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WILLIAM DE C. RAVENEL,

*Administrative Assistant to the Secretary,
in Charge of the United States National Museum.*

FEBRUARY 7, 1925.

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TERTIARY MOLLUSKS OF THE GENUS ORTHAULAX FROM THE REPUBLIC OF HAITI, PORTO RICO, AND CUBA.

By WENDELL P. WOODRING
Of Washington, District of Columbia.

A large number of Tertiary mollusks were collected during a geologic reconnaissance of the Republic of Haiti, under the supervision of the United States Geological Survey, by J. S. Brown, W. S. Burbank, and myself during the winter of 1920-21. The largest collections are from beds of Miocene age in the Central Plain, an interior plain in the northern part of the Republic, where a moluscan fauna of more than 300 species was obtained from the Thomonde formation. A preliminary account of the stratigraphy of the Miocene rocks of the Central Plain has been published,¹ and a detailed description of the rocks with faunal lists is now ready for press.²

Most of the Miocene mollusks are undescribed, and as a long interval of time may elapse before they are monographed it is planned to give accounts of the most interesting species.

Orthaulax aguadillensis Maury is the most striking and one of the commonest of the mollusks in the upper faunal zone of the Thomonde formation. In the Republic of Haiti it is confined to this faunal zone, which embraces the uppermost 100 meters of the Thomonde formation, and it was collected at every locality where collections were made from this zone.

During February, 1922, G. R. Mansfield, of the United States Geological Survey, while examining a dam site for the Porto Rican Government in the Province of Aguadilla, collected an interesting new species of *Orthaulax* from beds probably of middle Oligocene age on Rio Guajataca. This species is described to supplement Cooke's recent summary of all the known species of the genus.³ Mr. Mansfield also collected casts of *Orthaulax aguadillensis* Maury from the Quebradillas limestone at the locality given on page 8.

¹ Woodring, W. P., Stratigraphy, structure, and possible oil resources of the Miocene rocks of the Central Plain: Rep. Haiti Geol. Survey, 19 pp., map, 1922.

² Woodring, W. P., J. S. Brown, and W. S. Burbank, Geology of the Republic of Haiti: Rep. Haiti Geol. Survey (ready for press).

³ Cooke, C. W., *Orthaulax*, a Tertiary guide fossil: U. S. Geol. Survey Prof. Paper 129-B, pp. 23-31, pls. 2-5, 1921.

Geologists of the South American Gulf Oil Co. recently deposited in the United States National Museum collections of Tertiary fossils from the Province of Piñar del Rio, Republic of Cuba. A collection from the Consolacion limestone at a locality 5.6 kilometers north-east of San Cristobal (U.S.G.S. station 1/186) contains the small specimen of *Orthaulax aguadillensis* Maury figured on Plate 2, Figure 4. The rock in the body cavity of this specimen contains nests of *Miogypsina antillea* (Cushman). Small shells and casts of *Orthaulax caepa* Cooke were obtained in the same region and from the same limestone at the following localities: upper Oligocene, Consolacion limestone 8 kilometers west of Taco-Taco, W. Gretzinger collector, four specimens, U.S.G.S. station 1/181; Consolacion del Sur, W. Gretzinger, collector, five specimens (casts, identification doubtful), U.S.G.S. station 1/183.

Wythe Cooke, of the United States Geological Survey, has recently identified a specimen of *Orthaulax gabbii* Dall collected by Bruce Wade, of the Transcontinental Oil Co., at the Topila Hills, 25 kilometers southwest of Tampico, Vera Cruz, Mexico. Mr. Cooke has kindly given the following heretofore unpublished records of *Orthaulax pugnax* (Heilprin): U.S.G.S. station 1/103, Glendon limestone, sec. 25, T. 4 N., R. 20 E., on road to Elba, 1.1 kilometers, north of Goodman, Coffee County, Alabama, W. Cooke, and J. Gardner, collectors, May 12, 1921; U.S.G.S. station 1/104, Glendon limestone, Holmes County, Florida, 0.8 kilometer south of the State line on road from Geneva, Alabama, to Westville, Florida, W. Cooke and J. Gardner, collectors, June 9, 1921; U.S.G.S. station 1/106, Glendon limestone, 3.8 kilometers from Geneva, Ala., on road to Vaughanville, Alabama, W. Cooke and J. Gardner, collectors, May 10, 1921. The faunal associates of *Orthaulax pugnax* at these localities and their stratigraphic significance are given by Cooke in a paper awaiting publication by the United States Geological Survey. Dr. C. A. Matley, Government geologist of Jamaica, has recently collected *Orthaulax pugnax* from beds of middle Oligocene age near Jackson Town, Jamaica; and *Orthaulax aguadillensis* from beds of lower Miocene age near May Pen, Jamaica.

The preceding records bring up to date all the known localities for the genus.

THE GENUS ORTHAULAX.

Orthaulax is a peculiar stromboid mollusk found only in the tropical and subtropical faunas of middle Oligocene (Rupelian), upper Oligocene (Aquitanian), and lower Miocene (Burdigalian) age in the West Indies, Central America, Mexico, and southeastern United States. The genus thus has a restricted stratigraphic and geographic range. It was described by Gabb in 1872.⁴ The genotype is *O. in-*

⁴ Gabb, W. M., Acad. Nat. Sci. Philadelphia Proc., vol. 24, p. 272, 1872.

ornatus Gabb,⁵ collected by Gabb at an unknown locality in the Dominican Republic. The age of the beds from which this species came was not known until 1919, when D. D. Condit, then of the United States Geological Survey, during a geologic reconnaissance of the Dominican Republic under the direction of T. W. Vaughan, collected it from the Baitoa formation at the type locality of the formation on Rio Yaque del Norte at Baitoa. The known Baitoa molluscan fauna numbers about 60 species and is clearly of lower Miocene (Burdigalian) age.⁶ The type of *O. inornatus* has recently been redescribed by Pilsbry.⁷

The genotype was discovered also in beds of upper Oligocene age in Florida.⁸ The following four additional species have been described: *O. pugnax* (Heilprin) from beds of middle Oligocene age in Georgia⁹ and the island of Antigua,¹⁰ and from beds of upper Oligocene age in Florida;¹¹ *O. gabbii* Dall, from beds of upper Oligocene age in the Panama Canal Zone,¹² and from beds of lower Miocene age in Florida¹³ and Porto Rico¹⁴ (identification doubtful); *O. aquadillensis* Maury, from beds of upper Oligocene age in Porto Rico,¹⁵ Anguilla¹⁶ (identification doubtful), St. Croix,¹⁷ and the Dominican Republic,¹⁸ and from beds of lower Miocene age in the

⁵ Acad. Nat. Sci. Philadelphia, Proc., vol. 24, p. 272, pl. 9, figs. 3, 4, 1872.

⁶ See Vaughan, T. W., and W. P. Woodring, Chap. 4, Tertiary and Quaternary stratigraphic paleontology: A geological reconnaissance of the Dominion Republic. Dominican Rep. Geol. Survey Mem., vol. 1, p. 96, 1921.

⁷ Pilsbry, H. A., Acad. Nat. Sci. Philadelphia Proc., vol. 73, p. 368, pl. 30, figs. 13-15, 1922.

⁸ Dall, W. H., U. S. Nat. Mus. Bull. 90, p. 86, pl. 11, fig. 4, 1915; Dall, W. H., U. S. Nat. Mus. Proc., vol. 51, p. 509, pl. 88, fig. 9, 1916; Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 28, pl. 2, fig. 4, 1921.

⁹ Dall, W. H., U. S. Nat. Mus. Proc., vol. 51, p. 509, 1916 (also as *O. inornatus* on same page); Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 29, pl. 3, fig. 2, 1921.

See p. 2 for hitherto unpublished localities in Alabama and Florida.

¹⁰ Cooke, C. W., Carnegie Inst. Washington Pub. 291, p. 115, pl. 2, fig. 4, 1919; Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 29, pl. 3, figs. 3a, 3b, 1921.

¹¹ Heilprin, A., Wagner Free Inst. Sci. Trans., vol. 1, p. 107, pl. 15, figs. 36, 36a, 1887; Dall, W. H., Wagner Free Inst. Sci. Trans., vol. 3, p. 170, pl. 8, figs. 5, 8, 1890. Dall, W. H., U. S. Nat. Mus. Bull. 90, p. 87, pl. 15, figs. 5, 10, 1915; Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 29, pl. 3, figs. 1a, 1b, 4a, 4b, 1921.

¹² Cooke, C. W., in T. W. Vaughan, U. S. Nat. Mus. Bull. 103, p. 550, 1919 (as *O. pugnax*); Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 30, 1921.

¹³ Dall, W. H., Wagner Free Inst. Sci. Trans., vol. 3, p. 170, pl. 12, figs. 5, 5a, 5b, 1890; Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 30, pl. 3, figs. 5-7; pl. 4, fig. 1, 1921.

¹⁴ Hubbard, B., Scientific Survey of Porto Rico and the Virgin Islands, vol. 3, pt. 2, p. 145, pl. 23, fig. 3, New York Acad. Sci., 1921.

¹⁵ Maury, C. J., Scientific Survey of Porto Rico and the Virgin Islands, vol. 3, pt. 1, p. 58, pl. 9, fig. 4, New York Acad. Sci., 1920; Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 31, pl. 4, fig. 2, 1921.

¹⁶ Cooke, C. W., Carnegie Inst. Washington Pub. 291, p. 115, pl. 2, fig. 3, 1919 (as *O. pugnax*); Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 31, pl. 4, fig. 3, 1921.

¹⁷ Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 31, pl. 4, fig. 4, 1921.

¹⁸ Idem.

Dominican Republic¹⁹; and *O. caepa* Cooke from beds of upper Oligocene age in Cuba.²⁰ Cooke has fully described and figured the preceding five species. Hubbard²¹ has described as *O. portoricensis* casts that seem to be *O. aguadillensis* from beds of lower Miocene age in Porto Rico and Vieques. Pilsbry²² has recently described as *O. inornatus atilis* some of Gabb's specimens from the Dominican Republic that have a shorter spire than the type of *O. inornatus*. In view of the greater difference in outline of other species the separation of this subspecies is hardly warranted. *O. conoides* Woodring, collected from beds probably of middle Oligocene age in Porto Rico, completes the list of the six species that are here considered valid. All the species except *O. caepa* Cooke and *O. conoides* Woodring seem to have a stratigraphic range embracing two stages.

Family STROMBIDAE.

Genus ORTHAULAX Gabb.

Orthaulax GABB, Acad. Nat. Sci. Philadelphia, Proc., vol. 24, p. 272, 1872.

Type (by monotypy): *Orthaulax inornatus* Gabb, Acad. Nat. Sci. Philadelphia, Proc., vol. 24, p. 272, pl. 9, figs. 3, 4, 1872. Lower Miocene, Dominican Republic.

The following is a description of the genus:

Shell attaining a large size, fusiform, conical or ovate; cross section triangular or circular; early whorls bearing varices, entirely concealed in adult shells; after 7 to 10 volutions, outer lip extending to tip of spire and in each succeeding volution completely enveloping spire; space between spire and each enveloping whorl filled with callus; later whorls smooth, or sculptured with narrow spiral threads on and below the shoulder; aperture elliptical, gradually constricted posteriorly into a narrow channel ascending the spire; outer lip thin except at posterior end of aperture, expanded, bearing near the base a very shallow sinus; siphonal notch at base of aperture wide and very deep; anterior fasciole swollen; base of columella slender, curved backward, undercut by siphonal notch; columellar callus thickened at base of posterior channel, thinner over inner lip and extending to base of columella; base of body whorl of young shells sculptured with spiral sulci that widen toward the base.

¹⁹ Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 31, pl. 4, figs. 5, 6; pl. 5, figs. 1a, 1b, 1921.

See pp. 7, 8 for additional localities in the Republic of Haiti and Cuba.

²⁰ Cooke, C. W., Carnegie Inst. Washington Pub. 291, p. 116, pl. 2, figs. 1, 2, 1919 (as *O. inornatus*); Cooke, C. W., U. S. Geol. Survey Prof. Paper 129-B, pp. 25, 31, pl. 5, figs. 2a, 3b, 1921.

See p. 2 for additional localities in Cuba.

²¹ Hubbard, B., Scientific Survey of Porto Rico and the Virgin Islands, vol. 3, pt. 2, p. 146, pl. 25, figs. 1-5, New York Acad. Sci., 1921.

²² Pilsbry, H. A., Acad. Nat. Sci. Philadelphia Proc., vol. 73, p. 369, pl. 30, figs. 16-18, 1922.

The specimen of *O. gabbi* figured by Dall²³ (U.S.N.M. Cat. No. 112218) is the only known specimen of the genus that shows all the features of the aperture of a shell after the spire is covered. The backward curving of the slender base of the columella gives *Orthaulax* a characteristic stromboid appearance. The sinus near the base of the outer lip, a characteristic feature of *Strombus* and other genera of the family, is very shallow in *Orthaulax*. Most of the specimens of *O. gabbi* and *O. pugnax* have three thickened subsutural columellar calluses on the later whorls, and as they are not absorbed, they produce the triangular cross section of these species when concealed by growth. On a few specimens of *O. gabbi* the callus is thin, producing a subcircular cross section. The type of *O. inornatus* has a concealed thickened callus about 40° in a clockwise direction from the callus at the aperture, producing a dorso-ventral compression, but most of the specimens of this species apparently have a thin callus, or the callus is absorbed, as their cross section is circular. As specimens of *O. aguadillensis* of different growth stages have a thick subsutural callus at the aperture, it is inferred that the callus is absorbed in this species, which has a circular cross section. The columellar callus of *O. caepta* and *O. conoides*, both of which have a circular outline, is not known.

ORTHAULAX AGUADILLENSIS Maury.

Plate 1; Plate 2, figs. 3-6.

Orthaulax pugnax COOKE (part), 1919, Carnegie Inst. Washington Pub. 291, p. 115, pl. 2, fig. 3.

Orthaulax aguadillensis MAURY, 1920, Scientific survey of Porto Rico and the Virgin Islands, vol. 3, pt. 1, p. 58, pl. 9, fig. 4, New York Acad. Sci.

Orthaulax portoricensis HUBBARD, 1921, Scientific survey of Porto Rico and the Virgin Islands, vol. 3, pt. 2, p. 146, pl. 25, figs. 1-5, New York Acad. Sci.

Orthaulax aguadillensis MAURY, COOKE, 1921, U. S. Geol. Survey Prof. Paper 129-B, p. 30, pl. 4, figs. 2-6; pl. 5, figs. 1a, 1b.

The following is the original description:

Shell large and heavy, form of spire short and blunt, like that of *Orthaulax pugnax*. This at once distinguishes the shell from the Dominican species, *O. inornatus* Gabb, which is high-spined. A further characteristic of the shell is the evenly rounded form of the shoulder, which in cross section would be almost perfectly circular. This marks it off very decisively from the Floridian, Chipolan species, *Orthaulax gabbi* Dall, which is markedly triangular at the shoulder. The spire measures 45 mm. in diameter.

Type locality.—Aguadilla, station 3, Porto Rico.

Type.—American Museum of Natural History.

The following is a description of specimens from the Republic of Haiti:

²³ Dall, W. H., Wagner Free Inst. Sci. Trans., vol. 3, pl. 12, figs. 5a, 5b, 1890.

Shell attaining a large size, heavy, ovate in outline, circular in cross section; apex conical or hemispherical, apical angle 85° to 115° ; early whorls bearing an indeterminate number of low swollen varices (see pl. 2, figs. 3, 5); spire concealed at about beginning of seventh whorl; callus between succeeding whorls, as shown in axial section, thick at and below shoulder, rapidly thinning above shoulder; inner lip bearing a heavy subsutural callus; outer lip greatly thickened opposite this callus; channel between callus and thickened outer lip very narrow and deep on body whorl, filled with callus on earlier whorls; later whorls sculptured on and below shoulder with narrow, closely spaced spiral threads; base of body of young shells sculptured with narrow spiral grooves; base of outer lip and base of columella of adult shell not known.

The dimensions in millimeters of the most perfect specimens from the Republic of Haiti are as follows:

Height.	Diameter.
155	95 (pl. 1, fig. 9)
150	110
145	90
115	64
55	40 (cast, pl. 1, fig. 1)
28	15 (pl. 2, fig. 3)

The circular cross section, the shape of the whorls, of the callus between the whorls, and of the body cavity, as shown by axial sections, are the most characteristic features of *O. aquadillensis*. Cooke's method of studying axial sections is particularly useful in determining features of this species. The heavy subsutural callus and thickened outer lip are striking features. (See pl. 1, figs. 5, 8.) The deep narrow channel between them resembles the similar channel on *Strombus lacinatus* Chemnitz, *Strombus latissimus* Linnaeus, and other Indo-Pacific strombs that have the outer lip extending far up the spire. This deep channel is shown in casts by the sharp upper edge of the cast of the body whorl. The upper edge of casts of the whorls of the spire are progressively blunter toward the apex. As casts of different size show these features, and as shells of different size have the heavy subsutural callus, the deep channel at the posterior end of the body cavity is filled up as the animal withdraws during growth and the subsutural callus is absorbed. The filling of the channel by callus is shown in axial sections of the shell. The open space in the axial sections and the corresponding parts filled with sediment shown on Plate 1, Figures 3, 4, 10, 11, correspond to the casts (pl. 1, figs. 1, 6, 7). The range in outline of the shell is shown by Plate 1, Figures 4, 10, which represent two worn specimens from the same locality. As Cooke observed a similar difference in

outline of specimens of *O. aguadillensis* from the Dominican Republic and of *O. caepa* from Cuba, he suggested that the difference may be a sexual feature, although a similar sexual difference is not known in the living species of *Strombus*. The spiral threads are most conspicuous on medium-sized shells. (See pl. 2, fig. 6.) They are as prominent as on *O. caepa*, but are more closely spaced. The layers of shell and callus covering the spire have undulating growth lines similar to those shown in an exaggerated fashion on Maury's figure. (See pl. 1, fig. 1.)

Orthaulax aguadillensis was described by Maury from a single imperfect specimen collected in Porto Rico from the Aguadilla limestone, which is considered of upper Oligocene age. It seems to be very common as casts in the overlying Quebradillas limestone, which is of lower Miocene age. Hubbard called these casts *O. portoricensis*. A Porto Rican cast (pl. 1, fig. 7), collected at the cut just west of Rio Guajataca on the railroad from Quebradillas to Isabella by G. R. Mansfield (U.S.G.S. station 1/146), is introduced for comparison with casts from the Republic of Haiti (pl. 1, figs. 1, 6). The cast shown on Plate 1, Figure 6, was collected at a locality where shells were obtained. One specimen from this locality that has part of the shell dissolved revealing the cast conclusively shows that these casts from the Republic of Haiti are *O. aguadillensis*.

All the specimens from the Republic of Haiti were collected from the upper faunal zone of the Thomonde formation, which is the equivalent of the Baitoa formation of the Dominican Republic, and is of lower Miocene age. The Haitian specimens duplicate those collected on Rio Yaque del Sur, Dominican Republic, from beds of lower Miocene age.

The following is a list of the localities in the Republic of Haiti, all of which are in the southeastern part of the Central Plain in the Arrondissements of Las Cahobas and Hinche:

Crest of Thomonde anticline, left bank of Rivière Thomonde, about 4 kilometers east-southeast of Thomonde, W. P. Woodring and F. G. Evans, jr., collectors, 1921, five specimens, U.S.G.S. station 9782. North limb of Thomonde anticline, about 2.5 kilometers east-northeast of Thomonde on trail to Thomassique, W. P. Woodring and F. G. Evans, jr., collectors, 1921, two specimens, U.S.G.S. station 9780. North limb of Thomonde anticline, about 2.8 kilometers east-northeast of Thomonde, W. P. Woodring and F. G. Evans, jr., collectors, 1921, two specimens, U.S.G.S. station 9781. North limb of Thomonde anticline, about 4 kilometers north-northwest of Thomonde on trail to Hinche, W. P. Woodring and F. G. Evans, jr., collectors, 1921, one specimen (cast), U.S.G.S. station 9929. South limb of Thomonde anticline, about 1.3 kilometers south-southeast of

Thomonde on trail to Las Cahobas, W. P. Woodring and F. G. Evans, jr., collectors, 1921, 15 specimens, U.S.G.S. station 9779. South limb of Thomonde anticline, about 1.5 kilometers south-southeast of Thomonde on trail to Las Cahobas, W. P. Woodring and F. G. Evans, jr., collectors, 1921, one specimen (cast), U.S.G.S. station 9778. Left bank of Ravine Roche Salée at crossing of trail from Hinche to Thomassique about 6 kilometers southeast of Los Palos, W. P. Woodring and F. G. Evans, jr., collectors, 1921, three specimens, U.S.G.S. station 9945. Same locality as station 9945, but on right bank of stream and from beds about a meter higher stratigraphically, one specimen, U.S.G.S. station 9946. Trail from Thomassique to Cercala-Source, about 0.5 kilometer north-northeast of Thomassique, W. P. Woodring and F. G. Evans, jr., collectors, 1921, 18 specimens, U.S.G.S. station 9947.

