *Menopon titan*. Sections of a young *Menopon persignatum* show four fully formed tubules and one small one. Adults of *Colpocephalum osborni* show three well developed and one small one on each side. In *Trinoton luridum* there are four in the adult. Grosse in his paper on the anatomy of *Tetrophthalmus chilensis* (*Menopon titan*) quotes Nitzsch's statements in regard to the number of egg-tubes, but adds no observations on the number present in the form he describes. Nitzsch figures the female organs of *Menopon mesoleucum*. According to him there is present a short, wide vagina, narrowed in front where it gives off on each side an

oviduct. Each of these bears distally three egg-tubes. A double spermathæca opens into the base of the vagina. He figures also *Goniodes dissimilis*, in which the vagina is a straight tube branching in front into two rather wide oviducts into which open five egg-tubes. Into the posterior side of each duct three blind tubes open internal to the ovarian tubules. Kramer describes the female organs of *Lipeurus jejunus*, giving five as the number of egg-tubes present.

From the descriptions just given it is evident that the two suborders differ from each other in regard to the female organs simply in that there is a tendency amongst Amblyceran forms toward a reduction of the number of ovarian tubules from five—the constant number in the Ischnocera—to three.

The eggs (plate xvii, fig. 8) are large, oval, and generally rather elongated. They are attached to the bases of the feathers singly or in groups. On birds badly infested large numbers of eggs may be found. They are fastened by one end, having that end from which the embryo will emerge directed toward the tip of the feather. When the embryo leaves the egg it pushes off a circular cap and partly protrudes itself. In *Docophorus fuliginosus* the embryos apparently remain in the mouth of the open egg for some time, for many were found in this position. Some found thus were very immature (plate xvii, figs. 9 and 10), having the mandibles entirely unchitinized, the maxillæ almost as large as the mandibles, and the labium large, consisting of a transverse basal position and two lateral lobes. The most immature of those found free from the egg had the mandibles well chitinized.

Little has been done on the embryology of the Mallophaga. The work of Nusbaum (1882) on the

development of the reproductive organs has already been referred to. Melnikow (1869) made a more general study of the embryology, but since he concluded from his investigations that the Mallophaga are closely related to the Pediculidæ—a conclusion entirely untenable—his work cannot be very accurate. He proves that there is present a beak but no labium, and hence that the mouth-parts are Hemipteran!

## VII. SUMMARY.

The foregoing descriptions of the various systems of organs of the Mallophaga show that the two suborders are separated by wide structural differences. These may be tabulated as follows:

<i>Amblycera.</i>	<i>Ischnocera.</i>
Mesonotum and Metanotum Distinct.	Mesonotum and Metanotum Fused.
Antennæ concealed.	Antennæ exposed.
Antennæ clavate.	Antennæ not clavate.
Mandibles horizontal.	Mandibles vertical.
Labial palpi present.	Labial palpi absent.
Paraglossæ various in form.	Paraglossæ constant in form.
Œsophageal sclerite and connected glands absent or modified.	Œsophageal sclerite and connected glands present and normal except in a few scattered cases.
Crop simple.	Crop an œsophageal diverticulum.
Salivary glands various in form.	Salivary glands constant in form.
Ingluvial glands absent.	Ingluvial glands present.
Testes six.	Testes four.
Chitinous ♂ genitalia simple.	Chitinous ♂ genitalia more complex.
Egg-tubes three to five.	Egg-tubes five.

The above table shows that in nearly every character in which the two suborders differ the Ischnocera have a more specialized organization. That the separation of the two groups is very great is shown by the fact that nearly all the important organs are affected, the heart, tracheal system, and nervous system being the only ones alike in both. The exact systematic position of the Mallophaga cannot at present be determined, since enough of the anatomy of nearly related forms is not known. Packard (1887), however, has shown that they may be closely related to the Psocidæ, and Kellogg (1896) has given further evidence of this. But if the Psocidæ are the most closely associated with the Mallophaga, in what manner the two groups are related is impossible to say. Until this is known the relationship of the two suborders of the Mallophaga to each other cannot be determined nor that of the families composing these suborders.

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## EXPLANATION OF PLATES.