Other localities are as follows:

Upper Oligocene, Anguilla formation, southwest shore of Crocus Bay, Anguilla, T. W. Vaughan, collector, 1914, one specimen (identification doubtful), U.S.G.S. station 6965. Upper Oligocene, Montpellier East, St. Croix, J. T. Quin, collector, two specimens (casts), U.S.G.S. station 8650. Upper Oligocene, Cevicos limestone, east side of Arroyo Blanco, east of Loma de Los Palos, on road from Cotui to Cevicos, Dominican Republic, C. W. Cooke and C. P. Ross, collectors, 1919, six specimens, U.S.G.S. station 8598. Upper Oligocene, Aguadilla limestone, Aguadilla station 3, Porto Rico, C. A. Reeds, collector, one specimen (type), expedition of New York Academy of Sciences, the Porto Rican Government and the American Museum of Natural History cooperating. Upper Oligocene, Consolacion limestone, 5.6 kilometers northeast of San Cristobal, Province of Piñar del Rio, Republic of Cuba, W. Gretzinger, collector, 1922, one specimen, U.S.G.S. station 1/186. Upper Oligocene, Consolacion limestone, 7.2 kilometers south of San Diego de los Banos, Province of Piñar del Rio, Republic of Cuba, W. Gretzinger, collector, 1922, two specimens (casts, identification doubtful), U.S.G.S. station 1/182. Lower Miocene, Quebradillas limestone, stations 204, 41, 52(a), 801, and "numerous other localities not recorded," Porto Rico ("*O. portoricoensis*"), expedition of New York Academy of Sciences, the Porto Rican Government and the American Museum of Natural History cooperating. Lower Miocene (?), east coast of Vieques Island, A. K. Lobeck, collector, one specimen, expedition of New York Academy of Sciences, the Porto Rican Government and the American Museum of Natural History cooperating. Lower Miocene, cut on railroad from Quebradillas to Isabella, just west of Rio Guajataca, Porto Rico, G. R. Mansfield, collector, 1922, 18 species (casts, "*O. portoricoensis*") U.S.G.S. station 1/146. Lower Miocene, left bank

of Rio Yaque del Sur at upper edge of Los Güiros, Dominican Republic, D. D. Condit, collector, 1919, five specimens, U.S.G.S. station 8572. Lower Miocene, west bank of Rio Yaque del Sur opposite Palo Copado, Dominican Republic, D. D. Condit, collector, 1919, one specimen, U.S.G.S. station 8590. Lower Miocene, trail from Azua to Cabral, about 10 kilometers west of crossing of Rio Tábara, Dominican Republic, N. H. Darton, collector, 1920, one specimen, U.S.G.S. station 8760.

ORTHAULAX CONOIDES, new species.

Plate 2, figs. 1, 2, 7.

Shell medium sized, conical, spire low, the enveloping whorls bent almost at an angle of 90° at the shoulder; cross section circular; callus between the whorls lenticular below the shoulder, abruptly thinning above the shoulder and continuing as a very thin wedge to the apex of the shell; upper edge of body cavity angular on later whorls, more rounded on early whorls; aperture not known.

The dimensions in millimeters are given in the following table:

Height.	Diameter.
45+	53 (type, pl. 2, figs. 2, 7)
53+	47 (pl. 2, fig. 1)
52+	47
25+	43

Type.—Cat. No. 328395, U.S.N.M.

Type locality.—U.S.G.S. station 1/139, Porto Rico, Province of Aguadilla, pit No. 5, on right side of Rio Guajataca at dam site, from upper and harder layers of "lower limestone," altitude about 192 meters above sea level, G. R. Mansfield, collector, February 8, 1922, type and eight other specimens, four of which are casts.

The remarkable conical outline of the shell separates this species from all the described species of *Orthaulax*. A large specimen of *O. gabbi* in the collections of the United States National Museum from Alum Bluff, Florida (U.S.G.S. station 2211), has an unusually low spire and abruptly angulated shoulder, simulating the outline of *O. conoides*. The callus of *O. conoides* is more evenly lenticular below the shoulder than in *O. gabbi*, resembling *O. aguadillensis*, from which it differs in the abrupt constriction above the shoulder. As the body cavities of *O. conoides* and *O. aguadillensis* are similar, casts of the two species are virtually indistinguishable, although *O. conoides* does not reach the large size of *O. aguadillensis*. All the specimens of *O. conoides* are imperfect. They were embedded in limestone, but the shell and callus are preserved or faithfully replaced by calcite.

STRATIGRAPHIC SIGNIFICANCE OF ORTHAULAX CONOIDES.

The specimens of *Orthaulax conoides* were obtained from a soft clayey limestone that crops out in the area to be flooded by the proposed dam on Rio Guajataca. Borings at the dam site show that sandy and lignitic beds underlie this limestone. The sandy and lignitic beds are about 150 meters below the bed where the specimens of *Orthaulax* were collected. They resemble the rocks called "San Sebastian," "Lares," and "Collazo shales" by different members of the New York Academy of Sciences Scientific Survey of Porto Rico and the Virgin Islands. These rocks are at the base of the Tertiary section in the northwestern part of Porto Rico. As there is no other field evidence indicating such beds at a higher horizon, Mansfield believes that they are near the surface on the crest of an unsuspected low anticlinal arch trending almost westward.

Vaughan²⁴ has recently corroborated Maury's²⁵ correlation of the "San Sebastian," "Lares," and "Collazo shales" of the north side of the island, and the "Guanica shaly limestone" of the south side, with the middle Oligocene (Rupelian) Antigua formation of the island of Antigua.

The beds containing *Orthaulax conoides* are either an offshore phase of the upper part of these beds or are the equivalent of the overlying "Lares limestone," and are therefore considered of middle Oligocene age.

Evidence derived from other fossils is not very convincing. The following additional mollusks were collected at the type locality of *Orthaulax conoides*, station 1/139. Most of them are represented by casts or impressions.

Scaphander ? species.

Turritella, species.

Crepidula ? species.

Arca, species.

Barbatia, species.

Chlamys (Aequipecten), two species.

Lima, species.

Echinochama ? species.

Cardium (Trachycardium), species.

Teredo tubes.

A coral from the same locality seems to be the same as a coral collected by Hill at a locality 6.4 kilometers west of Lares, Porto Rico (U.S.G.S. station 3191), and identified by Vaughan as *Cyathomorpha antiguensis* (Duncan) Vaughan variety. The coral from station 1/139 is so poorly preserved, however, that positive identification has not yet been practicable.

²⁴ Vaughan, T. W., Carnegie Inst. Washington Pub. 306, p. 118, 1921.

²⁵ Maury, C. J., New York Acad. Sci., Scientific Survey of Porto Rico and the Virgin Islands, vol. 3, pt. 1, table opposite p. 4, New York Acad. Sci., 1920.

An apparently new species of the foraminiferal genus *Sorites* that has a larger early spiral stage than the upper Oligocene and lower Miocene species *S. americana* (Cushman) was collected at the same locality (station 1/139).

The following fossils were collected from lower beds in the same series at station 1/138, pit No. 4, on the right side of Rio Guajataka at the dam site, at an altitude of about 174 meters above sea level.

CORAL.

Cyathomorpha antiguensis (Duncan) Vaughan variety.

MOLLUSCA.

Chlamys (*Aequipecten*), two species.

Chlamys (*Plagioctenium*), species.

Spondylus, species.

Ostrea, species.

Cardium (*Trachycardium*), species.

Teredo tubes were collected at station 1/137 from the upper part of this series of beds on the right side of Rio Guajataka at the dam site, the altitude being about 208 meters above sea level.

EXPLANATION OF PLATES.

PLATE I.

All figures one-half natural size.

Orthaulax aguadillensis Maury.

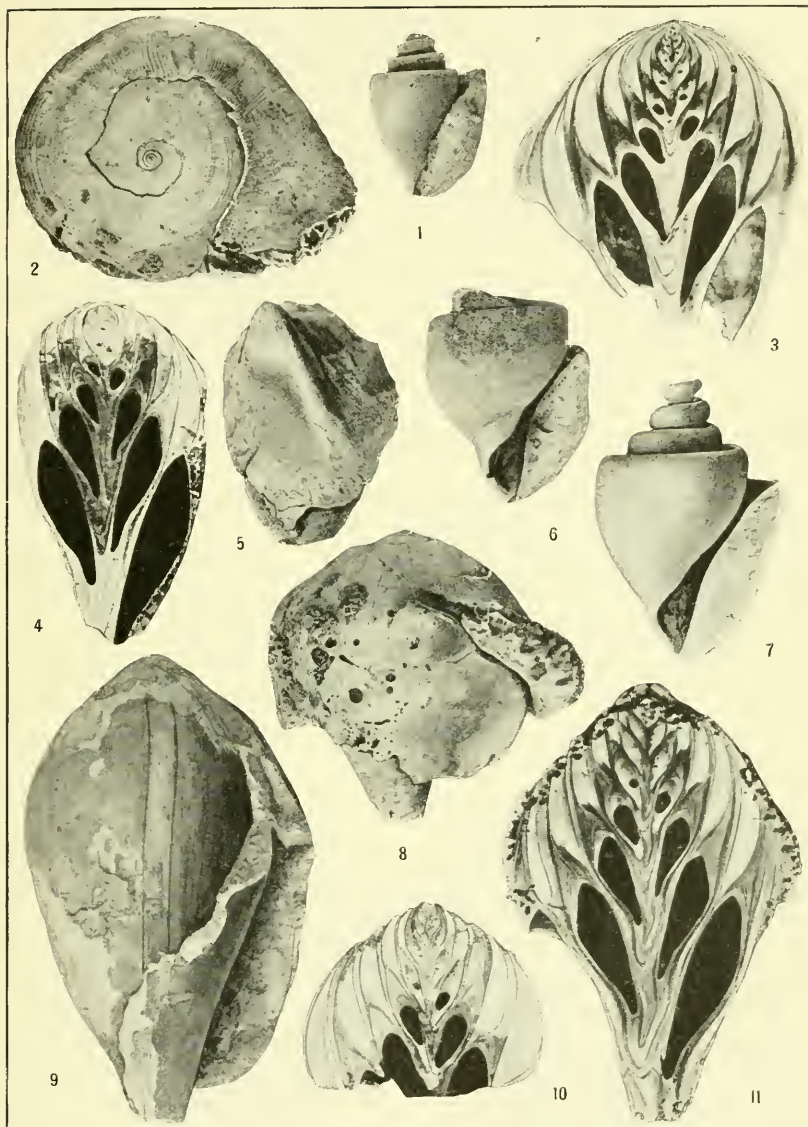
- FIG. 1.—Cast. Near Thomonde, Republic of Haiti, U.S.G.S. station 9778. Cat. No. 328388, U.S.N.M.
- 2.—Apical view of large specimen showing spiral threads on shoulder and curved growth lines. Near Thomassique, Republic of Haiti, U.S.G.S. station 9945. Cat. No. 328382, U.S.N.M.
- 3.—Axial section of specimen that has an almost perfect spire showing the completely enveloping whorls (dark) and the callus between them (light). Near Thomonde, Republic of Haiti, U.S.G.S. station 9782. Cat. No. 328385, U.S.N.M.
- 4.—Axial section of worn specimen. Near Thomonde, Republic of Haiti, U.S.G.S. station 9779. Cat. No. 328389, U.S.N.M.
- 5.—Side view of worn specimen showing thickened outer lip. Thomassique, Republic of Haiti, U.S.G.S. station 9947. Cat. No. 328383, U.S.N.M.
- 6.—Cast. Thomassique, Republic of Haiti, U.S.G.S. station 9947. Cat. No. 328387, U.S.N.M.
- 7.—Cast. Near Quebradillas, Porto Rico, U.S.G.S. station 1/146. Cat. No. 328393, U.S.N.M. Casts from the Quebradillas limestone of Porto Rico were called *O. portoricoensis* by Hubbard.
- 8.—Apertural view of specimen shown in fig. 2, showing thick columellar callus, thickened outer lip, and the deep channel between them.
- 9.—Large worn specimen. Near Thomonde, Republic of Haiti, U.S.G.S. station 9779. Cat. No. 328381 U.S.N.M.

- FIG. 10.—Axial section of specimen from same locality as specimen shown in Fig. 4. Cat. No. 328390, U.S.N.M.
- 11.—Axial section of large specimen. Near Thomonde, Republic of Haiti, U.S.G.S. station 9782. Cat. No. 328384, U.S.N.M.

PLATE 2.

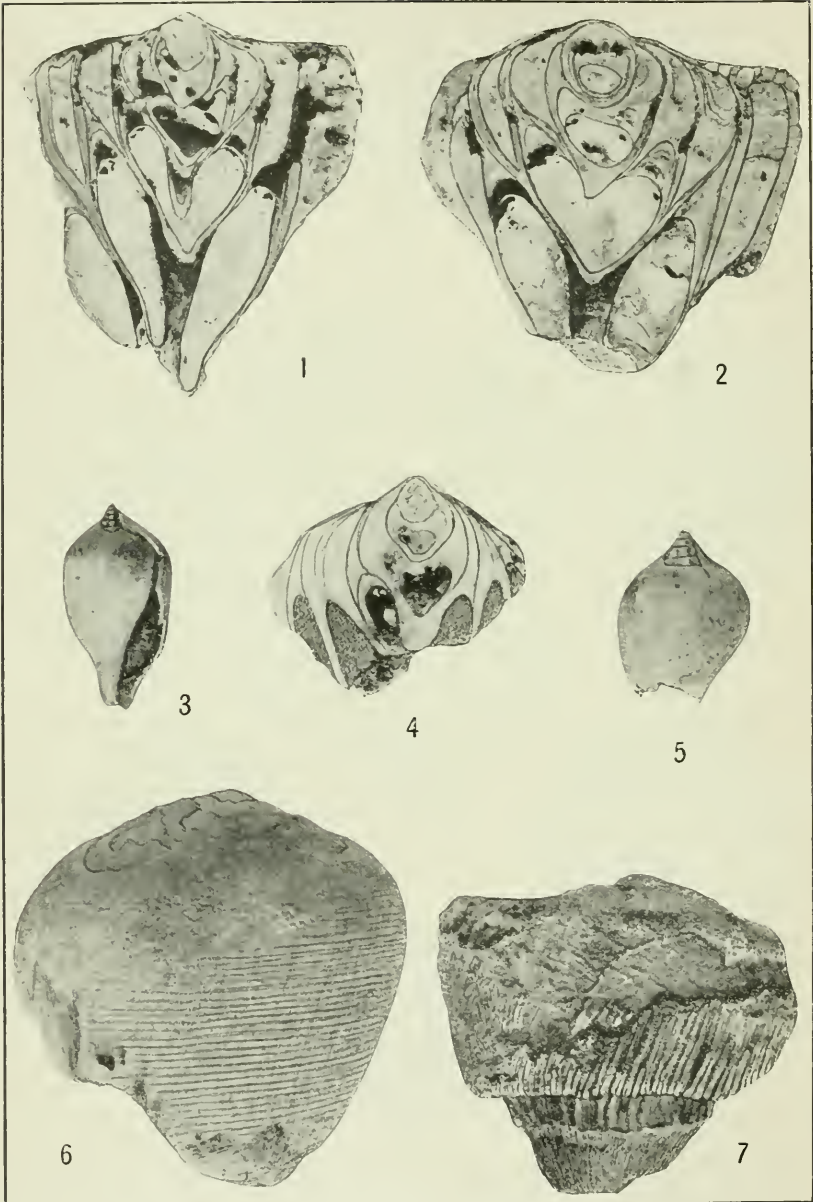
All figures natural size.

- FIG. 1.—*Orthaulax conoides* Woodring. Axial section. Rio Guajataca, Porto Rico, U.S.G.S. station 1/139. Cat. No. 328396, U.S.N.M.
- 2.—*Orthaulax conoides* Woodring. Axial section of type. Same locality. Cat. No. 328395, U.S.N.M.
- 3.—*Orthaulax aguadillensis* Maury. Apertural view of small specimen. In the last volution the whorl reaches the tip of the spire. Near Thomonde, Republic of Haiti, U.S.G.S. station 9782. Cat. No. 328391, U.S.N.M.
- 4.—*Orthaulax aguadillensis* Maury. Axial section. San Cristobal, Cuba, U.S.G.S. station 1/186. Cat. No. 328394, U.S.N.M. The rock in the cavity of this specimen contains nests of *Miogypsina antillea* (Cushman).
- 5.—*Orthaulax aguadillensis* Maury. Dorsal view of small specimen. Near Thomassique, Republic of Haiti, U.S.G.S. station 9946. Cat. No. 328392, U.S.N.M. The enveloping whorl is broken away, revealing the varices on the early whorls.
- 6.—*Orthaulax aguadillensis* Maury. Dorsal view showing spiral threads. Thomassique, Republic of Haiti, U.S.G.S. station 9947. Cat. No. 328386, U.S.N.M.
- 7.—*Orthaulax conoides* Woodring. Dorsal view of type. Rio Guajataca, Porto Rico, U.S.G.S. station 1/139. Cat. No. 328395, U.S.N.M.



ORTHAULAX AGADILLENSIS

FOR EXPLANATION OF PLATE SEE PAGES 11, 12.



ORTHAULAX CONOIDES AND O. AGUDILLENIS

FOR EXPLANATION OF PLATE SEE PAGE 12.

THE SHARPS METEORITE, RICHMOND COUNTY, VIRGINIA.¹

By THOMAS L. WATSON,
Of the University of Virginia.

The meteoric stone described below was received by the writer from Prof. Donald W. Davis, of the College of William and Mary, Williamsburg, Virginia, to whom he is indebted for the privilege of describing it. He is also indebted to Professor Davis for the information relative to the fall of the stone. Through the courtesy of Dr. George P. Merrill, of the United States National Museum, Washington, D. C., the meteorite was photographed, three casts made of it, and the stone sliced into three parts, one portion and cast each being sent to Professor Davis, the other two casts and portions being deposited in the collections of the United States National Museum and the University of Virginia.

According to information furnished by Professor Davis, the stone is reported to have fallen April 1, 1921, on the farm of F. W. Motley, a resident of Sharps, Richmond County, Virginia. Its fall was observed by Grant Yates, a colored resident of Sharps, who was working at the time in a field on the Motley farm. It is reported that Yates's attention was attracted by a whirring sound or noise which he could not account for and which badly frightened him but, on looking up, he observed "a falling body followed by a small tail of fire." The stone fell about 90 meters (100 yards) from Yates in ploughed ground and, according to his statement, was buried to a depth of 38 centimeters (15 inches). When he dug it up, it is reported to have "smelled strongly of brimstone." It will be known as the Sharps meteorite, and is the second stone thus far found within the State.

The total weight of the stone as received was 1,265 grams or about 3.4 pounds (troy); the specific gravity as determined on the entire mass was 3.53. The shape of the stone is shown in Plate 1, Figure 2. The dimensions are approximately 11.5, 7.5, and 6.5 cm. It is bounded by eight irregular, smooth faces of unequal size, which meet in edges that are well rounded. Three of the faces adjacent to each

¹For the photographs produced as Plate 1, fig. 1, and Plate 2, figs. 1 and 2, the writer is indebted to the United States Geological Survey, and Plate 1, fig. 2, to the United States National Museum.

other are concave, and each is characterized by smaller concavities or pits; the surfaces of the three faces being formed of a smooth black skinlike coating. The other faces are lighter in color (dark gray), several of which are only slightly concave, and all are essentially free from pits or minor concavities. Examination of the stone, especially the lighter-colored portion, clearly shows it to be tuffaceous in texture, which is pronounced in thin section under the microscope.

Thin sections under the microscope show the stone to be a crystalline spherulitic chondrite composed chiefly of olivine and enstatite and a considerable sprinkling of metallic iron. Plate 1, Figure 1, a composite photograph of the sawn surface of the stone, emphasizes in the right half the metallic portion shown in the tiny bright white spots, and in the left half, taken with the light at a different angle, the rock or silicate portion.

Microscopically, thin sections of the stone show it to be composed of chondrules of olivine and enstatite set in a dark brown groundmass composed of a mixture of particles of metallic iron and small fragments of the silicate minerals (pl. 2, figs. 1 and 2). The exact nature of the groundmass is largely obscured in most of the thin sections studied, due to the general presence of iron oxide stain derived from oxidation, which also frequently partially discolors the chondrules and large fragments of silicates. However, treatment of a thin section of the stone with dilute hydrochloric acid to remove the stain of iron oxide clearly shows the composition of the groundmass to be a mixture of metallic iron and small fragments of the silicate minerals olivine and enstatite. The general structure of the stone, which is characteristically tuffaceous, is shown in Figures 1 and 2 of Plate 2.

The metallic iron forms small particles of irregular shapes distributed through the groundmass as interstitial filling between the chondrules, as tiny particles inclosed in the chondrules, and occasionally as minute granular films between the fibers of the enstatite chondrules which show radiate structure. It sometimes forms partial rims or borders about the chondrules.

Chondrules of several types occur as shown in Figures 1 and 2 of Plate 2. They vary from holocrystalline to those composed of part glass and porphyritic, the outlines of which are usually sharply differentiated from the matrix. Some are of the radiate enstatite type which may show an excrescence or saucer-shaped depression (pl. 2, fig. 1), but most of them are of the glass porphyritic type composed either of olivine or of a mixture of olivine and enstatite in a glass base (pl. 2, fig. 2). An occasional barred form composed of olivine occurs. Plate 2, Figure 1, shows two large chondrules of the radiate enstatite type which, under cross nicols, exhibit pronounced cone-shaped extinction.

The ratio of phenocrysts to glass base in the glass porphyritic type of chondrule is subject to some variation, but the phenocrysts are always in excess (pl. 2, fig. 2). Except for a rare euhedral olivine phenocryst both the olivine and the enstatite of the chondrules are fragmental in appearance and are of angular or subangular outline. In origin Doctor Merrill regards these as "rock fragments reduced to their present form through mechanical attrition."² He says: "In brief, their present structural peculiarities, both external and internal, are entirely inconsistent with any conceivable theory of origin but that of detrital particles from solidified magmas."

The fragmental nature of the stone is strikingly shown in the angular fragments of both olivine and enstatite set in the dark brown ground. Some of these approach in size the larger chondrules, with smaller broken, angular ones of the same composition and form, so distributed about the larger ones as to afford unmistakable evidence of mechanical derivation.

A large number of measurements made on thin sections of the stone showed the chondrules and silicate fragments to range in size from a maximum of 0.63 mm. by 0.56 mm., and a minimum of 0.008 mm. by 0.008 mm. Of the total number of measurements, 37 per cent were equidimensional bodies, 52 per cent were of bodies whose diameters were in the ratio of 1.2 to 1.8, and 11 per cent exceeded the ratio of 2 to 1.

The following analysis of the Sharps stone I am permitted to use through the courtesy of Dr. George P. Merrill, of the United States National Museum, for whom it was made by Dr. J. E. Whitfield under a grant from the National Academy.

Metallic portions -----	Per cent. 9.69
Rock material -----	87.89
Troilite -----	2.42
	<hr/> 100.00

The metallic portion has the following composition:

Iron -----	Per cent. 88.54
Nickel -----	9.91
Cobalt -----	1.39
Phosphorus -----	trace
Sulphur -----	0.15
	<hr/> 99.99

The silicate portion freed from metal and troilite has the composition given in column 1 below, and recalculated with the proportionate amounts of metal and troilite as already given, in column 2.

²Merrill, G. P.: On Chondrules and Chondritic Structure in Meteorites. Proc. Natl. Acad. Sci., vol. 6, p. 449, 1920.

	Per cent.	Per cent.
Silica.....	42.98	37.775
Ferric oxide.....	0.16	0.138
Ferrous oxide.....	18.35	16.137
Phosphoric acid.....	0.23	0.22
Alumina.....	3.31	2.90
Manganous oxide.....	0.36	0.32
Lime.....	3.03	2.66
Magnesia.....	28.52	25.05
Nickel oxide.....	0.48	0.42
Cobalt oxide.....	trace	-----
Sulphuric anhydride.....	1.44	1.26
Soda.....	0.93	0.82
Potash.....	0.21	0.18
	100.00	87.88
Troilite.....		2.42
Metal.....		9.69
		99.99

Of the nine meteorites thus far recorded from Virginia, including the Sharps stone, seven were iron and two stone meteorites. They were distributed by provinces as follows: Four in the Mountain province west of the Blue Ridge, two in the Floyd-Carroll-Grayson counties plateau of the Blue Ridge, one in the Piedmont Plateau province, and two in the Coastal Plain province. Both the Sharps meteorite and one recorded as having fallen at Richmond, Henrico County, Virginia, June 4, 1828, are crystalline spherulitic chondrites.

EXPLANATION OF PLATES.

PLATE 1.

The Sharps, Virginia, Meteorite.

FIG. 1. Composite of a sawn surface of the stone. Right half emphasizes the metallic content in the tiny white dots, left half the stony (rock) content.

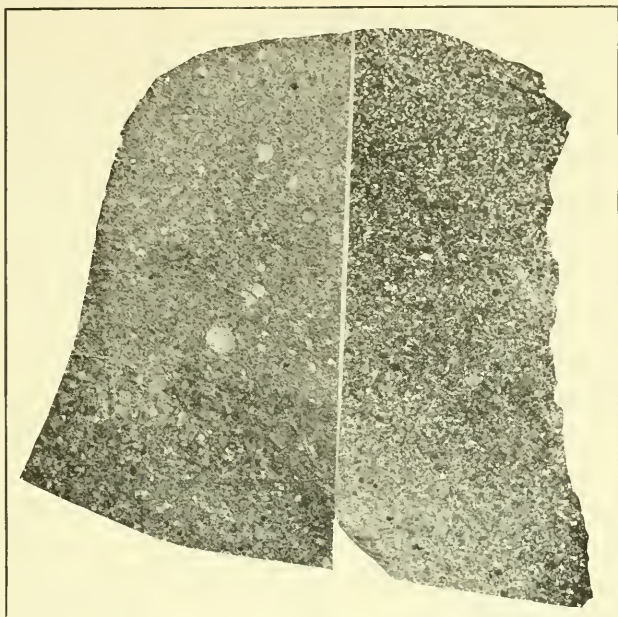
2. The stone as it was received from Professor Davis.

PLATE 2.

Microstructure of the Sharps, Virginia, Meteorite.

FIG. 1. Black, groundmass of a mixture of metallic iron and small fragments of silicate minerals; white, chondrules of enstatite and olivine. Two large chondrules of the radiate enstatite type with saucer-shaped depression and smooth outline sharply differentiated from groundmass are shown in the right and left portions of the figure.

2. Shows the pronounced fragmental (tuffaceous) character of the stone. Black, groundmass of a mixture of metallic iron and small fragments of silicate minerals; white, chondrules of glass porphyritic type and smaller angular fragments of olivine and enstatite, both usually sharply differentiated from the black groundmass. Note the rounded outline of some chondrules and the contrasted ragged, angular outline of others.



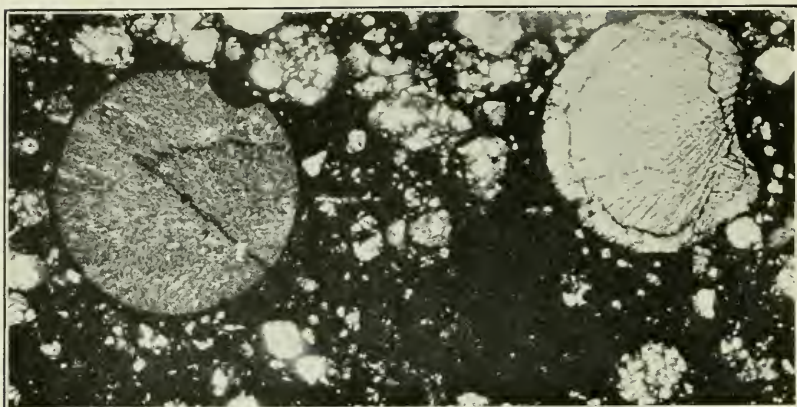
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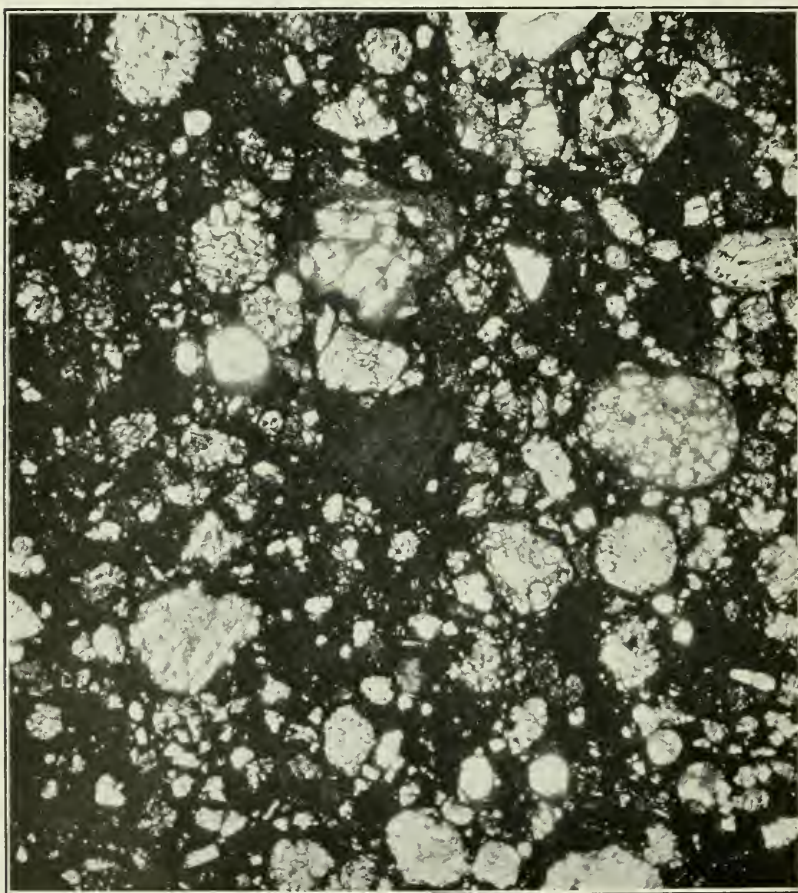
2

THE SHARPS, VIRGINIA, METEORITE

FOR EXPLANATION OF PLATE SEE PAGE 4.



1



2

MICROSTRUCTURE OF THE SHARPS, VIRGINIA, METEORITE

FOR EXPLANATION OF PLATE SEE PAGE 4.

A REMARKABLE NEW SEA STAR FROM JAPAN.

By W. K. FISHER,

Of the Hopkins Marine Station of Stanford University.

Lysastrosoma is remarkable for being the only genus known which is very closely related to *Pycnopodia* Stimpson. The latter is one of the most distinct types of Asteroiidae found in the north Pacific, and ranges from Unalaska to California (south of Monterey Bay). It is significant to discover its nearest relative on the Asiatic side of the north Pacific.

Genus **LYSASTROSOMA** Fisher.¹

Diagnosis.—Rays 5, soft and weak; abactinal skeleton reduced to isolated small spiniferous plates sometimes interspersed with vestigial perforated spineless platelets; marginal skeleton weak; superomarginals well separated, connected by a chain or festoon of small secondary ossicles; alternate superomarginals reduced in size and spineless; inferomarginals diplacanthid, spaced, sometimes connected by 1 or 2 secondary small ossicles; abactinal and marginal spines surrounded by a conspicuous, tough, retractile sheath expanded distally (and bearing numerous small crossed pedicellariae), that of the inferomarginals common to the 2 spines; adambulacral plates monacanthid, the spinelets without pedicellariae; mouth plates broad, with 1 pair of enlarged postoral adambulacral plates in contact; crossed pedicellariae with a conspicuously enlarged tooth on one side of the end of jaw, two or three smaller teeth on the opposite side, and very numerous small teeth on the shank.

Most nearly related to *Pycnopodia* Stimpson but differing in having the marginal plates disconnected or joined only by secondary intermediate marginal ossicles; broad mouth plates and enlarged postoral adambulacral plates; more conspicuous marginal circumspinal sheaths, the inferomarginal being common to two spines; adambulacral plates not sunken below level of inferomarginals; rays 5, not upward of 24.

Type.—*Lysastrosoma anthosticta*.

¹ Ann. and Mag. Nat. Hist., sec. 9, vol. 10, Dec. 1922, p. 590 (brief diagnosis).

LYSASTROSOMA ANTHOSTICTA Fisher.

Description.—Rays 5. $R=63$ mm., $r=9$ mm., $R=7r$; breadth of ray at base, 8 to 10 mm. Disk small; rays marked off from disk by a slight constriction at base. The whole body is very weak and flabby much as if it had been decalcified. This is due to the absence of a connected abactinal skeleton and also to the very loose connection between the marginal plates. Even the ambulacral and adambulacral plates are rather loosely articulated and the plates themselves are not hard and firm, but rather spongy.

The abactinal skeleton consists of widely separated, entirely disconnected, small irregular or faintly lobed plates, ordinarily from 0.4 to 0.6 mm. in diameter, each bearing a slender acicular spine surrounded by a thick, tough sheath, broadly expanded at the sum-

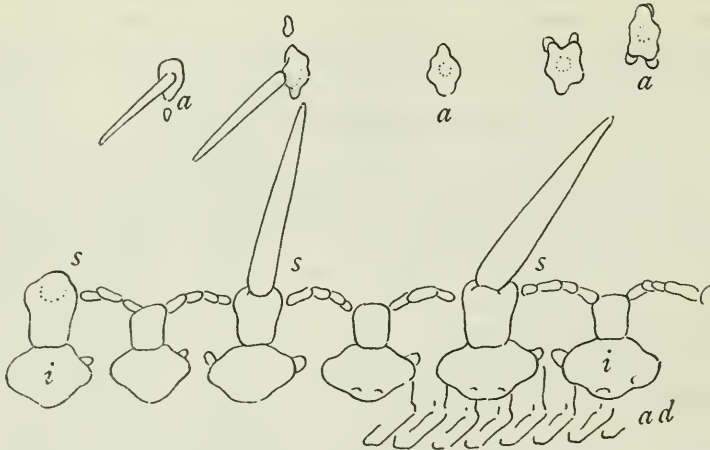


FIG. 1.—LYSASTROSOMA ANTHOSTICTA $\times 10$. MARGINAL AND 5 ABACTINAL PLATES FROM PROXIMAL HALF OF RAY; BASE OF RAY TO THE RIGHT; *a a a*, ABACTINALS; *s s s*, SPINIFEROUS SUPERMARGINALS; *i i*, INFERMARGINALS; *ad*, ADAMBULACRALS; SECONDARY MARGINALS SHOWN BETWEEN THE SUPERMARGINALS.

mit, which is very thickly beset with crossed pedicellariae. These spinelets (1 to 1.5 mm. long) are conspicuously smaller than the supermarginals, and are not at all in regular series. There appears to be the equivalent of about five longiseries, although at the base of some rays the arrangement is far too irregular to admit of exact determination. Scattered all over the abactinal surface, among the spiniferous plates and completely immersed in the integument, are numerous perforated "vestigial" plates of a generally subcircular or elliptic contour, which resemble holothurian plates and are 0.08 to 0.18 mm. in diameter. The skin is rather thickly beset with small, lanceolate straight pedicellariae of several sizes, the number varying in different examples.

Alternate supermarginal plates are spineless and smaller than the spiniferous. While at the very base of the series they touch one

another, over most of the ray they are spaced, and are connected by a curious festoon of small intermediate ossicles, as indicated in figure 1. The alternate and larger subquadrate supermarginals carry a conspicuous acicular spine about 3 mm. long, with a tough sheath expanded and convex at the summit, which usually hides the tip of the spine and is thickly covered with crossed pedicellariae. On the outer part of the ray the vestigial intermediate ossicles disappear entirely, while the marginals become very small (fig. 2).

The inferomarginal plates, which are also disconnected except at the base of the ray, each carry two equal, somewhat flattened, blunt or truncate, stout spines (subequal to the superomarginal) involved in a single sheath, which generally exceeds the spines in length and has an expanded convex summit closely beset with crossed pedicellariae. Vestigial intermediate ossicles subtend the ends of many of

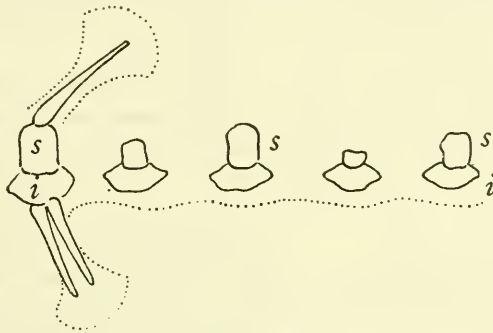


FIG. 2.—*LYSASTROSOMA ANTHOSTICTA* $\times 10$. MARGINAL PLATES FROM NEAR TIP OF RAY; BASE OF RAY TOWARD LEFT; NOTE ABSENCE OF CONNECTIVES; *s s s*, SPINIFEROUS SUPEROMARGINALS; *i i*, INFERMARGINALS.

the proximal inferomarginal plates but disappear entirely on the outer half of ray (figs. 1 and 2).

Adambulacral plates small, thin, the surface sunken somewhat below that of the inferomarginal plates which overlap them. The single spine is slender, a trifle tapered, blunt, or else untapered and subtruncate, and devoid of pendent pedicellariae. Small pedunculate, lanceolate pedicellariae occur on the furrow face of the plates.

Papulae large, numerous, in ill-defined longitudinal bands abactinally, and several to each intermarginal mesh. None actinal.

Actinostome not at all sunken. Mouth plates prominent with usually two chisel-shaped, actinostomial spines shorter than length of plate, and one similar, or more tapered, suboral spine, near the outer end of plate. The lateral or outer actinostomial spine bears a flap of tissue covered with numerous very small, lanceolate, straight pedicellariae. The first pair of postoral adambulacral plates is enlarged and in contact interradially; the second pair is widely sepa-

rated. The median suture of the first pair of plates is shorter than that of the oral plates (fig. 3).

Ambulacral furrows wide, with large, very crowded, quadriserial tube-feet. The ampullae are single and very large. The furrow widens at the base, in a very characteristic way, for the length of the first 8 to 12 ambulacral plates. The first two combined ambulacral ossicles are conspicuously enlarged; the others are very thin, and the pores are in four distinct series. Actinostome large and apparently very flexible. The nerve cord of each ray widens abruptly as it approaches the actinostome, and the circumoral cord, or fold, is conspicuous.

The madreporic body, sometimes invisible, is situated near the edge of the disk and surrounded by several spinelets.

Small crossed pedicellariae (0.2 to 0.22 mm. long) are situated, as detailed above, on the distal surface of the abactinal and marginal spine sheaths. Their form is best appreciated by the figure (fig. 5). The enlarged tooth, on one side of the jaw, and the numerous shank teeth are characteristic. Straight pedicellariae are small, slender to broadly lanceolate, but delicate and compressed; jaws apparently never spatulate. They are scattered over the surface of the body and occur on the furrow margin and outer

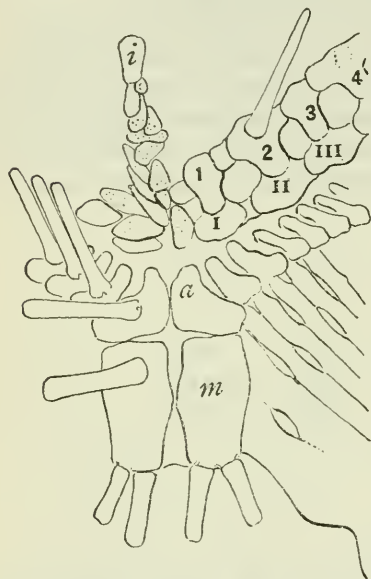


FIG. 3.—*LYSASTROSOMA ANTHOSTICTA* \times 10. DIAGRAM OF PLATES OF MOUTH ANGLE. 1-4, FIRST FOUR SUPEROMARGINALS; I-III, FIRST THREE INFEROMARGINALS; *i*, PROBABLE PRIMARY INTERRADIAL PLATE; *m*, MOUTH PLATE; *a*, FIRST, ENLARGED ADAMBULACRAL PLATE.

actinostomial oral spine. Length, 0.15 to 0.65 mm.

One of the characteristic features of this species is the fact that the rays are slightly spaced on the circumference of the disk so that there is no sharp interbranchial angle. Back of the mouth plates there is a vertical, broad, axillary channel having several fine, probably ciliated, furrows leading from the abactinal to the actinal surface. This axillary region is bounded by a distinct constriction, or furrow, which encircles each ray at its base, and beneath the skin a series of small plates extends upward from the interradial marginal plates to the abactinal end of the axillary channel, the last plate being probably the primary interradial (fig. 3, *i*). This column acts as a buttress from which a slight but tough membranous inter-

brachial septum projects into the lumen of the disk. The gonads are attached to the dorsolateral body wall, well above the superomar-

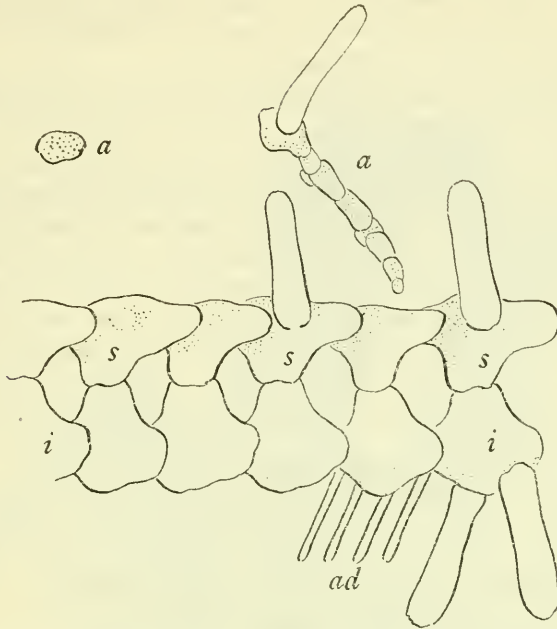


FIG. 4.—PYCNOPODIA HELIANTHOIDES. MARGINAL AND ABACTINAL PLATES OF A SMALL SPECIMEN. *a, a*, ABACTINALS; *s s s*, SPINIFEROUS SUPEROMARGINALS; *i i*, INFEROMARGINALS; *ad*, ACTINAL SURFACE OF 4 ADAMBULACRAL PLATES; BASE OF RAY TO THE RIGHT.

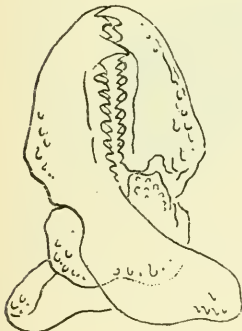


FIG. 5.—LYSASTROSOMA ANTHOSTICTA, A CROSSED PEDICELLARIA 0.21 MM. LONG, $\times 200$.



FIG. 6.—CROSSED PEDICELLARIA OF PYCNOPODIA HELIANTHOIDES, SMALL SPECIMEN. LENGTH, 0.29 MM. $\times 200$.

ginal plates, at a distance from the base about equal to minor radius. They have the usual branched structure.

Type locality.—Mororan, Hokkaido, Japan. Collected by D. S. Jordan and J. O. Snyder.

Type.—Will be deposited in the United States National Museum; cotypes in zoological collection, Stanford University, and in the British Museum (Natural History).

Remarks.—*Lysastrosoma* is sufficiently close to *Pycnopodia* to be included in the Pycnopodiinae.