PLATE X.—Fig. 1, Median dorsoventral longitudinal section of anterior half of *Menopon titan*; *h* head, *t*<sub>1</sub> prothorax, *t*<sub>2</sub> mesothorax, *t*<sub>3</sub> metathorax; *a*<sub>1</sub> first abdominal segment, *a*<sub>2</sub> second abdominal segment, *bw* outer body-wall, *bm* basement membrane, *m* mouth-opening, *bc* buccal cavity, *p* pharynx, *æ* œsophagus, *cr* crop, *v* anterior end of ventriculus, *sg* salivary gland, *b* brain, *s.æ. g* subœsophageal ganglion, *g*<sub>1</sub> prothoracic ganglion, *g*<sub>2</sub> mesothoracic ganglion, *g*<sub>3</sub> metathoracic ganglion, *tr* trachea, *lm* longitudinal muscle, *tm* transverse muscle, *o* anterior end of an egg-tube cut near the surface. Fig. 2, Throat skeleton with attached glands of *Eurymetopus taurus*; *æ. s* œsophageal sclerite, *l. g* glands, *d* duct, *ch. ped* chitinous pedicle. Fig. 3, Left maxilla, ventral aspect, of *Goniodes cervinicornis*. Fig. 4, Labial fork of *Ancistrona gigas*. Fig. 5, Mandibles, ventral aspect, of *Ancistrona gigas*. Fig. 6, Mandibles, posterior aspect, of *Goniodes cervinicornis*. Fig. 7, Œsophageal sclerite, dorsal aspect, of *Eurymetopus taurus*; *d* duct, *do* opening of duct, *m* median groove, *ant. p.* anterior process, *c. æ* circumœsophageal process. Fig. 8, Hypopharynx of *Ancistrona gigas*. Fig. 9, Labium of *Nitzschia dubius*; *sm* submentum, *m* mentum, *pf* palpifer, *lp* labial palpus, *g* glossa, *pg* paraglossa. Fig. 10, Right maxilla, ventral aspect, of a *Læmobothrium*. Fig. 11, Mandibles, ventral aspect, of *Læmobothrium* sp.; *c* condyles, *r* right mandible, *l* left mandible. Fig. 12, Right mandible, posterior aspect, of *Goniodes cervinicornis*; *c* condyle, *ch. pls* chitinous plates. Fig. 13, Labium, ventral aspect, of *Eurymetopus taurus*; *sm* submentum, *m* mentum, *g* glossa, *pg* paraglossa.

PLATE XI.—Fig. 1, Salivary glands of *Trichodectes geomydis*; *a* outer gland, *b* inner gland. Fig. 2, Salivary organs of *Menopon titan* (after Grosse); *a* salivary gland, *b* saliva reservoir. Fig. 3, Large-celled salivary gland of *Trichodectes geomydis*, with the cells in natural position; *d* duct. Fig. 4, Same as last but with cells spread apart showing branches of duct (*d*) to individual cells. Fig. 5, Large-celled gland of *Eurymetopus taurus*; *d* duct. Fig. 6, Longitudinal section of part of Malpighian tubule of *Menopon titan*; *mp* membrana propria, *ep* epithelium, *in* intima. Fig. 7, Part of alimentary canal with Malpighian tubules of *Colpocephalum osborni*; *v* lower end of ventriculus, *i* upper end of intestine. Fig. 8, Alimentary canal of *Docophorus lari*. Fig. 9, Crop (*cr*) with part of œsophagus and ventriculus of a *Trichodectes* from a horse. Fig. 10, Alimentary canal of *Trichodectes geomydis*; *g* large-celled glands of crop. Fig. 11, Alimentary canal of *Eurymetopus taurus*, ventral view; *r* outer salivary gland or saliva reservoir, *g*<sub>1</sub> inner gland, *g*<sub>2</sub> large-celled gland. Fig. 12, Alimentary canal of *Goniodes cervinicornis*. Fig. 13, Alimentary canal of *Menopon titan*.

PLATE XII.—Transverse sections of *Menopon persignatum*. Fig. 1, Section through head in region of anterior end of brain. Fig. 2, Section through head in region of posterior part of antennary fossæ. Fig. 3, Section through head, passing through the eyes. Fig. 4, Section through posterior part of head. Fig. 5, Section through prothorax just back of the legs. Fig. 6, Section of mesothorax through bases of the legs. Fig. 7, Section of metathorax just in front of the legs; *w* œsophagus, *an* antenna, *br* brain, *sg* subœsophageal ganglion, *e* eye, *tr* trachea, *h* heart, *l* base of mesothoracic leg, *f* fat-body, *cr* crop, *g<sub>1</sub>* prothoracic ganglion, *g<sub>2</sub>* mesothoracic ganglion, *c* nerve commissure in front of mesothoracic ganglion, *vw* thickened ventral wall of antennary fossa.