The structure of the crossed pedicellariae is strikingly similar² in the two genera. In *Lysastrosoma* the large inferomarginal spinal sheath envelopes both spines, but in *Pycnopodia* each spine has its sheath with a distinct mass of pedicellariae. The difference in the size of the mouth plates is, of course, due in part to the crowding of the rays in *Pycnopodia*, but not entirely, since some polybrachiate forms—*Coronaster*, for example—avoid extreme compression of the oral plates. The line drawings show the essential difference in the arrangement of marginal plates in specimens of approximately equal size (figs. 1 and 4).

EXPLANATION OF PLATES.

PLATE 1.

Lysastrosoma anthosticta. Abactinal view of type, enlarged.

PLATE 2.

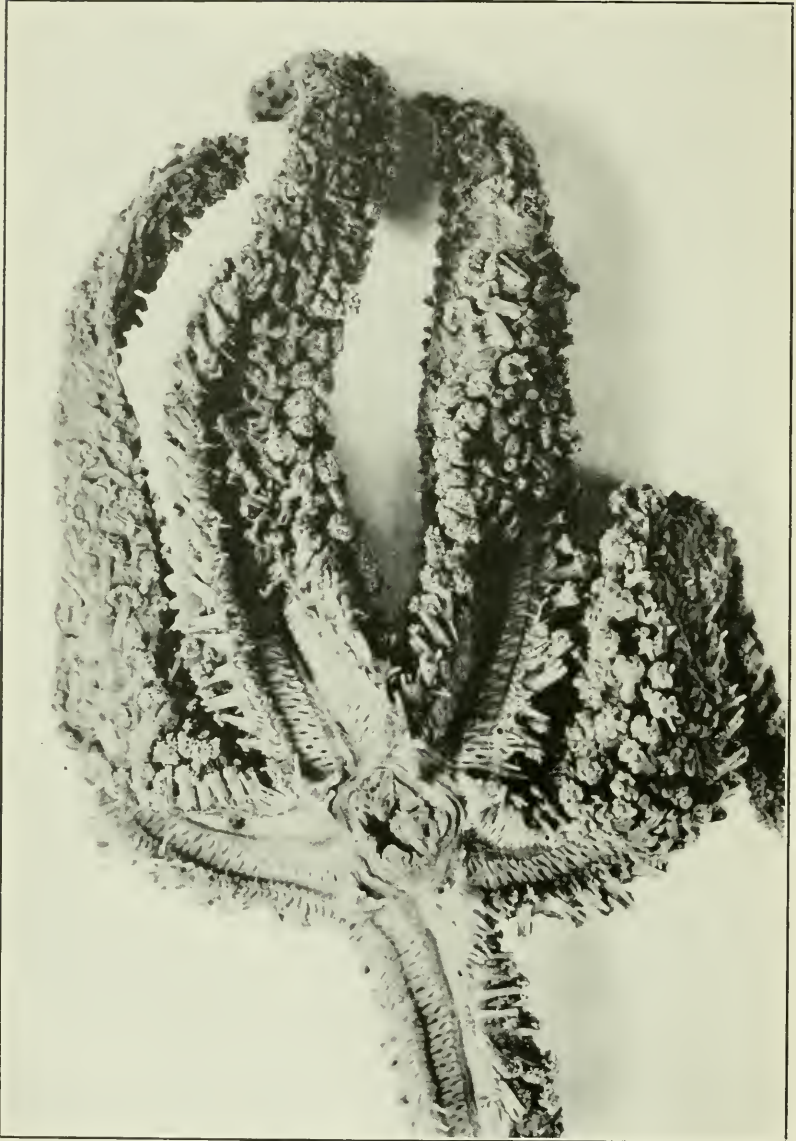
Lysastrosoma anthosticta. Actinal view of type, enlarged.

² The figures given by Verrill, *Shallow-water Starfishes of the North Pacific Coast, etc.*, 1914, text fig. 2; pl. 74, fig. 6; pl. 88, fig. 7c, for *Pycnopodia* are unlike any pedicellariae I have seen in that species. Some of the figures suggest pedicellariae of *Stylasterias forreri*.



LYSASTROSOMA ANTHOSTICTA. ABACTINAL VIEW OF TYPE, ENLARGED.

FOR EXPLANATION OF PLATE SEE PAGE 6



LYSASTROSOMA ANTHOSTICTA. ACTINAL VIEW OF TYPE, ENLARGED.

FOR EXPLANATION OF PLATE SEE PAGE 6

NEW GENERA AND SPECIES OF ICHNEUMON-FLIES.

By R. A. CUSHMAN,

Of the Bureau of Entomology, United States Department of Agriculture.

This paper contains the descriptions of two new genera and eleven new species of Ichneumonidae together with notes on a few already described species.

Subfamily CRYPTINAE.

TRIBE HEMITELINI.

Genus CHRYSOPOCTONUS Cushman.

The following key should serve to distinguish the North American species of this genus including the new one described below:

1. Ferruginous, head black, abdomen sometimes piceous at apex.

atriceps (Ashmead)

Otherwise colored ----- 2
2. Head ferruginous ----- bicolor, new species.
Head black ----- 3
3. Hind coxae in male red (female unknown) ----- chrysopae (Ashmead)
Hind coxae in male black ----- 4
4. Postpetiole in female polished and practically impunctate, in male sparsely punctate ----- rileyi (Ashmead)
Postpetiole in female laterally sparsely but coarsely and distinctly punctate, in male densely so all over ----- patruelis Cushman

CHRYSOPOCTONUS BICOLOR, new species.

Distinct from all of the other North American species in its ferruginous head.

Female.—Length 4 mm.; antennae 3 mm.

Head anteriorly densely punctate, posteriorly sparsely so; temples weakly convex; postocellar line nearly twice ocell-ocular line; face twice as wide as long; malar space longer than basal width of mandible; cheeks strongly convex. Pronotum obscurely shagreened and punctate above, striate below; mesoscutum opaque shagreened, medially densely punctate, laterally sparsely so; mesopleurum polished, prepectus punctate; scutellum polished impunctate, lateral areas strongly striate; metapleurum and propodeum rugulosely roughened; abdomen polished throughout, postpetiole with a few faint punctures posteriorly.

Head, entire thorax, and antennae ferruginous, propodeum piceous stained; front and middle legs piceo-testaceous; hind legs darker, their coxae nearly black; wings hyaline, veins and stigma blackish, the latter whitish at base; abdomen black, second tergite with a transverse yellowish band at base, from which lines of the same color project obliquely toward the posterior lateral corners, all tergites very narrowly golden at apex.

Male.—Aside from the usual sexual differences in form, differs from female practically only in having the propodeum and metapleura more strongly rugose and black.

Host.—*Chrysopa lateralis* Guerin.

Type locality.—Little River, Florida.

Type.—Cat. No. 25914, U.S.N.M.

Described from two females and one male reared from host on avocado by G. F. Mozzette, and received from the Bureau of Entomology, United States Department of Agriculture.

The paratype female has the propodeum darker than in the type and the yellow-marking of second tergite better defined.

ARACHNOLETER, new genus.

Because of the short fourth joint of the maxillary palpi in comparison with the fifth joint, together with its agreement with the characters leading up to this point in the key, the genotype runs in Schmiedeknecht's Genera Insectorum key to *Hemitelini* to *Blapsidotes* Foerster, a genus without included species.

Head transverse; temples receding to the very strong and complete occipital carina; eyes and ocelli small, the malar space and ocell-ocular line long; face short; clypeus separated, strongly elevated in middle, with a narrow reflexed margin; mandible with a strong transverse ridge at base; antennae filiform, slightly thicker beyond middle, basal joints long, first longer than second. Thorax: notauli strong, extending two-thirds the length of mesoscutum; scutellum convex, without carinae; sternauli strong and complete; prepectal carina extending to subalar tubercle; propodeum completely areolated, apophyses not prominent; legs slender; calcaria short; areolet open, the second intercubitus weakly indicated, cubitus abruptly weak beyond areolet; radial cell short, hardly as long on metacarpus as stigma, radius originating far beyond middle of stigma; nervulus inclivous and lower abscissa of postnervulus reclivous, so that brachial cell is shorter on brachius than on discoideus; abscissula shorter than intercubitella; nervellus broken at or below middle. Abdomen: first segment narrow throughout, postpetiole parallel sided, dorsal carinae strong to apex, spiracles in middle; other segments together broadly ovate; ovipositor sheath shorter than first tergite.

The male differs from female only in being slightly more slender. Sheath of genitalia very large, abruptly narrowed near apex.

Type.—*Arachnoleter swezeyi*, new species.

ARACHNOLETER SWEZEYI, new species.

Female.—Length, 5 mm.; antennae, 4 mm.

Head shagreened, the temples subpolished; temples convex; cheeks buccate; face twice as long as broad; malar space as long as basal

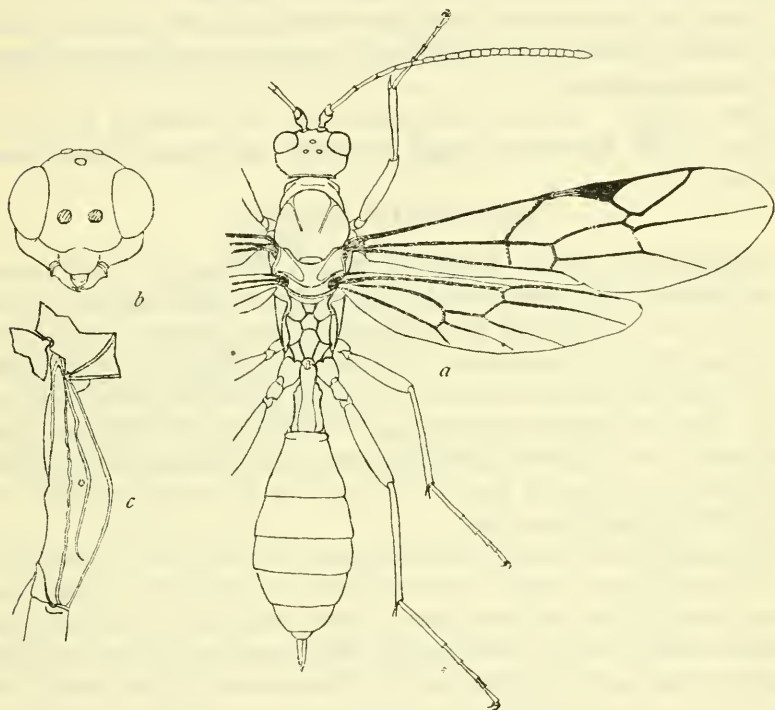


FIG. 1.—ARACHNOLETER SWEZEYI, NEW SPECIES: *a*, DORSAL VIEW SHOWING GENERAL FORM AND WING VENATION. *b*, HEAD, CEPHALIC VIEW. *c*, FIRST ABDOMINAL SEGMENT, LATERAL VIEW.

width of mandible; ocell-ocular line nearly twice the diameter of an ocellus, the postocellar line even longer; basal joint of flagellum five times as long as thick at apex. Thorax shagreened; notauli and sternauli foveolate; metapleurum and propodeum rugose, the propodeum less strongly so dorsally, areola hexagonal and broader behind than before. Abdomen shagreened; first tergite largely irregularly rugose; ovipositor sheath two-thirds as long as first tergite.

Head, thorax, and first and apical tergites black; tergites 2-5 ferruginous; flagellum brown, scape and pedicel testaceous; clypeus ferruginous; mandibles and palpi pale yellowish testaceous; legs testaceous, middle and hind tibiae and hind femur apically fuscous,

tarsal joints slightly darker at apex; wings hyaline, immaculate, venation brown, stigma basally and costa pale, tegulae testaceous.

Male.—Differs practically only sexually.

Host.—Spider eggs.

Type locality.—Oahu, Hawaii.

Type.—Cat. No. 25915, U.S.N.M.

Thirteen females and four males from various localities on Oahu and Kauai Islands reared by O. H. Swezey February to May and in November from the unidentified nests of a spider.

In size the species varies from that of the type down to 2.75 mm.; the smaller specimens also differing in having the red color of abdomen and legs paler.

Three female and one male paratypes are returned to O. H. Swezey, of the Hawaiian Sugar Planters' Association Experiment Station.

ANUROTROPUS, new genus.

The genotype runs in Foerster's key to his family Hemiteloidae to *Gynpetomorpha*, a genus without included species, and agrees with all of the few characters there assigned to the genus. But it possesses several very anomalous characters that Foerster would surely have employed had the species on which he based his genus possessed them. For this reason and because I believe that if Foerster's typeless genera are to be recognized the genotype should be selected from the European fauna, I prefer to give it a new name rather than assign it to *Gynpetomorpha*.

Antennae short, 15 to 16 jointed, scape not oblique at apex, pedicel cylindrical and nearly half as long as basal joint of flagellum, latter much thicker at apex than at base, especially in female; eyes small, broadly oval; malar space very long; ocelli very minute; temples broad and strongly convex. Thorax short, little longer than high; mesoscutum broader than long, notauli shallow but distinct and nearly complete; prepectus reaching only a short distance above front coxae, its bounding carina curving sharply forward and nearly reaching anterior margin of pleurum; sternauli deep and complete, arching apparently high up on the mesopleurum, the mesosternum swollen; propodeum very short, vertical from apex of areola, completely areolated except that costulae and apical abscissae of median carinae are obsolete or wanting, areola broadly transversely quadrangular, much wider at apex than at base, petiolar area comprising two-thirds the total length, spiracles small circular; legs long, femora stout, calcaria very short, hind tarsi tapering from base to apex; front wing incompletely veined, the second intercubitus and the postnervulus entirely lacking and the second recurrent indicated only by a very short stub on subdiscoideus and a hyaline line, radial cell very short,

areolet pentagonal in position, lower end of second recurrent much farther from base of wing than its upper end, subdiscoideus interstitial with first recurrent, second discoidal cell therefore pointed at base, nervulus postfurcal; hind wing with abscissula very short and forming a very widely obtuse angle with the intercubitus, apical abscissa of radiella wanting, nervellus slightly reclivous and curved, but not broken, the discoidella wanting, mediella wanting basally. Abdomen with first three tergites occupying practically the entire dorsal surface, each with a transverse furrow, those of the first two behind middle, deep and crenulate, that of the third shallow and smooth and before the middle; first nearly or quite as broad at apex as long, its sides divergent from base to apex, median carinae con-

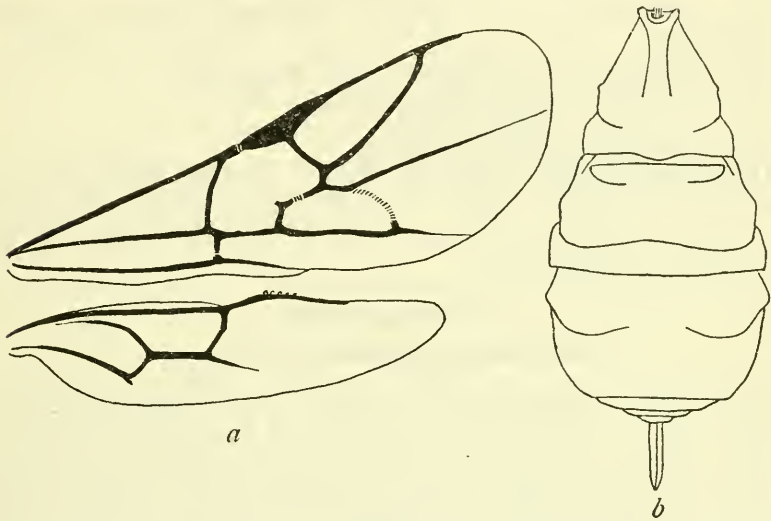


FIG. 2.—ANUROTROPUS MINUTUS, NEW SPECIES: *a*. WINGS. *b*. ABDOMEN OF FEMALE, DORSAL VIEW.

verging posteriorly and extending to transverse furrow; second tergite nearly as long as first, much broader at apex than long; third tergite slightly longer than second, its lateral and apical margins forming an almost continuous curve; ovipositor exerted, short.

Genotype.—*Anurotropus minutus*, new species.

ANUROTROPUS MINUTUS, new species.

Female.—Length 2.5 mm.; antennae 1.5 mm.

Head shining, weakly punctate, face more densely and strongly so; face nearly three times as wide as long medially; clypeus distinctly separated; malar space much longer than basal width of mandible; antennae 16-jointed, first joints of flagellum more than three times as long as thick at apex, others decreasing in length toward apex, the sub-apical ones little more than a third as long as first. Thorax shining,

sparsely punctate, polished and impunctate laterally, metapleurum subopaque; propodeum longitudinally rugulose between the transverse carinae, shining before and behind. First and second tergites very densely opaquely punctate basad of the transverse furrows, polished beyond, second with a transverse longitudinally striate impression just before the furrow; third tergite polished; ovipositor sheath two-thirds as long as first tergite.

Black; clypeus piceous; scape and pedicel, mandibles, palpi, tegulae, and legs (largely) stramineous to pale testaceous, the palpi palest and the hind legs with the most red, hind femur and tibia and all tarsi apically infuscate; wings hyaline, venation, except costa, pale.

Male.—Smaller and more slender; antennae 15-jointed; otherwise like female.

Type locality.—Agricultural College, Michigan.

Allotype locality.—Algonquin, Illinois.

Type.—Cat. No. 25916, U.S.N.M.

One female (type) bearing the label "Ag. Coll. Mich., 234," and one male (allotype) labeled "5.10.96-151" and also the number 6714; also one female (paratype) taken at Madison, Connecticut, July 25, 1919, by W. E. Britton.

TRIBE CRYPTINI.

CRYPTOIDEUS BITUMINOSUS, new species.

In my key to North American species¹ runs directly to *luctuosus* (Provancher), from which it may at once be distinguished by the very indistinct sternauli not at all indicated posteriorly; first flagellar joint distinctly longer than second; immaculate wings; long and distinct notauli; propodeum coriaceous before and punctate behind basal carina. The propodeal spiracles are only slightly oval though distinctly not round as in *agrili* (Viereck); and the malar space is only slightly longer than the basal width of mandible.

From *agrili* it is at once distinguishable by its lack of antennal annulus and immaculate, pale infumate wings as well as by the structural character used in the key.

Female.—Length 8.5 mm.; antennae 6.5 mm.; ovipositor 2 mm.

Temples narrower than eyes, evenly convex; cheeks from in front weakly convex; malar space slightly longer than basal width of mandible; vertex, frons and face confluent punctate; inner orbits, malar space and temples shagreened, the last sparsely punctate; cheeks polished and sparsely punctate. Mesoscutum opaque shagreened, finely and densely punctate; scutellum polished, sparsely punctate; pleura and propodeum coarsely, confluent punctate, the

¹Proc. U. S. Nat. Mus., vol. 55, 1919, p. 536.

latter coriaceous before the basal carina; apical carina complete; areolet not convergent toward radius; discocubitus practically straight. First tergite subpolished, faintly shagreened, postpetiole laterally roughened and opaque; abdomen otherwise subopaque the earlier tergites strongly, closely punctate.

Coal black; wings dilutely infumate.

Host.—*Sphenophorus pertinax* Olivier.

Type locality.—Flushing, New York.

Type.—Cat. No. 25917, U.S.N.M.

One specimen reared April 30, 1920, from material collected October 13, 1919, by A. F. Satterthwaite.

CRYPTOIDEUS ANTHRACINUS, new species.

Because of its entirely black color and short malar space, runs in my key to species best to *agrili* (Viereck); but the spiracles are slightly oval, the temples slightly narrower than the eyes, the sternauli more distinct, the apical propodeal carina complete, and the ovipositor longer. It also differs in several of the following characters. From *bituminosus* it is at once distinguished by its fasciate wings and annulated antennae.

Female.—Length 12 mm.; antennae 8 mm.; ovipositor 5 mm.

Head coarsely and confluent punctate throughout, the sculpture becoming more or less rugulose on temples; temples slightly narrower than eyes; malar space distinctly shorter than basal width of mandible, granular; clypeus polished at apex, the apical tooth strong; cheeks buccate; basal joint of flagellum very slightly longer than second; apical joint cylindrical, truncate at apex. Thorax coarsely punctate, confluent so on sides of pronotum and on pleura, the punctures on mesoscutum, especially laterally, and on scutellum separated, the interspaces polished; notauli and sternauli distinct; propodeum basad of basal carina polished and sparsely punctate, apical of the carina coarsely reticulately rugose, apical carina strong on angles, weak and irregular medially; spiracles very broadly oval; discocubitus subangulate just basad of middle; intertubiti convergent above. Abdomen finely, opaquely shagreened; tergites 2-4 also densely punctate; petiole broadly flattened above, medially opaque, laterally polished, postpetiole medially at apex and base of second tergite, including gastrocoeli also polished; ovipositor sheath nearly as long as abdomen.

Black; posterior orbits and tibiae slightly reddish; flagellum with white annulus; wings hyaline with distinct stigmal and apical fasciae.

Host.—*Saperda obliqua* Say.

Type locality.—Lyme, Connecticut.

Type.—Cat. No. 25918, U.S.N.M.

One female reared by A. B. Champlain under Hopkins U. S. No. 11948.^a

HELCOSTIZUS ANNULICORNIS (Walsh).

Echthrus annulicornis WALSH, Trans. St. Louis Acad. Sci., vol. 3, 1873, p. 159.

This species appears to be a small, slender *Helcostizus* with two transverse carinae on the propodeum, though the wording regarding the latter character is somewhat obscure. Except for the size and the proportions of the flagellar joints and tergites the type of *Helcostizus bicarinatus* Cushman agrees very well.

SPILOCRYPTUS CIMBICIVORUS, new species.

Very closely related to its European congener of the same host-relations, *cimbicis* (Tschek), but the basal flagellar joints are relatively stouter and in the female the inner orbits immaculate. In the male also it differs in having the front and middle coxae entirely black, the face white only laterally, the malar space immaculate, the frontal orbits not at all or only narrowly white, the pronotum white at most only medially, and the subalar tubercle, scutellum and post-scutellum, and propodeum immaculate, and the white of the hind tarsi confined to joints 2-4.

In Provancher's key² to the species of *Cryptus* the female runs to *nuncius* Say and the male to *apicatus* Provancher. From *nuncius* the female differs in the relatively shorter basal flagellar joints, medially wanting apical carina of propodeum and stronger apophyses, the partly red fourth tergite, and the lack of white on the hind tarsi. From *apicatus* the male differs in its white inner orbits, clypeus, mandibles, palpi, and tegulae; stouter thorax; medially wanting apical carina; smooth and noncarinate first tergite with its spiracles far beyond the middle; entirely red tergites 2-4; white spotted seventh tergite and white annulate tibiae and tarsi.

Female.—Length, 7 mm.; antennae, 5 mm.; ovipositor, 1.5 mm.

Head shagreened and sparsely punctate; temples strongly convex, receding, almost impunctate; cheeks polished below; frons medially finely, irregularly rugulose; face medially longitudinally elevated, with a shallow impression on each side just above clypeus; clypeus elevated medially and with a narrow reflexed margin; malar space about as long as basal width of mandible; eyes parallel; basal joints of flagellum elongate, first slightly longer than second. Thorax rather stout; pronotum longitudinally rugulose laterally behind the distinct epomia, mesoscutum polished, with fine separated punctures, notauli fine but distinct; scutellum like mesoscutum but more sparsely punctured; mesopleurum finely rugulose punctate, sternum punc-

^a Add. Faune Ent. Can., 1889, p. 61.

tate, sternauli short but strong; metapleurum and propodeum irregularly rugulose, the latter polished and sparsely punctate before the weak basal carina; apical carina broadly incomplete medially, apophyses prominent, flange like; areolet large, sides slightly convergent; discocubitus sinuate but not broken; nervulus interstitial; nervellus broken far below middle, perpendicular. Abdomen finely shagreened; first tergite depressed, petiole flat above and polished, postpetiole very broad, spiracles at apical third; ovipositor sheath a half longer than first tergite.

Black, with middle of abdomen, including postpetiole and base of fourth tergite ferruginous, incomplete annulus occupying flagellar joints 5-9, radices of wings, and spot on seventh tergite white; flagellum otherwise fuscous with basal joints more reddish; front and middle coxae and all trochanters largely piceous, hind coxae red; hind femur at apex, hind tibia and tarsus fuscous, the tibia with a white basal annulus; legs otherwise testaceous to stramineous; wings faintly brownish hyaline, venation brown.

Male.—Has malar space shorter, apophyses weaker, and abdomen much more slender with postpetiole longer than wide, but structurally otherwise much like female; flagellum, except a white spot at extreme base above, black; anterior orbits, broadly below and narrowly above antennae, clypeus except margin, disk of mandible, palpi, anterior median margin of pronotum, tegulae largely, spot at apex of seventh tergite, base of hind tibia and middle three joints of hind tarsus white; all coxae and apical half of femur black.

Host.—*Cimex americana* Leach.

Type locality.—Brookings, South Dakota.

Type.—Cat. No. 25919, U.S.N.M.

Seven females and seven males reared May 17-26, 1891, at the South Dakota Experiment Station, and determined by G. C. Davis as *Cryptus extrematus* Cresson.

There is considerable variation in size in both directions from that of the type, the largest female being 9 and the smallest 5 mm. long. In the male the frontal orbits, the collar, and the seventh tergite are sometimes not at all white marked and the second joint of hind tarsus is largely black.

One pair of paratypes is returned to the South Dakota Experiment Station.

Subfamily ICHNEUMONINAE.

TRIBE ODONTOMERINI.

ODONTOMERUS STEJNEGERI, new species.

Female.—Length 9 mm.; ovipositor 6.5 mm.; antennae (flagella missing).

In Rohwer's key³ to North American species runs best to couplet 7, where it differs from *aethiops* Cresson in its short ovipositor and impunctate second and third tergites and from *atripes* Rohwer female in its black abdomen and short ovipositor. From *aethiops*, to which its black abdomen most closely allies it, it differs further in having the head wider behind the eyes and the temples not evenly convex as in *aethiops*, but much more strongly so posteriorly than immediately behind the eyes; also in having the front legs with a distinctly reddish tinge.

Mouth much wider than face; eyes strongly convergent below, small, twice as long as wide; face, cheeks, and lower temples coarsely and sparsely punctate, upper temples, vertex and frons polished and practically impunctate; ocellar triangle hardly broader than length of ocell-ocular line. Thorax polished, sparsely punctate, the punctures coarsest and densest in middle of mesoscutum and scutellum; propodeum completely areolated, but costellae and median carinae weak, hind angles dentate; hind femur stout, its thickness at apex of tooth about half its length. First tergite about twice as long as broad at apex, coriaceous, carinae obsolete; abdomen otherwise polished, unsculptured, second tergite about as long as broad at base; ovipositor as long as abdomen and half of thorax, the sheath broadened in its apical half.

Entirely black except that front and middle legs, palpi, and mandibles are more or less reddish; wings fusco-hyaline, venation black.

Type locality.—Robben Island, Okhotsk Sea.

Type.—Cat. No. 25920, U.S.N.M.

One female taken by Leonhard Stejneger on August 17, 1922.

TRIBE PHYTODIETINI.

PHYTODIETUS PULCHERRIMUS (Cresson).

This species differs from all of the other North American species with maculated propodeum in that the propodeum lacks all trace of a median longitudinal impression and the yellow spot instead of being divided or medially emarginate in front projects roundly toward the base; also the antennae are ferruginous with base and apex black, more contractingly so in the male.

The female has not been described. There is in the National Collection a female from Georgetown, District of Columbia, H. H. Smith, collector, that I take to be of this species. It runs in Rohwer's⁴ key to species to couplet 8, where in its uniformly ferruginous hind femora it agrees with *distinctus* Cresson, but it has a large precoxal white spot on mesopleurum and a smaller one at the

³ Proc. U. S. Nat. Mus., vol. 57, 1920, p. 455.

⁴ Idem, p. 461.

dorsal end of the prepectal carina, in addition to differing by the characters mentioned above.

From the male it differs in having the eyes larger and nearly parallel; the face and malar space narrower; the face medially black with a large yellow spot below each antenna; the thorax much less extensively yellow with the mesosternum entirely black; the metapleurum and sides of propodeum partly rufous; the legs generally darker testaceous, this color including the hind coxae, which lack the dorsal black stripe; and the antennae less distinctly bicolored, though distinctly paler before the apex and below.

Another female specimen from Montana which appears not to differ structurally has the basal three tergites rufous instead of black and the fourth partly so.

Phytodietus gracilicornis Cresson, from Mexico, is related in structure and color to *pulcherrimus*.

Subfamily OPHIONINAE.

TRIBE CAMPOPLEGINI.

HYPOSOTER RUBIGINOSUS, new species.

Remarkable chiefly because of its entirely ferruginous body, with only the head black. In color most like (*Limneria*) *Hyposoter rufa* (Ashmead), from which the male of the present species is at once distinguished by its black face and whitish clypeus.

Female.—Length 8 mm.; antennae 7 mm.

Head strongly transverse with temples and postvertex strongly sloping, opaque shagreened; face densely punctate and densely gray pubescent, slightly narrowing below; eyes slightly emarginate; clypeus broadly subtruncate and with a narrow reflexed margin; malar space half basal width of mandible; diameter of lateral ocellus shorter than postocellar line and longer than ocell-ocular line; flagellum rather stout, tapering toward apex. Thorax opaque shagreened throughout with more or less distinct punctuation on mesoscutum, pleura, and sternum; notauli obsolete, rugulose; propodeum nearly completely areolated, the costulae present and the areola and petiolar area separated; spiracles broadly oval; petiolar area transversely rugulose, propodeum otherwise granularly opaque; legs moderately stout; hind calcaria two-thirds as long as basitarsus, apical tarsal joint slightly longer than fourth, claws large and strongly pectinate; tibiae and tarsi spinose; stigma and radial cell narrow lanceolate, radius barely angulate; areolet petiolate, recurrent beyond middle; nervulus postfurcal; subdiscoideus slightly above middle of post-nervulus; lower outer angle of second discoidal cell acute; abscissula slightly longer than recurrentella; nervellus vertical, unbroken. Abdomen granularly opaque, stout, weakly compressed toward apex, the compression beginning beyond base of third segment; first tergite

slightly decurved, spiracle beyond apical third; postpetiole about three times as wide as petiole, a deep fovea on each side at junction of petiole and postpetiole; spiracles of second tergite slightly before middle, gastrocoeli slightly removed from base; ovipositor slightly exerted.

Ferruginous; head black with clypeus, mouthparts, and scape and pedicel largely yellowish; flagellum black, apex reddish; radices of wings and tegulae white; front coxae, front and middle trochanters, their tibiae outwardly and their tarsi stramineous; calcaria white; legs otherwise testaceous; sheath black.

Male.—In form and structure like female except in usual sexual differences. Front and middle legs entirely, and hind coxae beneath and their trochanters white.

Host.—*Olene basiflavus* Packard.

Type locality.—Stonington, Connecticut.

Allotype locality.—Rochester, Massachusetts.

Other locality.—Marion, Massachusetts.

Type.—Cat. No. 25921, U.S.N.M.

Described from three females and one male reared at the Gypsy Moth Laboratory, Melrose Highlands, Massachusetts, under Nos. 12209 (type and paratype *a*), 10067 *d* 4 (paratype *b*), and 10067 *c* 1 (allotype).

The cocoon of this species is very remarkable. The cocoon proper is spun inside the skin of the host exactly as in *Hyposoter fugitios* (Say), but on the ventral side and protruding through a slit in the skin of the host is a small cocoon-like structure with its anterior end open as though some smaller insect had emerged from it.

ECHTHRONOMAS OCHREOFRONS, new species.

Because of its rather elongately oval propodeal spiracle, rather weakly compressed abdomen, and long calcaria this species runs to *Echthronomas* in both Foerster's and Schmiedeknecht's keys, and agrees in structure perfectly with the latter's description of the genotype, *ochrostoma* Holmgren; but aside from the shape of the spiracle it does not seem to me to differ generically from species placed by American writers in *Hyposoter*, *Hypotherutes*, *Ischnoscopus*, and *Ameloctonus* and those assigned by European writers to *Anilastus*, all of which have been synonymized by Gahan⁵ under *Hyposoter*. Moreover, I doubt if the male, which I do not know, would differ even in the form of the spiracle from *Hyposoter*. In fact, I have before me a certainly congeneric, though not conspecific, male with even more elaborate yellow markings, that has the spiracles perfectly circular.

Female.—Length, 8 mm.; antennae, 8 mm.

⁵Proc. U. S. Nat. Mus., vol. 48, 1914, p. 156.

Head antero-posteriorly very thin with the temples very strongly receding and postvertex nearly perpendicular from ocelli to occipital carina; face and frons finely granularly opaque with obscure punctures, the former slightly narrowing below, flattened, and clothed with rather long, white pubescence; clypeus broadly subtruncate at apex; labrum triangularly exerted, the apical angle notched, malar space barely a third as long as basal width of mandible; eyes rather strongly emarginate within; mandibles much longer than wide at base, where they are nearly twice as wide as at apex, upper tooth larger and slightly longer than lower; antennae rather stout, scape not obliquely truncate at apex; diameter of lateral ocellus a half longer than ocellular line and subequal to postocellar line. Thorax opaque, even the speculum shagreened, clothed with conspicuous white hair, mesoscutum, scutellum, lower mesopleura and sternum and metapleura also more or less punctate, mesoscutum most strongly so; lower angle of pronotum and upper portion of mesopleurum rugulose, punctiform fovea very deep and conspicuous; propodeum basally and laterally sculptured like metapleurum; medially slightly concave and transversely rugulose, basal carina and lateral portion of apical carina distinct, spiracle about twice as long as wide; legs, especially hind femur, rather stout, hind tibia and tarsus spiny, longer calcarium more than two-thirds as long as basitarsus, last two tarsal joints equal in length; stigma and radial cell narrow lanceolate, the radius hardly angulate, areolet petiolate with recurrent beyond middle, nervulus strongly postfurcal, subdiscoideus at about middle of postnervulus; abscissula and intercubitella subequal, nervellus reclivous unbroken. Abdomen compressed from base of third segment; first tergite with postpetiole about twice as wide as petiole, in side view slightly decurved, spiracles at apical two-fifths, petiole foveate laterally, postpetiole ridged but not distinctly carinate laterally; spiracles of second tergite at the middle, gastrocoeli nearly circular and shortly removed from base; ovipositor scarcely exerted.

Black, with abdomen largely ferruginous; face, cheeks, clypeus, mouth parts, frontal orbits except narrow interruption above antennae, scape and pedicel beneath, tegulae, humeral angle of pronotum, and a spot beneath hind wing yellow; flagellum black; front and middle legs stramineous with the femora and apices of the tibiae slightly testaceous; hind coxa black at base and above, ferruginous beneath, trochanter black at base, otherwise stramineous, femur ferruginous, tibia black with a broad whitish band between middle and base, reddish below toward apex, calcaria white, tarsus black; first tergite except apex and stains on apical tergite black.

Type locality.—Veitch, Virginia.

Type.—Cat. No. 25922, U.S.N.M.

One female taken by William Middleton.

TRIBE CREMASTINI.

Genus XIPHOSOMELLA Szepligeti.

Judging from the new species described below, this genus is, in several respects, intermediate between *Eiphosoma* Cresson and *Pristomerus* Curtis. The lateral edges of the first tergite, although touching along the ventral median line, are not completely fused as in *Eiphosoma*, but leave a distinct suture. The stigma is relatively broader than in *Eiphosoma* though narrower than in *Pristomerus*, and the radius originates at about its middle. The petiolar area is much longer than in *Eiphosoma*. The areola is usually open at the sides, though according to Szepligeti, it is closed in the genotype, *Xiphosomella brasiliensis* Szepligeti. The hind femur is stouter and not attenuate at the base as in *Eiphosoma*, and the tooth is before the apical fourth in the female and at about the apical third in the male. The abdomen is in form about intermediate between the two genera, being shorter and less strongly compressed than in *Eiphosoma* and broader and more strongly compressed than in *Pristomerus*.

In general form and in more minute structure it is perhaps somewhat more closely related to *Eiphosoma*.

XIPHOSOMELLA STENOMAE, new species.

Will run to neither of Szepligeti's three species in his key,⁶ agreeing with *brasiliensis* in the sculpture of the mesoscutum and with *boliviensis* and *cremastoides* in the incomplete areola and distinct though short intercubitus. From the only other described species, *tabascensis* Morley, it is immediately distinguishable in having the mesoscutum black not red.

Female.—Length 13 mm.; antennae 8 mm.; ovipositor 4 mm.

Head broad and very thin, temples very narrow, the occiput occupying nearly the entire posterior surface; frons, vertex, and temples opaque shagreened; frons with a longitudinal welt on each side next to the eyes; face polished, sparsely punctate, medially longitudinally elevated, nearly twice as wide as long; eyes nearly parallel within, the face very slightly wider than frons; clypeus about half as wide as face; distinctly separated, strongly convex, rounded at apex, with a narrow reflexed margin; malar space about half as long as basal width of mandible; mandibles nearly as broad at base as long with lower margin narrowly flangelike, upper tooth slightly longer and larger than lower. Thorax short; pronotum polished, deeply impressed laterally, epomia strong; mesoscutum polished with very sparse punctures anteriorly, notauli very deep but fading

⁶ Ann. Mus. Nat. Hung., vol. 4, 1906, p. 120.

out on the disk, a small longitudinally striate area between their posterior extremities; scutellum transverse, convex; polished; mesopleurum and sternum densely punctate, the former obliquely striate in upper anterior corner and in the oblique impression, polished along dorsal and posterior margins; sternauli distinctly impressed; metapleurum vertically striately shagreened with sparse punctures, propodeum completely areolated except that areola is open laterally; basal areas shagreened; middle area shagreened, laterally more or less punctate and medially transversely striate; apical areas transversely rugose; petiolar area as long as areola, rounded in front; intercubitus short but not entirely obliterated; abdomen nearly three times as long as head and thorax; second tergite slightly longer than first; epipleura of third tergite extending to spiracle; ovipositor sheath half as long as abdomen.

Tricolored; middle of face, frons, vertex, occiput, flagellum, mesoscutum, anterior margin of mesopleurum, the oblique impression in front, sternauli, part of lateral areas of scutellum, basal lateral areas and streaks in middle lateral areas, and a narrow median stripe extending the entire length of the abdomen except the petiole black; the head and thorax otherwise, except ferruginous stains on mesopleurum, sternum, propodeum, and the posterior orbits yellow, abdomen ferruginous, petiole stramineous; palpi, front and middle coxae and trochanters, apices of all femora and of hind coxae, hind tibia beneath at base and its calcaria stramineous; legs otherwise testaceous, except hind tibia and tarsus which are black; wings hyaline, venation black, front wings apically infumate.

Male.—Differs only sexually from female.

Type locality.—Ancon, Canal Zone, Panama.

Type.—Cat. No. 25923, U. S. N. M.

One pair reared August 8, 1921, from *Stenoma catinifer* Walsingham by J. Zetek, under his No. Z1532.

TRIBE PANISCINI.

PANISCUS RUGOSUS, new species.

Very distinct in its complete and very high propodeal carina.

Female.—Length 23 mm.; antennae 23 mm.

Temples nearly flat and sharply receding; occipital carina strong and complete though weak medially and approaching closely to ocelli; face longer than wide slightly convergent below, distinctly, sparsely punctate, the interspaces shagreened; clypeus sculptured like the face, long, narrowly truncate; frons narrower than face; ocelli very large, touching the eyes, postocellar line one-third as long as ocellar diameter; antennae rather stout, basal flagellar joint

nearly as long as next two combined, middle joints nearly twice as long as thick. Thorax granularly opaque; notauli distinct to beyond middle of mesocutum; scutellum margined to apex, the space between carinae about three-fourths as wide at apex as at base, with a median fovea; position of sternauli deeply and broadly concave; metapleurum posteriorly strongly and irregularly rugose; propodeum with apical carina very strong and high, the area in front with a few irregular rugae; areolet subelongate, the lower side nearly continuous with rest of cubitus, second intercubitus sharply broken; second recurrent strongly bent at upper third, otherwise nearly straight, interstitial; nervulus postfurcal by about half its length, nearly perpendicular; postnervulus broken at upper two-fifths; ramellus long; nervellus broken below upper third; legs stout, hind femur three-fourths as long as tibia, latter four-fifths as long as tarsus; tarsi very stout, very finely and densely pubescent beneath, fourth joint of middle tarsus about as broad as long, apical joint as long as or slightly longer than second, claws very large with about fourteen large teeth and several small basal ones. First tergite nearly four times as long as wide at apex; second two-thirds as wide at apex as long, two-thirds as long as first; sheath distinctly shorter than first tergite.

Rufo-testaceous; head more yellowish; vertex concolorous; flagellum black; wings hyaline, venation dark, stigma and costa pale testaceous; legs testaceous, tarsi paler.

Type locality.—Chejel, Guatemala.

Paratype locality.—Cordova, Vera Cruz, Mexico.

Type.—Cat. No. 25924, U. S. N. M.

Described from three females, the type and paratype *a* taken at the type locality in June by Schaus and Barnes and paratype *b* at the Mexican locality by Frederick Knab.

The paratypes exhibit only slight variations of color, size, and structure.

FOSSIL BIRDS FROM SOUTHEASTERN ARIZONA.

By ALEXANDER WETMORE,

Of the Biological Survey, United States Department of Agriculture.

During February, March, and April, 1921, Dr. J. W. Gidley, assistant curator of fossil mammals, United States National Museum, made an extensive collection of fossils from newly discovered beds in the upper San Pedro Valley, Cochise County, Arizona. Among rich deposits of mammalian remains were found a small number of bones of birds, all considerably broken, that Doctor Gidley has kindly placed in the hands of the writer for study; those that may be identified with any degree of certainty are described in the pages that follow.

The first locality where excavations were made was in a wash draining into what are known as the Curtis Flats (near the Curtis Ranch), in Sec. 25, T. 18 S., R. 21 E., a point about 14 miles southeast of Benson. Bird remains from this site, few in number, are dark slate in color, and have been considerably crushed and broken. They include the following:

Odontophoridae (indeterminate).

Chloroenas micula, new species.

Fringillidae (indeterminate).

More extensive collections were secured at a second site in a quarry on Sec. 22, T. 17 S., R. 20 E., a point about 2 miles south of Benson. A considerable excavation here yielded a large quantity of fossil material among which was a considerable number of bones of birds. These, though fairly fossilized, are almost as light in color as natural bone. The specimens are all small and were secured, with many remains of other small vertebrates, by careful search in unconsolidated material.

The list of identified specimens from this quarry is longer than that from the first point worked, as it includes the following:

Colymbus, species.

Querquedula, species.

Dendrocygna eversa, new species.

Branta minuscula, new species.

Anatidae (indeterminate).

Colinus, species.

Gallinula, species.

Micropalama hesternus, new species.

Corvus, species.

Junco, species.

Fringillidae (indeterminate).

A few bones were secured from a point one-half mile south of the second quarry (mentioned in the preceding paragraph) at a distance of $2\frac{1}{2}$ miles south of Benson. A limited excavation here revealed various mammalian bones (among them remains of a mastodon of Pliocene age), but yielded only one bird, a specimen nevertheless of great interest. It is identified as follows:

Agriocharis, species.