PLATE XIII.—Internal male genitalia. Fig. 1, Transverse section of testis of *Menopon titan*; *mp* outer tunica, *ep* epithelium. Fig. 2, Transverse section of vas deferens of *Menopon titan*; *mp* membrana propria, *ep* epithelium, *in* intima. Fig. 3, Reproductive organs of male *Goniodes cervinicornis*; *t* testes, *vd* vas deferens, *sv* vesiculæ seminales, *ej* ductus ejaculatorius. Fig. 4, Transverse section of ductus ejaculatorius of *Menopon titan*; *mp* membrana propria, *ep* epithelium, *in* intima, *m* circular muscles. Fig. 5, Transverse section of lower end of vesicula seminalis of *Menopon titan*; letters as in last. Fig. 6, Transverse section through middle of vesicula seminalis of *Menopon titan*; letters as in fig. 4. Fig. 7, Reproductive organs of male *Colpocephalum flavescens* (after Nitzsch); *t* testes, *vd* vas deferens, *sv* seminal vesicle, *ej* ductus ejaculatorius, *r* chitinous rod attached to inner tube of genital cavity. Fig. 8, Same of *Eurymetopus taurus*; letters as before. Fig. 9, Same of *Physostomum diffusum*; letters as before. Fig. 10, Same of *Menopon titan*; letters as before, but also, *ve* vas deferens, *cd* transverse duct connecting the two vasa deferentia, *int* innermost invaginated tube of genital cavity, having rod (*r*) attached to its lower end.

PLATE XIV.—External male genitalia. Fig. 1, Chitinous genital parts of *Lipeurus fuliginosus major*, dorsal aspect. Fig. 2, Same of *Goniodes cervinicornis*, dorsal aspect. Fig. 3, Same of *Physostomum diffusum*. Fig. 4, Same of *Giebelia mirabilis*. Fig. 5, Same of *Eurymetopus taurus*, dorsal aspect. Fig. 6, Same of *Colpocephalum osborni*. Fig. 7, Same of *Trinoton luridum*. Fig. 8, Same of *Docophorus lari*. Fig. 9, Same of *Goniocotes creber*. Fig. 10, Same of *Menopon mesoleucum*.

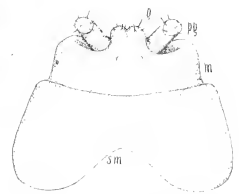
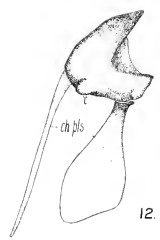
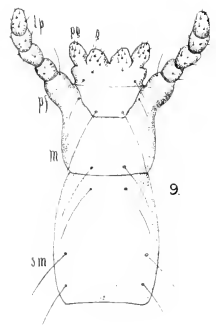
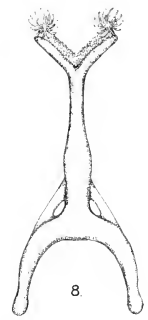
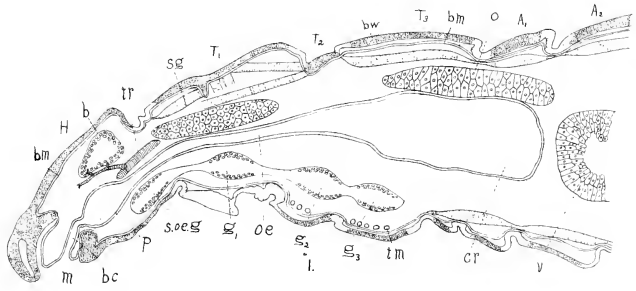
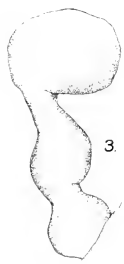
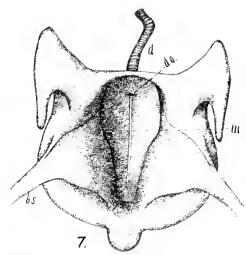
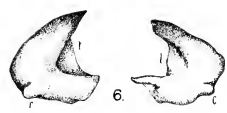
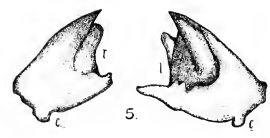
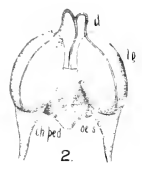
PLATE XV.—Fig. 1, Longitudinal section of two posterior somites of male *Eurymetopus taurus*. Fig. 2, Longitudinal section of six posterior segments of male *Menopon titan*. Figs. 3-5, Transverse sections of abdomen of male *Menopon titan*. Fig. 3, Through anterior end of segment VIII. Fig. 4, Through segment VII. Fig. 5, Through segment V; *tm* transverse muscles; *lm* longitudinal muscles, *em* extrusor muscles, *m* membrane surrounding muscles, *gc* genital chamber, *i* intestine, *a* anus, *p* penis, *pl* internal plate, *r* internal rod, *t<sub>1</sub>* outermost invaginated tube,