Following his preliminary examinations of the mammalian remains with which these bird bones are associated Doctor Gidley now considers these Benson beds as upper Pliocene, a supposition that is not controverted by the avian fossils. In the four forms of birds described as new from these deposits are three species of aquatic or littoral habit, a tree-duck, a small goose, and a sandpiper, not one of which has been reported from the first interglacial deposits at Fossil or Silver Lakes, Oregon, noted for their wealth of water fowl remains. A fourth form, the ocellated turkey (*Agriocharis*, species) in its modern phase (*Agriocharis ocellata*) is restricted to a tropical or subtropical climate, so that it may be supposed that its fossil representative existed during a period marked by element climatic conditions.

The make-up of the avifauna of these deposits is of some interest. Water-birds outnumber those that frequent dry land to a considerable extent. They include a grebe, several ducks, a small goose, a sandpiper, and a gallinule. Among other groups the gallinaceous birds are represented by two quails and a peculiar turkey, the latter not reported heretofore from the limits of the United States. A pigeon, a small raven, a junco, and at least three additional finches complete our tale of the bird life of this period. It is noteworthy that the tree-duck, goose, and pigeon described are all smaller than other known representatives of their respective genera.

The drawings illustrating this report have been prepared by Miss Ludwicka Wieser.

Family COLYMBIDAE.

COLYMBUS, species.

The head of a coracoid unearthed two miles south of Benson comes from a grebe of this group, probably from one near *C. nigricollis*. The bone differs in conformation from that of *Podilymbus*, but agrees

in form and in size with that of the eared grebe. It is distinctly larger than that of *C. dominicus* and is smaller and less robust than the coracoid of *C. auritus*.

Family ANATIDAE.

QUERQUEDULA, species.

This genus of teals is recorded on the basis of the distal portion of a left metacarpal, a badly broken right metacarpal in two parts, and two fragmentary ulnas exhumed two miles south of Benson. The fragments in question agree rather closely in contour with *Querquedula discors*, but are slightly larger and vary in minute details of outline. Until a larger series of *Q. discors* and *Q. cyanoptera* is available to demonstrate individual variation in this genus I do not care to assign these specimens a specific name. It is highly probable that they come from a species now extinct.

DENDROCYGNA EVERSA, new species.

Characters.—Proximal part of humerus similar to that of *Dendrocygna bicolor* (Vieillot) but smaller; shaft more sharply ridged at upper end on posterior surface; deltoid ridge extending parallel to line of shaft, reaching to base of tuberculum externum; crista inferior forming an acute angle with side of shaft; caput humeri relatively thicker, with more pronounced overhang on posterior surface.

Description.—Type, Cat. No. 10547, U.S.N.M., proximal half of right humerus (figs. 1 and 2), collected by J. W. Gidley, April, 1921, in quarry on Sec. 22, T. 17 S., R. 20 E., two miles south of Benson, Arizona. Upper Pliocene.

Shaft slender, slightly elliptical below nutrient foramen, becoming strongly triangular at level of crista superior, and continuing thus to head; nutrient foramen located on lower side; shaft becoming sharply ridged at level of lower edge of crista inferior, and continuing thus to base of humeral head, where the ridge merges into a rounded surface; deltoid ridge beginning at margin below lower end of crista superior, and passing in a slight curve obliquely forward, interrupted for the space of 5 millimeters in center, and then continued as a well-marked ridge that broadens to disappear at lower margin of articular surface of tuberculum externum; tuberculum externum elevated, with articular surface extensive, triangular in form, excavated slightly, delimited externally by a sharp angle, and projecting proximally beyond lower margin of caput humeri; caput humeri relatively small, contracted toward external tubercle, ex-



FIG. 1.—PROXIMAL PORTION OF HUMERUS (TYPE) OF *DENDROCYGNA EVERSA*, POSTERIOR VIEW. (NAT. SIZE.)

panded on anterior and posterior faces, on latter forming a shelf-like overhang, that, after turning in a rounded point continues at a right angle over incisura capitis to merge at the anterior end of this groove with the other, more rounded, margin of the head; tuberculum inferior elevated slightly beyond level of humeral head, strong, excavated slightly for a prominent triangular muscle attachment on upper side of point, outer margin rounded below in a gradually sloping obtuse angle to merge into crista inferior; incisura capitis deep, narrow, rounded at bottom, with perpendicular walls on either side; a rounded depression below humeral head; distal inner margin of inferior tubercle produced over fossa subtrochanterica, the line of the margin slightly concave, the



FIG. 2.—PROXIMAL PORTION OF HUMERUS (TYPE) OF *DENDROCYGNA EYERSA*, ANTERIOR VIEW. (NAT. SIZE.)

external point slightly projecting; fossa subtrochanterica deep, excavated so that walls are thin, perforated internally by a pneumatic foramen; outer margin of crista superior slightly broken; crest sloping in a slightly concave line from base of external tubercle, becoming thinner, and then passing down to merge with side of shaft; point of tendinal attachment elongate, somewhat curved, with concave side outward, terminating proximally at highest point of crest, ending distally above lower end of ridge, the crest projecting at an angle of 70° with the shaft; coraco-humeral groove extending at an angle across lower part of base of humeral head toward outer margin of bone, shallow and broad, illy defined internally, becoming impressed and narrowed at incisura capitis, and terminating near margin of bone below inferior tubercle, where the straight walls forming it meet at the bottom in an acute sharp angle; bicipital surface rounded, slightly elevated toward upper side, limited on posterior, inner

margin by a slight line, but with no distinct bicipital groove; deltoid groove broad and poorly marked; lower margin of crista inferior meeting shaft at a sharp, slightly obtuse, angle.

Measurements in millimeters.—Length from head to nutrient foramen 38.2; greatest breadth of head 15; transverse diameter of shaft at nutrient foramen 4.7; distance from outer bicipital surface to end of tuberculum inferior 7.7;

Range.—Upper Pliocene: Known only from type locality, 2 miles south of Benson, Arizona.

Remarks.—In studying the present specimen I have had available skeletons of the following species of the genus *Dendrocygna*: *D. autumnalis*, *D. bicolor*, *D. arborea*, and *D. arcuata*, all save *arborea* represented by two or more specimens. Modern tree-ducks offer so many anomalies in distribution—the species *D. bicolor* for example

ranging now in South America, southern North America, southern Africa, India, and Burma—that, lacking skeletons of some of the species of the genus, I should have hesitated to describe this fossil bird as new were it not that it represents a species distinctly smaller than any of those known to-day. The dimensions of the fossil humerus are less than those of *D. arcuata*, that species and *D. javanica* being the smallest of modern *D.* representatives of the group.

A fossil tree-duck, *Dendrocygna validipennis*, has been described by C. W. de Vis¹ from what are said to be “post-pliocene deposits” in Queensland, Australia. This species need not figure in the present comparison as it also is a larger form, compared by the describer with the Australian tree-duck, now known as *Leptotarsis eytoni*. If *validipennis* is correctly allocated as a tree-duck, as seems from the figures and description to be the case, then it is probable that the skeleton of *Leptotarsis* offers some difference from that of *Dendrocygna* in the form of the internal and external tubercles, the crista superior and the head of the shaft. Material is not at hand to verify this supposition.

In the diagnosis given for *Dendrocygna eversa* comparison has been made with *D. bicolor*. The fossil *D. eversa*, differs from all the tree-ducks at hand (as listed above) in smaller size, position of deltoid ridge, and angle formed by crista inferior at junction with side of shaft. In the other diagnostic characters assigned *eversa* agrees with *arborea* in sharp ridging of upper end of shaft, and with *arcuata* and *arborea* in the amount of overhang of the humeral head.

Dendrocygna eversa will stand for the present as the smallest of known tree-ducks.

The humeral head in *Dendrocygna* resembles that of geese (*Branta*, *Anser*, *Chen*, and *Philacte*) and differs from ducks (*Dafla*, *Marila*, *Erismatura*, *Histrionicus*, *Oidemia*, etc.) and Mergansers (*Mergus* and *Lophodytes*) in that when the bone is viewed from in front no overhang of the caput humeri is evident in the cleft of the incisura capitis, in the compressed ridge at the upper end of the shaft on the posterior side, and in general narrow form of the humeral head. *Dendrocygna* differs from the geese mainly in the relatively lessened bulk of the caput humeri, in the position of the nutrient foramen nearer the middle of length of shaft, and in the sharper angle on the margin of the crista superior, differences more or less intangible, that do not hold definitely for all the genera of geese as a group. *Anser albifrons* in particular strongly suggests *Dendrocygna*.

¹ Proc. Linn. Soc. New South Wales, ser. 2, vol. 3 (for 1888), 1889, p. 1282, pl. 34, figs. 5a, 5b, and 6.

BRANTA MINUSCULA, new species.

Characters.—Humerus similar to that of *Branta canadensis* (Linnaeus) but size small (smaller than in subspecies *B. c. minima* Ridgway), angle of *caput humeri* at dorsal end of *incisura capitis* abrupt, nearly a right angle, forming a distinct shoulder instead of a gradual slope; head of humerus proportionately more narrow, with external fossa relatively larger; external tubercle reduced.

Description.—*Type*, Cat. No. 10548, U.S.N.M., proximal half of right humerus (figs. 3 and 4), collected by J. W. Gidley, April, 1921, in quarry on Sec. 22, T. 17 S., R. 20 E., 2 miles south of Benson, Arizona. Upper Pliocene.

Shaft (badly splintered but restored) with slightly indicated sigmoid flexure; expanded broadly to support humeral head, an acute ridge extending to base of *caput humeri* at external margin on posterior face; deltoid ridge beginning on side of bone well below lower margin of *crista superior*, proceeding with a slight sigmoid flexure inward toward center of shaft, with an abrupt cavity beyond center of length where line is very faint, terminating finally as an elongate tubercle set at a slight angle external to median line of shaft, separated by a space of 4 millimeters from the base of the external tubercle; ridge on end of shaft low with sides meeting at a sharply pointed but obtuse angle; the head of the humerus impressed below *caput humeri*, this impression sharply delimited proximally by a line continuous with the ridge on shaft, and excavated slightly under lower margin of *caput humeri*; *tuberculum externum* heavy, elevated, external margin slightly curved, set with outer margin not projecting laterally beyond external line of shaft; tubercle excavated on posterior



FIG. 3.—PROXIMAL PORTION OF HUMERUS (TYPE) OF BRANTA MINUSCULA, POSTERIOR VIEW. (NAT. SIZE.)

face; external side straight, forming a right angle with posterior face; proximal end projecting slightly beyond base of *caput humeri*; *caput humeri* relatively low, with elongate, rounded proximal surface, rounded in outline on anterior margin, angulated posteriorly toward *incisura capitis*, with whole posterior margin forming an overhang especially prominent toward *incisura capitis*; inferior tubercle with point missing; *incisura capitis* deep, narrow, ending as a simple notch on anterior face, but curving externally on posterior side, where it is overhung by internal angle of *caput humeri*; *fossa subtrochanterica* moderately large, with a slight shelf marking lower margin of *crista inferior* above which there is

a slight elevation serving as a raised threshold for the main fossa; opening of fossa rudely ovate with internal pneumatic foramina; projecting angle of crista superior missing; base showing impressed curved line of muscle attachment; bicipital surface broad, regularly rounded, delimited posteriorly by a curving, faintly impressed, but distinct bicipital groove; crista inferior with rounded outer margin forming a clean cut angle at junction with shaft; deltoid groove broad, shallow, poorly marked; coraco-humeral groove broad, shallow, indistinctly delimited until it reaches level of incisura capitis, where it becomes suddenly narrowed with elevated margins, and terminates as a deep cleft, with walls meeting at bottom in an acute angle on lower margin of inferior tubercle, the external end of groove open without impression; a slight overhang of proximal wall beyond incisura capitis; a slight excavation between tuberculum externum and base of caput humeri.

Measurements in millimeters.—Transverse diameter of shaft below crista superior 9; width of head from external point of bicipital surface to line of external margin of tuberculum externum 21.7 (projecting points of bone broken away in such a manner as to make taking of definite measurements difficult).

Remarks.—This bird is remarkable chiefly for its size, as it seems from the fragment available to represent a form smaller than the smallest living representatives of *Branta canadensis*. It is a member of the group containing the Canada goose and is not a sea goose or brant (*Branta bernicla* group) as these differ from *canadensis* in that they lack the impressed space on the head of the shaft below the caput humeri, a character in which brant resemble *Oenanthe* and *Anser*. *Branta minuscula* would seem to have been but a trifle larger than our large ducks.

Family ANATIDAE (indeterminate).

Three fragmentary coracoids represent as many species of duck-like birds that may not be identified with certainty. The largest of these three, a nearly complete coracoid, represents a bird about as large as a canvasback, and may have been a member of the subfamily Anserinae. The two others seem to belong in the subfamily Fuligulinae, and appear to have come from birds somewhat smaller in body than the lesser scaup or harlequin ducks. All three specimens come from the quarry 2 miles south of Benson.

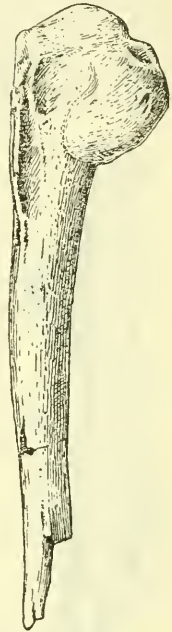


FIG. 4.—PROXIMAL PORTION OF HUMERUS (TYPE) OF *BRANTA MINUSCULA*, ANTERIOR VIEW. (NAT. SIZE.)

Family MELEAGRIDAE.

AGRIOCHARIS, species.

A broken right tarso-metatarsus (fig. 5) secured in a quarry two and one-half miles south of Benson near the Gum Ranch, March 8, 1921, represents an ocellated turkey, a genus not previously recorded within the limits of the United States. The specimen consists of the lower half of the tarso-metatarsal bone of an adult male, with the middle trochlea complete, but with both lateral ones broken away. Through the kindness of Dr. Loye H. Miller, I have been able to examine a tarso-metatarsus of a modern *Agriocharis ocellata*, and have also had available a figure of that species taken from a photograph published by Dr. R. W. Shufeldt.²



FIG. 5. — BROKEN TARSO-METATARSUS OF AGRIOCHARIS, SPECIES, ANTERIOR VIEW. (NAT. SIZE.)

The fossil bone, while not absolutely identical with the specimens available for comparison, agrees closely with them. The slight differences that it offers consist mainly in slightly different sculpturing of the sides of the median trochlea, characters that may perhaps vary with age. Should further material become available it is possible that the fossil may be described as specifically distinct from the modern bird.

At the present period the ocellated turkey is found only in Guatemala, Honduras, Campeche, and Yucatan, where it ranges in tropical regions. The present record for southern Arizona is a distinct addition to what we consider the typically North American avifauna, and marks a considerable extension in the known range of the genus in question. As this would seem to indicate a former distribution throughout much of Mexico, further records will be awaited with considerable interest. Especial attention should be paid to scrutiny of turkey bones from caverns and from ancient sites of Indian villages, as it is barely possible that *Agriocharis* may have survived in the north until comparatively recent times.

Identification of this fossil from Arizona led naturally to examination of the remarkable species *Parapavo californicus* L. H. Miller, described from the Pleistocene asphalt beds at Rancho La Brea. Three tarso-metatarsi (the type bone in this species) were loaned for this purpose through the kindness of Dr. C. Stock, of the University of California. The species in question was first described by Doctor

² *Aquila*, vol. 21, 1914, pl. 14, fig. 52.

Miller as *Pavo californicus*.³ Later, when an abundance of additional material became available Doctor Miller,⁴ in an excellent account of his further studies of the species, proposed for it the generic name of *Parapavo*, and compared it with *Agriocharis*. His careful and lucid account of the characters of this bird leave nothing to be added in the way of description.

From examination of the tarsal bone it is my opinion that *Parapavo* is a meleagrine form intermediate in its characters between modern *Meleagris* and *Agriocharis*. The three, though evidently closely allied, offer distinctions of generic value. The characters marking adult males may be conveniently shown in form of a key.

a¹. Distance from lower margin of spur core to distal end of middle trochlea 50 mm. or more; the two lateral trochleae less produced posteriorly beyond axis of shaft; bone stronger, heavier.

b¹. Intermediate hypotarsal ridge absent or but slightly developed; inner border of middle trochlea produced proximally on posterior face as a sharp ridge that extends upward toward shaft, beyond upper end of groove on face of trochlea; head of bone proportionately broader and heavier.

Meleagris.

b². Intermediate hypotarsal ridge well developed; inner border of middle trochlea cut away on posterior face, not produced in a proximally extended ridge; head of bone proportionately more slender.

Parapavo.

a². Distance from lower margin of spur core to distal end of middle trochlea 45 mm. or less; the two lateral trochlea more produced posteriorly beyond axis of shaft; bone slighter, more slender.

Agriocharis.

It will be noted that *Parapavo* has been grouped above with *Meleagris*. Six characters have been found in which these three genera offer points of difference. In three of these *Parapavo* agrees with *Meleagris*, and in three with *Agriocharis*. One character in each group is based on size and may be disregarded as of slight importance. Of the others the two that unite *Parapavo* and *Meleagris*, that is, elevation of spur core and position of the lateral trochlea with regard to the shaft seem of greater weight than the two that join *Parapavo* to *Agriocharis*, namely the presence of an intermediate hypotarsal ridge and the conformation of the inner border of the middle trochlea. The first two are deemed of greater importance since they are established when the tarsal elements coalesce during development of the young individual, while the others, less primitive, are more subject to modification through subsequent stress or strain as the bird gains in age.

The two species of modern peacocks, *Pavo muticus* and *P. cristatus*, members of the family Phasianidae, and the two modern

³ Univ. Calif., Publ., Bull. Dept. Geol., vol. 5, August, 1909, p. 285.

⁴ Idem, vol. 9, Mar., 10, 1916, pp. 89-96.

species *Meleagris gallopavo* and *Agriocharis ocellata* of the family Meleagridae differ constantly from one another in the relative position of the trochleae of the tarso-metatarsus. In the peacocks the two lateral trochleae have less elevation above the middle trochlea, while in the turkeys the elevation of the lateral trochleae, particularly that of the inner one, is much more pronounced. *Parapavo*, in this respect is similar to *Meleagris* and *Agriocharis*. The relative position of these articular prominences is established during ossification and ankylosis when the animal is in a very immature stage of development. Of necessity therefor this character must be considered a basic one in the separation of major groups, and must carry much more weight than, for example, the presence or absence of an intermediate hypotarsal line, where the play of important tendons may alter considerably the stresses that serve to form such a ridge.

In my opinion *Parapavo* is a true meleagrine form and any characters that may seem to connect it at all closely with the peacocks are superficial and due to some parallelism of development. In confirmation of my belief in this regard I may add that though the intermediate hypotarsal ridge is usually absent in *Meleagris gallopavo* I find it developed to a greater or less extent in eleven of thirty-four specimens of varying ages (all feral individuals). Its presence or absence can not therefore be considered weighty in establishing group relationships.

Family ODONTOPHORIDAE.

COLINUS, species.

The distal end of a right tarso-metatarsus secured 2 miles south of Benson is similar to that of *C. virginianus*, but has the foramen situated lower down, nearer the notch between middle and outer trochleae.

The genus *Colinus* is represented in Mexico and Central America by several species and subspecies whose skeletons are not at present available, so that it is not practicable to identify the present scrap of bone further than to state that it represents a quail similar in size to our familiar bobwhite, but probably of another species. The fossil fragment differs from *Callipepla* in smaller, more narrow middle trochlea, while from both *Colinus virginianus* and *Lophortyx gambeli* it is distinguished by the low position of the external foramen.

Family ODONTOPHORIDAE (indeterminate).

The head of a right humerus secured 14 miles southeast of Benson in March, 1921, belongs in this family, but may not now be identified through lack of skeleton material of the quails of Mexico and Central America. This broken humerus is as large and robust as

that of *Oreortyx*, but has characters that seem to ally it more closely with *Colinus*. It is possible that it belongs in one of the genera at present of more southern range, or it may come from a genus now extinct. In either case, it is a representative of a group not known in our modern fauna north of the Mexican border.

Family RALLIDAE.

GALLINULA, species.

The distal ends of two tibiae secured in the collecting locality 2 miles south of Benson average a little large, but otherwise agree fairly well with material of the common gallinule (*Gallinula chloropus*) at hand.

Distinctions between the lower end of the tibia in *Fulica* and *Gallinula* are slight, and in a large series the characters available inosculate, so that there is no hard and fast line between the two genera. Recourse must be had to the sum of all in deciding on the identity of these intermediate individuals. In general, in *Fulica* the internal condyle is heavier, the articular surface on the posterior face of the bone broader in proportion to its length, the intercondylar sulcus broader, and the indentation near the center of the raised margin of the internal tubercle smoother, less abrupt than in *Gallinula*. *Fulica*, in addition, may be larger, though large gallinules may exceed small coots in size.

Family SCOLOPACIDAE.

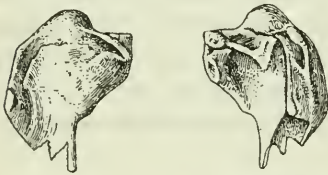
MICROPALAMA HESTERNUS, new species.

Characters.—Head of humerus similar to that of *Micropalama himantopus* (Bonaparte) but with caput humeri smaller, less rounded, more pointed at tip, on under surface forming a more oblique angle with shaft; lower end of coraco-humeral groove straight, not curving distally, so that end of groove comes nearer to tuberculum inferior.

Description.—*Type*, Cat. No. 10550, U.S.N.M., head of right humerus (figs. 6 and 7), collected by J. W. Gidley, April, 1921, in quarry 2 miles south of Benson, Arizona. Upper Pliocene.

Crista superior placed at nearly a right angle to lateral diameter of bone, triangular in lateral outline, with proximal margin indented below highest point, then swelling slightly before joining base of caput humeri; point located just above lower, distal margin of internal crest on opposite side of bone, inclined slightly from perpendicular toward shaft; depression marking attachment for pectoralis major extending to center of shaft; caput humeri rounded, elevated and narrowed toward highest point; coraco-humeral

groove shallow and slightly marked below head, becoming much deeper with abrupt sides and rounded bottom beyond line of incisura capitis to end abruptly with steep terminal wall at level of outer margin of tuberculum inferior, passing in a nearly straight line across humerus at slightly less than a right angle (distally) to axis of shaft; proximal margin of groove opposite incisura capitis slightly arcuate with a slight overhang; groove for deltoid beginning at anterior margin of insertion for pectoralis major, and extending as a deep groove with abrupt margin on bicipital side, where there is an overhang on lower half, to become more shallow and merge in a curve with coraco-humeral groove; bicipital surface shorter than broad, irregular, delimited below by an impressed line extending transversely from lower margin of inferior crest in a slight curve toward distal end of deltoid groove to end near center of shaft; tuberculum inferior triangular in outline, elevated, square at point; shaft on lower surface compressed to form a sharp, angular line extending to base of caput humeri, excavated on lower side, in an elliptical depression below caput humeri where the margin of the humeral head



FIGS. 6 AND 7.—HEAD OF HUMERUS (TYPE) OF *MICROPALAMA HESTERNUS*, ANTERIOR AND POSTERIOR VIEWS. ($\times 2$.)

forms a slight overhang; tuberculum externum elongate, prominent, excavated at median point so that the surface is concave, extending proximally to margin of bone, and forming a slight anterior projection at base of caput humeri; fossa subtrochanterica sloping gradually from side of shaft, comparatively shallow, though overhung by elevated tuberculum inferior; no pneumatic foramen; a sharp compressed ridge extending inward obliquely to shaft, with a low rounded ridge passing from point of junction with shaft to base of overhanging caput humeri, the latter line delimiting a small concavity, rudely triangular in outline, at base of incisura capitis, and forming the inner margin of the median depression below the articular head; viewed laterally the inferior tubercle slightly hooked; posterior line of crista inferior joining shaft at an oblique angle, with outer margin shallowly concave near center.

Measurements in millimeters.—Length from outer end of bicipital groove to end of caput humeri 7.1; greatest breadth of head 7.7; height of crista superior above lower margin of shaft 3.5.

Range.—Upper Pliocene: Known only from type locality 2 miles south of Benson, Cochise County, Arizona.

Remarks.—This species represents a sandpiper very closely allied to the modern stilt sandpiper (*Micropalama himantopus*) that at the present time breeds from near the coast of Mackenzie for an indeterminate distance southward, and ranges in migration through

the western part of the Mississippi Valley, Central America, and the West Indies, south into South America. It is recorded in small numbers from the Atlantic coast, and is casual in occurrence in British Columbia. The species has not been recorded from Arizona.

The discovery of *Micropalama hesternus* is interesting as the stilt sandpiper has stood as the representative of a monotypic genus. The differences between *hesternus* and *himantopus* as shown by the head of the humerus are slight but appear constant as a series of five humeri of *M. himantopus* at hand seems sufficient to illustrate individual variation in that species. It is possible that *M. hesternus* may have represented a well-marked western form of *M. himantopus*. On this supposition the case of the stilt sandpiper would be similar to that of *Macrorhamphus griseus*, *Catoptrophorus semipalmatus*, and *Tringa solitaria*, shore birds that to-day are represented by eastern and western subspecies.

The identification of *hesternus* as a member of the genus *Micropalama* led to a review of the humerus in all of our Charadriiformes and brought out an interesting similarity in the form of the humeral head in the turnstones (*Arenaria*) and the stilt sandpiper a similarity that is astonishing as the two groups are not closely allied (usually they are placed in separate families), and to be explained probably as convergent evolution. So close are the two in form (*Arenaria* has a longer, heavier humerus) that it was only after considerable study that the following key was worked out to distinguish the two genera. The differences outlined are largely relative, adding to the difficulty in distinguishing the two from disparity in size of the humerus in the two groups.

a¹. Coraco-humeral groove more shallow, less sharply defined at inner end, inner part of proximal margin straight, with little or no overhang below incisura capitis; anterior outer margin of fossa subfrochanterica below tuberculum inferior less hooked; tuberculum inferior relatively less prominent; ridge of tuberculum externum nearly straight with very slight median excavation.

Arenaria.

a². Coraco-humeral groove deeper, more strongly impressed at inner end, anterior (proximal) margin slightly arcuate with distal overhang; angle below tuberculum inferior more hooked; tuberculum inferior relatively more prominent; ridge of tuberculum externum excavated in median portion.

Micropalama.

Family COLUMBIDAE.

CHLOROENAS MICULA, new species.

Characters.—Distal part of tarso-metatarsus similar to that of *Chloroenas fasciata* (Say), but considerably smaller; external projection (ala interna) on inner trochlea more acute; inner trochlea less deeply grooved on posterior surface; inner margin with outline show-

ing no sinuation; middle trochlea with inner and outer margins nearly parallel, very slightly convergent at upper end on posterior face; outer trochlea separated from middle by relatively broader groove.

Description.—*Type*, Cat. No. 10549, U.S.N.M., distal end of right tarso-metatarsus, (figs. 8 and 9) collected by J. W. Gidley, March, 1921, in quarry 14 miles southeast of Benson, Ariz. Upper Pliocene. Lower end of shaft slightly rounded anteriorly, though broad and comparatively plane, expanded to support the distal trochleae; a distinct external groove that becomes deeper to terminate in the inferior foramen, well above the external intertrochlear sulcus; shaft expanded more toward outer than toward inner side; external trochlea compressed, with anterior external angle cut away in an abrupt slope that forms an angled articular facet for fourth toe, with a very faint central sulcus, and an equally slight basal excavation to receive the end of the facet of basal digit of the outer toe; external face of external trochlea flattened but slightly rounded (external posterior margin imperfect); external intertrochlear sulcus moderately deep with rounded bottom and very slightly divergent



FIGS. 8 AND 9.—LOWER END OF TARSO-METATARSUS OF *CHLOROENAS MICULA*, ANTERIOR AND POSTERIOR VIEWS. ($\times 2$.)

sides, continued as a well-marked groove that passes back to become continuous with the groove containing the inferior foramen; middle trochlea moderately strong, with sides whose faces are excavated to form distinct median concavities; in lateral outline evenly rounded on free portion to form an ellipse with posterior side slightly flattened; a rather broadly excavated median groove that

merges with the shaft posteriorly and on anterior face terminates in a distinct pit; on the posterior side with external margin projecting farther, and extending somewhat higher on shaft, than inner; inner margin lower, converging slightly at upper end toward center of trochlea; internal digital trochlea, viewed from in front, broad, with surface rounded; internal face flat, projecting posteriorly well beyond middle trochlea, and placed correspondingly less far forward on anterior face, where the middle trochlea projects anterior to it; posterior face with a sharp posterior projecting ridge, with a very slight sulcus at its base; a distinct winglike inner tubercle or ala interna projecting as a rounded, somewhat flattened cone at a right angle from the outer face of this posterior portion; ala interna well separated from main trochlea; posterior face of shaft slightly excavated in center, forming a longitudinal trough with rather sharp margins.

Measurements in millimeters.—Greatest breadth across trochlea 5.4 mm.; transverse diameter of inner trochlea, including ala interna 2.0 mm.; transverse diameter of middle trochlea 1.5 mm.; transverse diameter of external trochlea 1.2 mm.

Range.—Upper Pliocene, known only from type locality, 14 miles southeast of Benson, Ariz.

Remarks.—The present species was a small pigeon apparently more or less similar in size to the modern mourning dove. The metatarsus in the group of what may be termed the columbine pigeons, formerly all embraced in the broad genus *Columba*, has the inner trochlea less elevated and the trochlea as a whole shorter and stronger than in related groups. *Chloroenas micula* suggests *Melopelia asiatica* strongly in appearance but may be distinguished by the characters just cited and by other minor points. *Zenaida* is distinguished by the slight depth of the incisions between the trochlea, while *Zenaidura* is peculiar in the slight development of the winglike process on the internal trochlea. *Scardafella* and *Chamaepelia*, genera that in spite of their small size are suggestive of affinity to the fossil, are to be distinguished by the elongate outer face of the external trochlea which is considerably longer than broad.

The affinities of *micula* are with *Chloroenas* and not with the West Indian species now segregated in the genus *Patagioenas*. The distinction in the lower end of the tarso-metatarsus between these groups may be summarized conveniently in the form of a key:

*a*¹. Inner trochlea with winglike projection smaller, less swollen, not projecting so far posteriorly; junction with main body of trochlea marked by a distinct depression.

Patagioenas squamosa.

Patagioenas leucocephala.

*a*². Inner trochlea with winglike projection relatively larger, more swollen, projecting farther posteriorly; junction with main body of trochlea indicated if at all by a very slight depression.

Chloroenas fasciata.

Chloroenas inornata.

Chloroenas micula.

Family CORVIDAE.

CORVUS, species.

The distal portion of a right tibio-tarsus secured two miles south of Benson belongs to a small raven of the *Corvus corax* group, closely related to, and perhaps identical with, *C. shufeldti* from the Fossil lake deposits of Oregon. The latter species, described originally by Dr. R. W. Shufeldt as *Corvus annectens*,⁵ a name unfortunately pre-occupied by *C. annectens* Brüggemann⁶ was subsequently renamed *Corvus shufeldti* by Sharpe.⁷

In Doctor Shufeldt's original description his form, based on a right tarso-metatarsus, is said to resemble *C. corax* but to be smaller, a

⁵ Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 9, 1892, p. 419, pl. 15, figs. 14-16.

⁶ Abh. Naturwiss. Ver. Bremen, vol. 5, April, 1876, p. 75.

⁷ Hand-l. Gen. Spec. Birds, vol. 5, 1909, p. 599.

statement fully born out by examination of a beautifully made cast of the type specimen, secured through the courtesy of Dr. W. D. Matthew of the American Museum of Natural History. Though somewhat similar in size to the modern white-necked raven, *Corvus cryptoleucus*—a species now found in semi-desert regions from western Texas and southeastern California, south to Guanajuato and Michoacan, that in the last century ranged north into western Kansas and Nebraska—*shufeldti* has the strong, robust form that characterizes *Corvus corax*, and is allied to it rather than to *cryptoleucus*.

The tibio-tarsus secured near Benson is also of the *Corvus corax* type, though it represents a bird only about as large as a common crow, *Corvus brachyrhynchos*. Careful comparison shows that this specimen comes from a bird slightly smaller than the type of *shufeldti*. The difference in size between the two is, however, within the possible limit of sexual variation, as shown by a study of a series of *Corvus corax* and *C. brachyrhynchos*. In other words the type of *shufeldti* might represent a male and the Pliocene bird a female of the same species, a possibility not in conflict with the geological evidence in the case, since there would be nothing to prevent a species (represented by the Benson specimen) that existed in the upper Pliocene from extending its range during the milder climate of the first interglacial period (when it is supposed that the Fossil and Silver Lake deposits were formed) to the region in south-central Oregon where the type of *shufeldti* was secured. On the other hand the Benson specimen may represent a distinct species, a matter that is left in abeyance until further material may be available.

Following is a detailed description of the tibio-tarsus secured by Doctor Gidley: Inner and outer malleoli nearly similar in form and size but the inner one slightly wider in transverse diameter on external face; intercondylar sulcus broad, divided by a low but well marked ridge that begins on the posterior face at the level of the upper margin of the condyles and passes down to end abruptly at the lowest point of the sulcus, where it is abruptly delimited by the margin of the intercondylar fossa, so that it does not extend around on anterior face of sulcus; intercondylar fossa, for the reception of the intercondylar process of the tarso-metatarsus, broad and well excavated, including most of anterior face of sulcus with a distinct ridge at level of upper third, below which the fossa has its deepest excavation; inner condyle set at a slight angle so that it flares outward, on the anterior side thickened toward the upper end, where the inner surface, toward the intercondylar sulcus, is smoothly rounded, extended as a low ridge bounding the intercondylar sulcus around on to the dorsal face of the bone; external face

roughly rounded in outline, flattened slightly from above downward, with the external margin raised slightly so that the external face is concave; posterior proximal margin deflected inward in a direct slope to merge with the shaft; anterior proximal margin projected farther beyond level of shaft than posterior; internal ligamentary tubercle elevated as a low flattened cone with lower margin above center of outer face of condyle, placed in a line with the anterior margin of the shaft; outer condyle nearly on a plane with the outer face of the shaft, with the anterior margin thickened, rounding into intercondylar sulcus; posterior margin becoming thin and swinging in to merge with the shaft at the same level as that from the internal condyle; outline of external condyle roughly elliptical, with a raised margin all around so that the external face of the bone is concave; a very slight almost imperceptible eminence slightly above center; shaft in cross-section elliptical near center, rounded on posterior side, becoming flattened as it proceeds downward on anterior face; distal end somewhat expanded, distinctly flattened on anterior side; supratendinal bridge (above extensor digitorum communis) moderately broad, passing obliquely from a point slightly external to center of shaft to an elevated inner prominence on the antero-internal end of the shaft above the outer condyle; a distinct sulcus on outer anterior angle for the passage of the peroneus longus; margins of this sulcus raised as distinct crests, the external one being more acute than the inner one; the sulcus passing at a slight angle outward; a *linea aspera* marking the peroneal muscle passing upward from outer of these crests for a distance of 15 millimeters; on inner anterior margin of shaft a *linea aspera* that marks the extensor digitorum muscle, this line forming the point of junction of inner and anterior faces of shaft; this line terminates in a thin raised crest for the attachment of the inner end of the oblique ligament (below which passes the tendon of the tibialis anticus); external tubercle for oblique tendon a crest above upper external margin of the tendinal bridge for the extensor digitorum communis.

Measurements of the specimen are as follows: Condylar breadth, 9.4 mm.; transverse diameter of shaft near center (of complete specimen), 4.5 mm.; transverse diameter of internal condyle, 8.7 mm.; transverse diameter of external condyle, 7.6 mm.; distance from center of tubercle for internal ligament to lower margin of internal condyle, 5 mm.

In the genus *Corvus* the lower end of the tibio-tarsus in the ravens is distinguished by the prominent high, sharp crest that extends well up on the inner side of the shaft, with the groove for the *peroneus profundus* relatively broader and placed at a higher elevation. In this *Corvus cryptoleucus* agrees with *C. corax*. The crows, on the contrary (*C. brachyrhynchos* and *C. ossifragus*), have the

crest on the inner side of the shaft lower and less prominent, with the external face below distinctly rounded and the groove for the *peroneus profundus* relatively narrower, less elevated.

The specimen secured by Doctor Gidley is the oldest representative of its genus at present known from North America.

Family FRINGILLIDAE.

JUNCO, species.

The premaxilla of a small finch secured 2 miles south of Benson agrees with that of the genus *Junco*, and among modern groups of snowbirds is closely similar to that of *Junco hyemalis*. From other allied American finches of modern times it is distinguished by minute differences in outline sufficient to separate it definitely. Fossil passeriform birds have been reported seldom in North America, and the present record, save for *Palaeospiza bella* Allen, whose fringillid affinity may be open to doubt, is the first account of a finch in the Tertiary.

Family FRINGILLIDAE (indeterminate).

Among scant passerine remains are three fragments representing finches that may not be identified save to family, tantalizing glimpses of ancient birds of this group that give mere suggestions of species concerning whose appearance we may only speculate. The distal end of an ulna, found 2 miles south of Benson, comes from a bird the size of a white-crowned sparrow. Another ulna, even more broken, of similar size, was secured at the site 14 miles southeast of Benson, and with it the proximal end of a left tibia that is almost identical with that of *Zonotrichia leucophrys*, both in size and in detail of structure. All of these bits represent species belonging in the group that Mr. Ridgway⁸ has designated as the Zonotrichiae.

Another broken ulna (secured 2 miles south of Benson) from a bird nearly as large and robust as a meadow lark is from a finch of another group.

⁸ Birds North and Middle America, vol. 1, 1901, p. 28.

DESCRIPTIONS OF NEW SPECIES AND HITHERTO UNKNOWN CASTES OF TERMITES FROM AMERICA AND HAWAII.

By THOMAS E. SNYDER,

Entomologist, Forest Insect Investigations, Bureau of Entomology, United States Department of Agriculture.

The following 12 new species of termites are described in this paper:

KALOTERMITIDAE.

- Kalotermes marjoriae*, new species, Hawaii, Hilo.
Kalotermes tabogae, new species, Panama, Taboga Island.
Neotermes angustoculus, new species, United States, Florida (Paradise Key).
Glyptotermes pubescens, new species, Porto Rico, Aibonito.

RHINOTERMITIDAE.

- Leucotermes convexinotatus*, new species, Panama, Colon.
Leucotermes cardini, new species, Bahamas, Andros Island.
Leucotermes longiceps, new species, Brazil, Coxipo, Cuyabã.

TERMITIDAE.

- Syntermes magnoculus*, new species, Brazil, Chapada.
Syntermes emersoni, new species, Brazil, Iguaripe.
Syntermes colombianus, new species, Colombia.
Nasutitermes (Subutitermes) zeteki, new species, Panama, Summit, C. Z.
Anoplotermes hondurensis, new species, Spanish Honduras, La Ceiba.

Descriptions are also given of the hitherto unknown winged sexual adults of *Amitermes wheeleri* Desneux of Texas, which is also figured, and *Amitermes beaumonti* Banks of Panama, as well as that of *Nasutitermes guayanae*, form *columbicus* Holmgren of Panama, which I designate a distinct species.

The soldier of *Syntermes dirus*, form *hageni* Holmgren, is described more fully and figured; I believe it to be a distinct species and have so designated it; keys to the soldiers of 15 species and to the winged adults of 9 species of *Syntermes* are given.

It has been found that there are two species of *Neotermes* in southern Florida, namely, *angustoculus* Snyder—a small-eyed new species—and *N. castaneus* Burmeister—a large-eyed species; the latter has been redescribed for comparison with my new species; specimens of these distinct species had been confused in the collection

of the United States National Museum until my attention was called to the differences by A. Emerson. Specimens from Venezuela and Brazil in the Hagen collection are also large-eyed; they are referred to by Hagen¹; Hagen writes that Burmeister's type agrees with these specimens from southern Brazil (St. Leopoldo), collected by Winthem. Soldiers have been correlated with the winged adults of both *angustoculus* and *castaneus*. The winged adults of *N. castaneus* collected by Appun at Porto Cabello, in Venezuela, in the Hagen collection form the basis for Hagen's redescription (1858); the long diameter of the eye of these specimens is 0.60 mm.; the specimens collected in Brazil by Winthem have an eye diameter of 0.65. A soldier from Brazil in the Hagen collection is labeled by Hagen *castaneus*?; it is from the Nuremburg Museum and has short mandibles (less than the width of the head), as do specimens from Florida.

Hagen also has winged adults of a variety, a=*cubana* (label on specimens) in his collection under the species *N. castaneus*; he referred to these specimens in 1858 (p. 41) but did not publish the name; this variety is a small (13 mm. in length), small-eyed form (eye 0.45 mm. in diameter), collected by Gundlach in 1864. *N. angustoculus* from southern Florida and Cuba has an eye diameter of 0.35 mm. A dealated adult of *N. castaneus* in the Hagen collection from St. Thomas, collected by Uhler, has an eye diameter of 0.70 mm.

Winged adults of another variety, b=*chilensis* (label on specimens) from Chile referred to by Hagen 1858 (p. 41) but the name not published, is 17 mm. in length and has an eye diameter of 0.45 mm. It is remarkable in that the pulvillus is not visible. This may be Blanchard's species *Termes chilensis*; however, Hagen 1858 (p. 41) refers to both this variety of *N. castaneus* and (p. 103) to *Termes chilensis* (Gay) Blanchard as occurring in Chile, stating that he believes, instead of *chilensis* being in synonymy with *Porotermes quadricollis* Rambur, it is a closely related species to "*Calotermes castaneus*."² Blanchard's figure of *Termes chilensis* shows wing venation differing from that of Hagen's specimens of *N. castaneus*, var. b. *chilensis*, but the figures of both the winged adult and soldier are very poor. Blanchard's type of *T. chilensis* is in the Museum of Paris and, until I can examine this type, I shall consider Hagen's var. *chilensis* Blanchard's species.

The termite *Kalotermes approximatus* Snyder, described from Ortega, Fla., in 1920, is described more fully with detailed measurements and also figured.

In addition, there is a general discussion of the genus *Leucotermes*, its systematic position, and its genotype *L. tenuis* Hagen; keys have

¹ Linnæa Entomologica, vol. 12, pp. 40-41, 1858.

² Desneux (Ann. Soc. Ent. Belg., vol. 49, 1905, pp. 336-8) has redescribed the type and states that he believes it is near *C. castaneus* Burmeister and is not a *Porotermes*.

been made to include all the known American species—five in number. In the past several species have been included under the name *tenuis*. My species *Reticulitermes aureus*, originally described from dealated adults from southern Arizona, I have found to be a *Leucotermes* after the winged adults have been collected; I have redescribed this termite. It is extremely interesting but unfortunate that a species of this genus occurs in the United States; as yet this species *aureus* is apparently confined to unsettled regions at the base of the Santa Catalina Mountains and has not been found damaging the woodwork of buildings or crops.