$t_2$  middle tube,  $t_3$  innermost tube,  $re$  anterior recurved edges of outer and middle tubes,  $t$  testes,  $vd$  vas deferens,  $sv$  seminal vesicle,  $ej$  ejaculatory duct,  $vp$  ventral plate to which transverse muscles are attached,  $mt$  Malpighian tubule,  $f$  fat-body,  $tr$  trachea,  $tg$  tergum,  $s$  sternum,  $p$  pleuron.

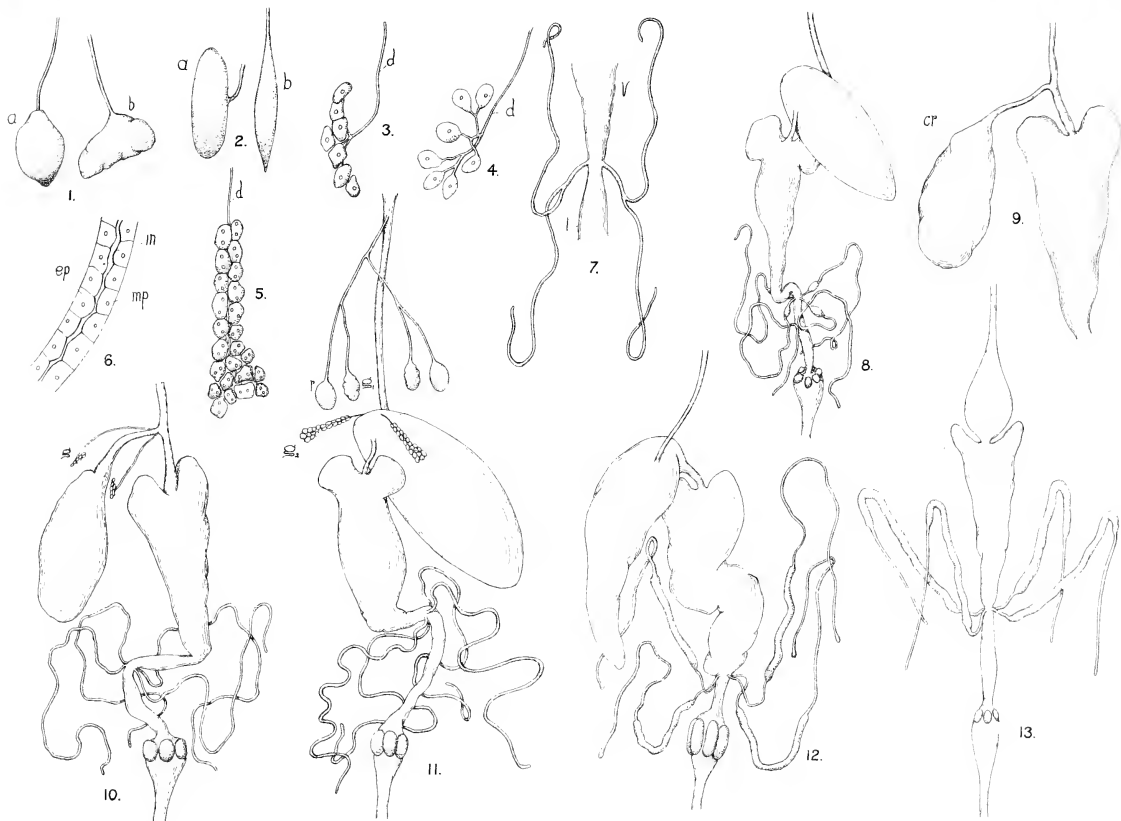
PLATE XVI.—Fig. 1, Reproductive organs of female *Eurymetopus taurus*;  $o$  ovaries,  $od$  oviduct,  $va$  vagina,  $sp$  spermathæca,  $g$  gland. Fig. 2, Accessory gland of female *Eurymetopus taurus*;  $d$  duct,  $m$  attached muscles. Fig. 3, Reproductive organs of female *Menopon titan*;  $o$  ovaries,  $od$  oviduct,  $va$  vagina. Fig. 4, Transverse section of oviduct of *Menopon titan*;  $ep$  epithelium,  $m$  circular muscles,  $mp$  membrana propria. Fig. 5, Detached egg-cap (See plate xvii, fig. 8). Fig. 6, Longitudinal section through an egg-tube of *Menopon titan*;  $a$  lowermost egg-chamber containing a mature egg ( $o$ ),  $b$  an upper egg-chamber containing an immature egg ( $g$ ),  $ep$  small epithelial cells forming side-walls of egg-chambers,  $ac$  very large epithelial cells filling the anterior ends of egg-chambers,  $mp$  membrana propria,  $in$  intima,  $od$  oviduct. Fig. 7, Nervous system of *Eurymetopus taurus*;  $b$  brain,  $sg$  subcesophageal ganglion,  $g_1$  prothoracic ganglion,  $g_2$  mesothoracic ganglion,  $g_3$  metathoracic ganglion,  $tr$  trachea. Fig. 8, Longitudinal dorsoventral section of brain ( $b$ ) and subcesophageal ganglion ( $sg$ ), passing through the circumcesophageal commissure of *Menopon titan*;  $fg$  frontal ganglion.

PLATE XVII.—Figs. 1-5, Transverse sections through posterior end of abdomen of female *Menopon titan*, from behind forward; Fig. 1, through middle of genital cavity ( $gc$ ); Fig. 2, through the beginning of the vagina ( $vo$ ); Fig. 3, cut in front of vaginal opening; Fig. 4, taken in front of genital cavity; Fig. 5, through anterior end of vagina;  $r$  rectum,  $rg$  rectal glands,  $tr$  trachea,  $f$  fat-body,  $gc$  genital cavity,  $tm$  transverse muscles,  $lm$  longitudinal muscles,  $ci$  inner chitinous wall of genital chamber,  $b$  enlarged base of outer chitinous wall of genital chamber,  $vo$  vaginal opening into anterior part of genital chamber,  $av$  anteriorly running part of vagina,  $pv$  posteriorly running part of vagina,  $cv$  anterior end of vagina where the two arms meet,  $o$  egg-tubes,  $pr$  prerectal part of intestine,  $od$  sections through the coils of the oviduct. Fig. 6, Longitudinal dorsoventral section of five posterior abdominal segments of female *Menopon titan*;  $bw$  chitin wall of body,  $bm$  basement membrane,  $m$  longitudinal muscles,  $a$  anus,  $r$  rectum,  $rtm$  transverse muscles of rectum,  $ch$  chitinous lining of rectum,  $rg$  rectal glands,  $gc$  genital chamber,  $v$  vagina,  $vtm$  transverse muscles of vagina,  $od$  sections of oviduct. Fig. 7, Ventral view of posterior end of abdomen of female of *Menopon titan*; VII, VIII, IX, X segments of abdomen,  $pl$  plate forming ventral wall of genital cavity,  $gc$  opening of genital cavity to exterior. Fig. 8, Three eggs attached to shaft of a feather;  $a$  egg containing an embryo,  $b$  empty egg with cap off. Figs. 9 and 10, Young nymphs just hatched;  $lb$  labrum,  $mn$  mandible,  $mx_1$  maxilla,  $mx_2$  labium,  $an$  antenna,  $m$  mouth-opening.

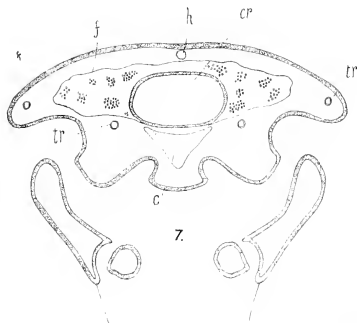
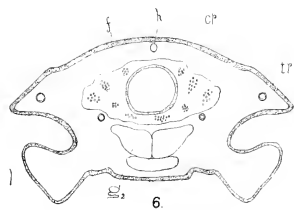
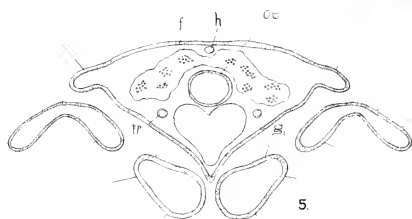
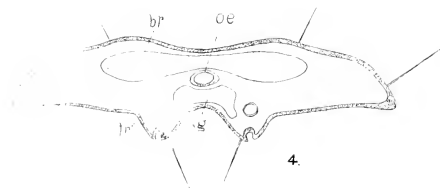
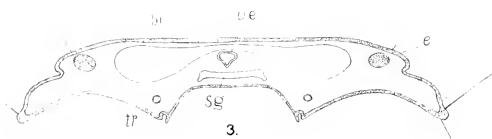
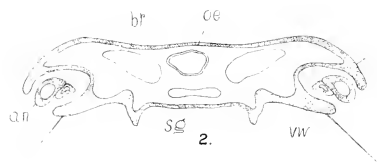
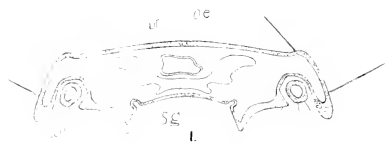




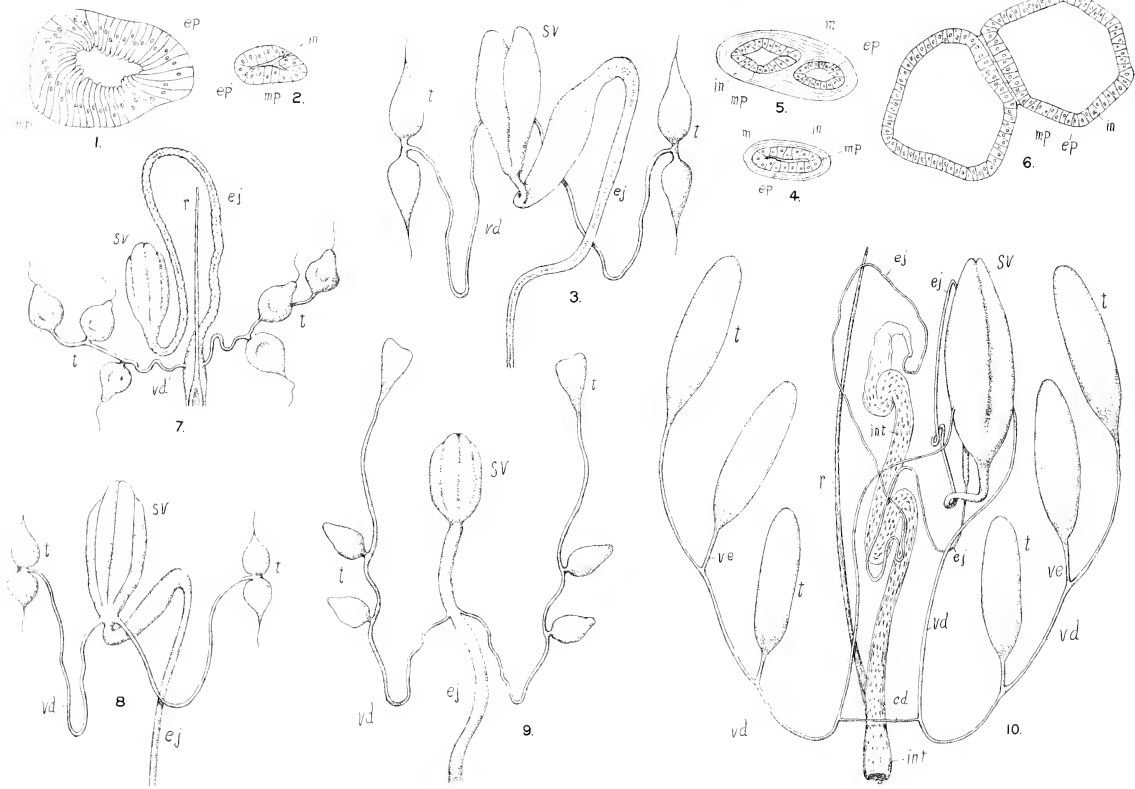






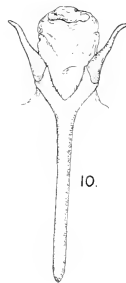
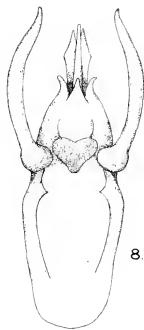
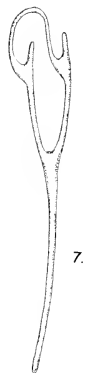
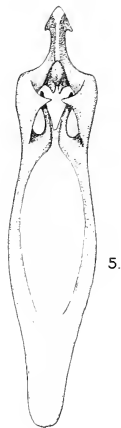
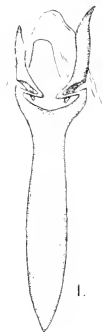




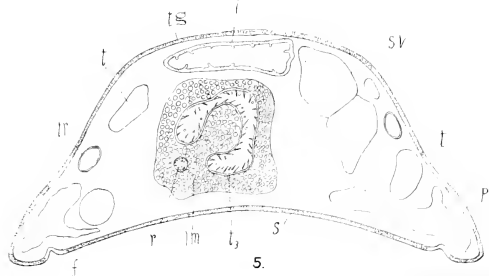
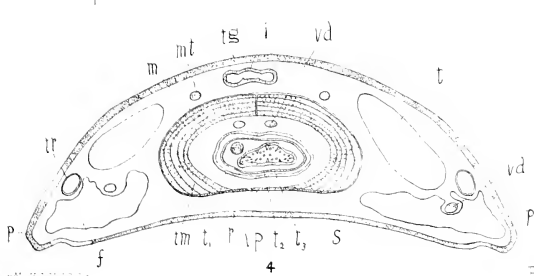
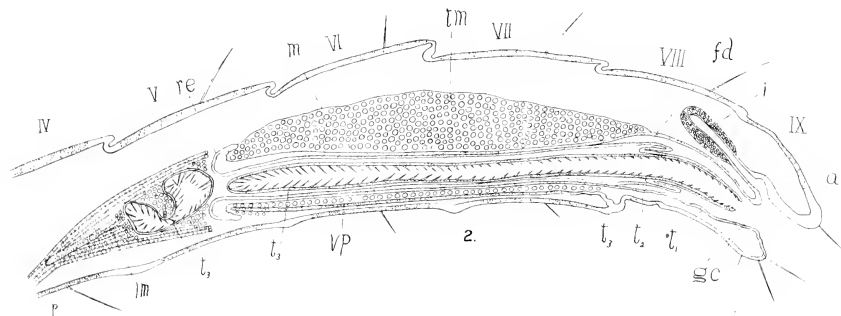
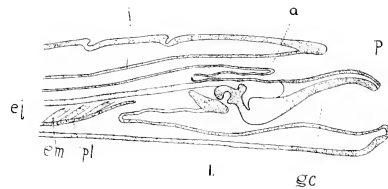
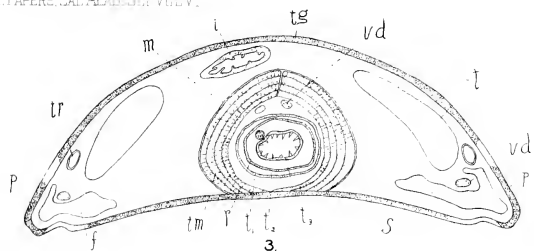




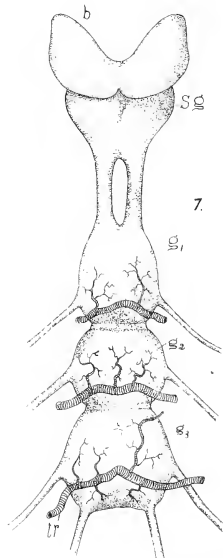
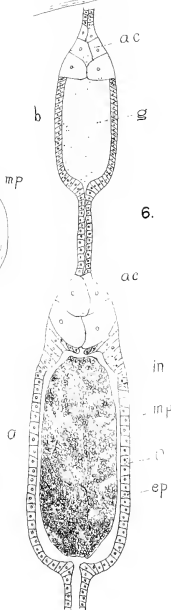
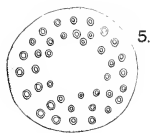
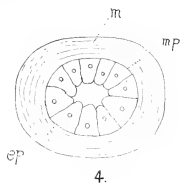
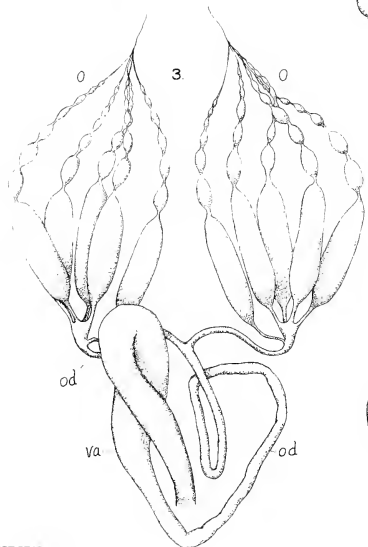
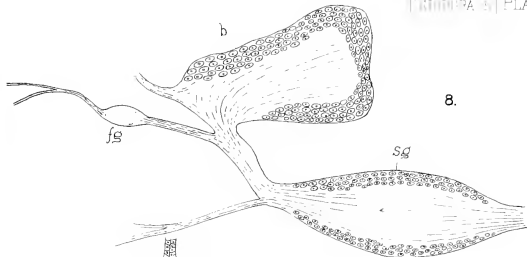
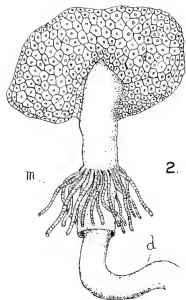
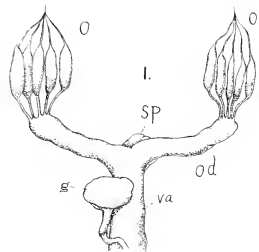




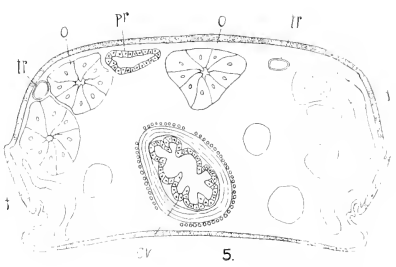
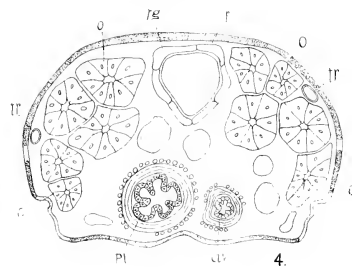
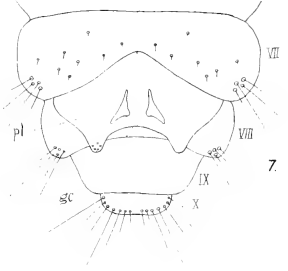
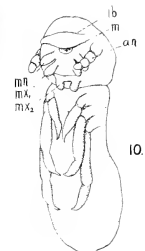
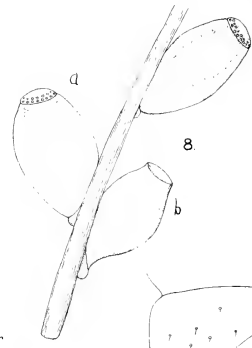
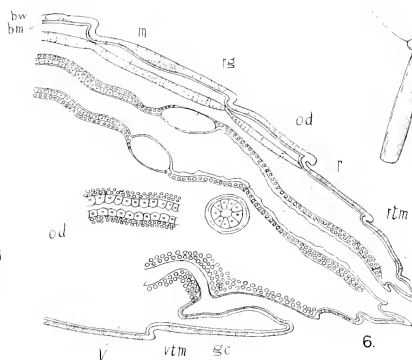
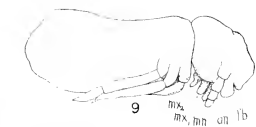
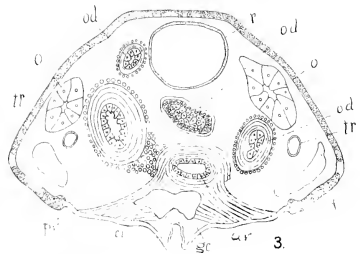
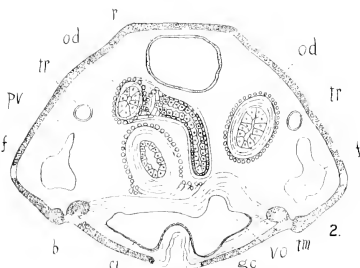
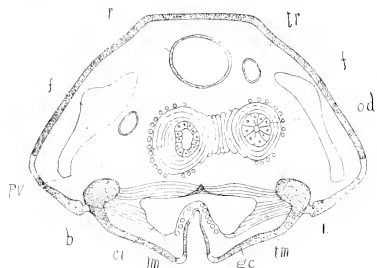
















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