Species in the genus *Leucotermes* of South, Central, and North America are extremely destructive both to timber and to living crops. The presence of two species of this genus, *convexinotatus* and *cardini*, in the West Indies—in close proximity to the United States—renders it very desirable to make a careful study of these termites. Possibly they might be introduced into the southern portions of the United States, where they would be very injurious. Indeed, species of *Leucotermes* may even now be present on some of the offshore Florida keys, where but little collecting of termites has been done.

A key to seven American species of *Anoplotermes* is given in this paper.

Thanks are gratefully rendered to Dr. S. Henshaw and N. Banks, of the Museum of Comparative Zoology, for courtesies and the unrestricted use and examination of the Hagen collection.

KALOTERMES MARJORIAE, new species.

Winged adult.—Head light castaneous, darker between the eyes, shining, slightly longer than broad, rounded posteriorly, with scattered, fairly long, light yellow hairs.

Antennae light yellow brown, first three segments darker colored than the others; 18 segments, segments become longer and broader toward apex, pubescent; first segment stout, cylindrical; second narrower, shorter, somewhat clavate; third segment shorter than second, clavate; fourth approximately the same size as the third (first half of antennae more ring or bead-like, last half more elongate and clavate); last two segments shorter than sixteenth—possibly there is a segment or two missing.

Palpi segments short but broad, apical segment longer and conical—pointed at tip.

Eye black, large, not round, separated from lateral margin of head by a distance equal to less than half its long diameter. Ocellus large, elongate, very close to eye, set somewhat obliquely but nearly parallel to eye.

Labrum yellowish, somewhat tongue-shaped, broadest in middle, rounded anteriorly, with long hairs.

Post-clypeus light yellow, broad but short, posterior margin nearly straight.

Pronotum slightly lighter colored than the head, not twice as broad as long, broader than head, quadrilateral, anterior corners high, sides rounded; anterior margin slightly concave, with fairly long hairs on margins.

Legs light yellow, fairly long.

Wings white, veins yellowish, iridescent, tissue reticulate or rugose; 5-7 long branches from subcosta (radius sector) to costa, first branch arises nearer to wing scale than to apex (before middle of wing). Median vein halfway between subcosta and cubitus branched to apex of wing and with short branches running up to the subcosta. Cubitus in about the center of the wing, with 17-20 branches or subbranches (pl. 1, fig. 6).

Wing scale slightly longer than the pronotum, with long hairs.

Abdomen slightly lighter colored than the head, shining, lighter colored ventrally, with scattered, fairly long, light yellow hairs.

Measurements.—Length of entire deãlated adult, 6.5 mm.; length of head (from tip of labrum to posterior margin), 1.8 mm.; length of pronotum, 0.9 mm.; length of hind tibia, 1.01 mm.; length of wings, 9.5 mm.; width of head, 1.4 mm.; diameter of eye (long diameter), 0.402 mm.; width of pronotum, 1.5 mm.; width of wings, 2.5-3 mm.

Type locality.—Hilo, Hawaii, Territory of Hawaii.

Described from a single winged adult, now deãlated, collected at the type locality in July, 1900, by H. W. Henshaw.

Named in honor of Marjorie Edgar Benjamin.

Type, winged adult.—Cat. No. 25082, U.S.N.M.

KALOTERMES TABOGAE, new species.

Winged adult.—Head yellow-brown to light castaneous, with a darker castaneous-brown horizontal stripe just back of the ocelli; paler at posterior margin, V-shaped, darker depression at front of head, in center, epicranial suture. Head longer than broad, broadest at the compound eyes, head rounded to posterior. Head with scattered but long hairs. Labrum yellow-brown, broadly rounded in front and with long hairs.

Compound eye black, not round, large and slightly projecting, much larger than in *K. marginipennis* Latreille of Texas; less than its diameter from the lateral (lower) margin of head or front of head, less than two diameters from posterior of head. Ocellus large, larger and closer to eye than in *marginipennis*, elongate, nearly parallel to compound eye, very close to eye.

Antennae paler than head, longer than width of head, 16-18 segments, pubescent; third segment shorter or as long as second, chitin colored more deeply than other segments, but not as long or as dark as in *marginipennis*; fourth short, ring-like; last segment shorter and not so broad, subelliptical.

Pronotum paler than head except at margins, broader than long, nearly as broad as head, slightly emarginate at anterior (less so than in *marginipennis* where deeply and roundedly emarginate-concave) and posterior, lateral margins rounded and narrowed to posterior, pronotum shorter than wing stub (longer in *marginipennis* where not so broad, however), with long hairs on margins.

Body same color as pronotum, ventral surface and legs paler, body with long hairs, tibiae and tarsi darker.

Wing pale, marginal veins yellowish-brown, radial sector usually with over 5 (to 8) branches to costa; median nearer to radial sector than to cubitus, branches or not to tip of wing, cubitus with 19 branches or sub-branches.

Legs with femora white with tinge of yellow, tibiae and tarsi yellow-brown.

Abdomen with long light yellow hairs.

Measurements.—

	<i>K. taboga</i> Snyder.	<i>K. marginipennis</i> Latreille. ³
	Mm.	Mm.
Length of entire winged adult	12.5 -13.0	11.0 -12.0
Length of entire dealated adult	6.0 - 7.5	6.0 - 7.5
Length of head (to tip of labrum)	1.65- 1.75	1.60- 1.75
Length of pronotum	0.90- 0.95	1.0 - 1.05
Length of hind tibia	1.1 - 1.2	1.05- 1.2
Length of anterior wing	9.0 - 9.75	9.0 - 9.5
Diameter of eye (long diameter)	0.41- 0.47	0.30- 0.35
Width of head (at eyes)	1.40- 1.45	1.40- 1.45
Width of pronotum	1.60- 1.65	1.45- 1.50
Width of anterior wing	2.9	2.95- 3.0

Larger than *K. marginipennis*, with larger eyes, shorter but broader pronotum; lighter colored and larger than *K. immigrans* Snyder, body hairs slightly longer.

Soldier unknown.

Type locality.—Taboga Island, Republic of Panama.

Described from several winged adults collected by J. Zetek on March 30, 1922; the species was collected at Taboga Island by August Busck of the National Museum as early as June 9, 1911.

Type, winged adult.—Cat. No. 25691, U.S.N.M.

³ Specimens from Texas.

KALOTERMES APPROXIMATUS Snyder.

Soldier (pl. 1, fig. 1).—Head yellowish-brown (light castaneous), darker anteriorly, one and one-half times as long as broad, sides parallel to slightly concave, with few, scattered, light yellow, long hairs; front of head slopes anteriorly, with V-shaped depression.

Antennae pale yellowish, 13 segments, reach tip of mandibles when mandibles are crossed, pubescent; third segment yellow-brown, subclavate, not quite as long as fourth and fifth segments together

Eye hyaline, white, round to oval; ocellus visible above eye spot.

Labrum yellow-brown, broader than long, hardly round at apex, with long hairs.

Mandibles black, shining, reddish-brown at base, nearly as long as width of head; broad at base, pointed and incurved at tip; right mandible with two short, pointed, subequal marginal teeth near base, left mandible with three broader blunt marginal teeth on lower two-thirds, the median tooth being broadest (molar). (See figure.)

Gula slender, over twice as broad at front as at middle.

Pronotum dirty white with pale yellowish tinge, wider than head, less than twice as broad as long, roundedly and fairly deeply concave anteriorly, anterior margin not dentate as in *K. marginipennis* Latreille; sides slope roundedly to posterior, posterior margin convex.

Legs pale yellow, tarsi yellow, legs short, hind femora swollen, legs with short hairs.

Abdomen dirty white gray, with tinge of yellow, with light yellow long and short hairs.

Measurements.—Length of entire soldier, 7.50–7.75 mm.; length of head with mandibles, 3.3–3.7 mm.; length of head without mandibles (to anterior margin), 2.2–2.4 mm.; length of head without mandibles (to tip of labrum), 2.6 mm.; length of pronotum (at corners), 1.10–1.15 mm.; length of left mandible, 1.35–1.40 mm.; length of hind tibia, 1.1 mm.; width of head, 1.40–1.55 mm.; width of pronotum, 1.6–1.7 mm.

Species close to *marginipennis* but differs in antenna, mandibles, and pronotum. The winged adult is unknown. I described this species in 1920,⁴ but this more complete description and figure is desirable.

Type locality.—Ortega, Fla.

Described from specimens collected by the writer at the type locality on March 5, 1919.

Type, soldier.—Cat. No. 22359, U.S.N.M.

⁴ 1920. Banks, N., and Snyder, T. E. Revision of Nearctic Termites. Bull. 108, U. S. National Museum, p. 22, Apr. 13.

NEOTERMES CASTANEUS Burmeister.

Deälated adult.—Head castaneous-brown, darker anteriorly especially at sides of depression, longer than broad, depression between epicranial suture, lines of suture not visible as in *N. angustoculus* Snyder, with scattered short hairs, trace of round frontal gland depression. Compound eye black, large, projecting, not round, separated from lateral margin of head by a distance less than its diameter,⁵ less than two diameters from posterior margin. Ocellus hyaline, large, obliquely inward from but very close to eye.

Labrum light yellow-brown, widest at middle, nearly truncate on tip, with long hairs.

Post-clypeus yellow, broader than long.

Antennae yellow-brown, 16 (20?) segments, pubescent; third segment slightly modified, clavate, darker colored, longer than second or fourth.

Pronotum paler than head, much broader than head, not twice as broad as long (length measured to corners where high) and shorter than wing scale, not very deeply emarginate anteriorly, sides narrowed slightly posteriorly, slightly emarginate posteriorly, with short hairs.

Abdomen dorsally same color as pronotum with short hairs.

Legs yellow-brown, tibiae darker, slender, pubescent.

Measurements.—Length of entire deälated adult, 8.5–9.5 mm.; length of head (to tip labrum), 2.1 mm.; length of pronotum, 1.35–1.45 mm.; length of hind tibia, 1.6 mm.; length of wing scale, 1.45 mm.; diameter of eye, 0.45–0.50 mm.; width of head, 1.85–1.90 mm.; width of pronotum, 2–2.15 mm.

Soldiers were not collected with these adults, but Mr. Banks states (Banks and Snyder, 1920⁶) that there is variation in the soldiers of *N. castaneus* Burmeister; I believe, however, two species are represented—*N. castaneus* and *N. angustoculus*. It is probable that the soldier of *N. castaneus* is the form with mandibles short and stout, with blunt points, being not nearly as long as the width of the head; head shorter than in *N. angustoculus* Snyder, pronotum not so narrowed behind. However, this may be variation within the species.

Deälated adults distinct from *angustoculus* by the very large eye, long pronotum, trace of round frontal gland depression (absent in *castaneus*) and short hairs. However, close to *connexus* Snyder but has short pubescence.

⁵ This distance is greater in *N. angustoculus* Snyder and this difference was noted by N. Banks in Antillean Isoptera, Bull. Mus. Comp. Zoology, vol. 57, No. 10, p. 477, pl. 1, fig. 10, January, 1919; he believed that there were two forms of *castaneus*.

⁶ 1920. Banks, N., and Snyder, T. E. Revision of the Nearctic Termites, Bull. 108, U. S. National Museum, Washington, Apr. 13.

This description is based on two deãlated adults—a male and female—collected at Coconut Grove, Fla., in a hollow mangrove branch on May 23, 1887, by Dr. E. A. Schwarz, of the Bureau of Entomology; these specimens are deposited in the collection of the United States National Museum.

NEOTERMES ANGUSTOCULUS, new species.

Winged adult.—Head yellow-brown or light castaneous, epicranium slightly darker, epicranial suture Y-shaped, trace of frontal gland present; longer than broad, rounded at base, with scattered light yellow long hairs.

Compound eye black, *small*, nearly round, separated from lateral margin of head by a distance nearly equal to its long diameter, fully two diameters from posterior margin. Ocellus large, oval, close to and at oblique angle to eye.

Labrum light yellow-brown, broadest at middle, constricted at base and apex, apex truncate, with long hairs.

Post-clypeus same color as head, broad but not long, convex posteriorly—that is, front of head concave.

Antennae light yellow-brown, 18 segments, pubescent; third segment darker colored than other basal segments, clavate, as long as or longer than second segment, longer than fourth; last segment shorter and narrower, subelliptical.

Pronotum lighter colored than head, light yellow-brown, much broader than head, nearly twice as broad as long, shorter than wing scale, broadly roundly emarginate anteriorly and rounded posteriorly where also emarginate; with long and short hairs.

Abdomen light castaneous dorsally, with long hairs near hind margin each segment.

Legs pale yellow-brown, tibiae darker.

Wings but little longer than entire insect, hyaline, costal veins yellow-brown; in fore wing 6–7 long branches from subcosta to costa, median vein very close to subcosta reaches apex of wing, cubitus with 17 branches or sub-branches, not reaching apex.

Measurements.—Length of entire winged adult, 15 mm.; length of entire deãlated adult, 10 mm.; length of head (to tip of labrum), 2.10–2.15 mm.; length of pronotum, 1.25 mm.; length of hind tibia, 1.6 mm.; length of anterior wing, 10.5–11 mm.; length of wing scale, 1.55 mm.; width of head (at eyes), 1.70–1.75 mm.; diameter of eye, 0.32–0.35 mm.; width of pronotum (at widest point), 2.15–2.25 mm.; width of anterior wing, 3.50–3.65 mm.

This species is closely related to *N. castaneus* Burmeister, but has a much smaller eye, hence its specific name.

Soldier.—Head light castaneous, somewhat darker in front, twice as long as broad, broadest anteriorly, front of head depressed at epicranial suture, with long hairs.

Eye spot hyaline, elongate, long diameter at right angles to lateral margin of head. Labrum light yellow-brown, broadest in middle, front convex, with long hairs.

Mandibles black, reddish brown at base, slender, elongate, sharp pointed at tip, nearly as long as width of head, left mandible with two sharp-pointed teeth near apical third, smaller tooth at middle and molar near base; right mandible with only two larger pointed teeth near base.

Antenna yellow-brown, pubescent, with third segment slightly modified and darker colored, clavate and longer than second or third segments.

Gula slender, one-third as wide in middle as at front.

Pronotum light yellow-brown, not as broad as head, about twice as broad as long—length measured to corners of pronotum where high, anteriorly broadly concave, sides rather narrowed behind, posteriorly not emarginate, with long hairs.

Legs with tinge of yellow, slender, pubescent.

Abdomen dirty gray, with tinge of yellow, long hairs near base each segment.

Measurements.—Length of entire soldier, 9.5–12.5 mm.; length of head with mandibles, 4.75–5.5 mm.; length of head without mandibles (to tip labrum), 3.8–4.1 mm.; length of head without mandibles (to anterior), 3.3–3.5 mm.; length of left mandible, 2.1–2.2 mm.; length of pronotum (to corners), 1.20–1.35 mm.; length of hind tibia, 1.70–1.75 mm.; width of head (at widest point), 2.3–2.5 mm.; width of pronotum, 2.3–2.4 mm.

Similar to the soldier of *N. castaneus*, except that the mandibles are nearly as long as the width of the head and more sharply pointed, the head is proportionately a little longer and the pronotum rather more narrowed posteriorly.

Type locality.—Paradise Key (Lower Everglades), Dade County, Fla.

Described from a series of winged adults collected with soldiers and nymphs at the type locality by T. E. Snyder, on May 14, 1916, Hopkins U. S. No. 14083n. *N. angustoculus* also occurs at Miami Beach, Fla., and in Cuba.

Type, winged adult.—Cat. No. 25747, U.S.N.M.

Genus GLYPTOTERMES Froggatt.

The genus *Glyptotermes* was established by Froggatt in 1896; its contained species are widely distributed throughout the world. The wing venation of the sexual adult is distinctive; the wings are opaque. *Lobitermes* established by Holmgren in 1910, for Silvestri's species "*Calotermes*" *lobicephalus*, described in 1903 from Argentina, as a subgenus of the genus *Kalotermes* Hagen, is closely related to

Glyptotermes. The winged sexual adult of *Lobitermes* is similar to that of *Glyptotermes*; the soldier of *Lobitermes* has a shorter darker colored (black) head and has more segments to the antennae than in *Glyptotermes*.

In habits, species of *Glyptotermes* are similar to species of *Kalotermes*; they live in small colonies in the trunks of dead trees; the galleries (pl. 2, figs. 11, 12) are small and the pellets of excrement are similar to those of other Kalotermitidae (pl. 2, fig. 13).

GLYPTOTERMES PUBESCENS, new species.

Dealcated adult (pl. 2, fig. 10).—Head dark castaneous-brown to piceous, smooth, shining, arched, nearly as broad as long, highest in center, rounded posteriorly, with scattered, long, light yellow hairs.

Antennae light castaneous-brown, broken, segments become broader toward apex, with long hairs; first segment elongate, cylindrical; second shorter than first but longer than third, subclavate; third more wedge shaped, segments become longer after fifth segment.

Palpi last segment elongate, cylindrical, pointed at tip.

Eyes black, somewhat projecting, not round, separated from lateral margin of head by a distance less than their diameter. Ocellus large, round, close to eye.

Labrum yellowish-brown, wider than long, broadly rounded at apex, broadest at center, with long hairs.

Pronotum same color as head, over twice as broad as long, emarginate anteriorly, convex posteriorly, sides rounded, gradually slope toward posterior margin, margins with long hairs.

Meso- and metanotum emarginate posteriorly.

Wing scale longer than pronotum, with long hairs.

Legs light yellow-brown, tibiae darker, fairly elongate, with hairs; tibiae with 3 spines at apex.

Abdomen slightly lighter colored than pronotum, paler ventrally, margins with long, dense, light yellow hairs as well as shorter hairs; styli present.

Measurements.—Length of entire dealcated adult, 4.75–5.75 mm. (the smaller being a dry specimen); length of head, 1.3–1.4 mm.; length of pronotum, 0.6–0.7 mm.; length of hind tibia, 1–1.005+ mm.; width of head (at eyes), 1.1–1.2 mm.; diameter of eye, 0.302 mm.; width of pronotum, 1.1–1.4 mm.

Soldier (pl. 1, figs. 2–5).—Head light yellow-brown, darker anteriorly, where deeply lobed, longer than broad but relatively short, subcylindrical, narrowed slightly at front, highest in center; front rimmed with black, almost vertical, with scattered long, light-yellowish hairs on margins and 4 long hairs in a transverse row on dorsum at about middle of head, the 2 inner hairs being slightly

shorter than the outer, another row of hairs is on the anterior of the head.

Antennae light yellow-brown, 10 or 11 segments, a little longer than mandibles, with long hairs, segments become broader toward apex; first segment elongate, cylindrical; second shorter than first, not clavate; third longer than second, clavate, appears to be divided near narrow base, latter however with no hairs; fourth broader, shorter than third; last segment elongate, subelliptical.

Eyes pale, large, elongate, subelliptical, near antennal socket.

Labrum yellow-brown, longer than broad, somewhat tongue-shaped, rounded at apex, with 2 long hairs (longer than labrum) set in center of apex, also with shorter hairs.

Mandibles blackish, short, not as long as width of head, broad at base, pointed and incurved at tips; 2 pointed, small marginal teeth near tip and a broader tooth near base on left mandible; right mandible with 2 broader marginal teeth nearer base (pl. 1, fig. 3).

Gula elongate, narrowed in center, not twice as broad at front as in center.

Pronotum paler than head, twice as broad as long, anterior and posterior margins nearly parallel, anterior corners high, sides rounded, gradually slope to posterior, with long, light-yellow hairs on margins (pl. 1, fig. 4).

Legs with tibiae and tarsi yellowish, fairly elongate, femora thickened.

Abdomen gray-white, with long, dense, light-yellow hairs.

Measurements.—Total length of soldier, 5.5–6.5 mm.; length of head with mandibles, 2.4–2.5 mm.; length of head without mandibles, 1.8–1.9 mm.; length of left mandible, 0.85 mm.; length of pronotum (at corners), 0.65–0.80 mm.; length of hind tibia, 0.57–0.705 mm.; width of head, 1.2–1.4 mm.; width of pronotum, 1.1–1.4 mm.

Described from 2 soldiers found with the typical dealated adult.

The genus *Glyptotermes* Froggatt has not been previously recorded from the Antilles.

Type locality.—Aibonito, Porto Rico.

Described from several dealated adults collected at the type locality from partly dead coffee tree on December 2, 1921, by F. Sein and George N. Wolcott, Acc. No. 488-'21; 2 soldiers and nymphs were found with these dealated adults.

Type, dealated adult.—Cat. No. 25415, U.S.N.M.

Biological.—The burrows of *G. pubescens* in a partly dead coffee tree at Aibonito, Porto Rico, in dry, hard, sound wood (pl. 2, figs. 11–12) are similar to those of *Cryptotermes*. The impressed pellets of excrement are small, more elongate, irregular in shape and are pointed at the apex, as an apple seed (pl. 2, fig. 13).

Genus *LEUCOTERMES* Silvestri.

This genus was established in 1901 with Hagen's *tenuis* as the type species. Apparently it is closely related to the genus *Reticulitermes* Holmgren—more closely than Mr. Banks realized when he stated (1920) that our common species of *Reticulitermes* are not congeneric with the type species of *Leucotermes*. One divergent character from *Reticulitermes* emphasized by Banks was the absence of ocelli in the type specimen of *tenuis*; however, the species has ocelli variably absent or present. Another factor was that the margins of the wings are ciliate in *Leucotermes*, whereas in *Reticulitermes*, *Prorhinotermes* Silvestri, and also in *Rhinotermes* Hagen they are not ciliate; however, the wing margins are ciliate in *Coptotermes* Wasmann, which, nevertheless, has a subcordate pronotum and is contained in Holmgren's family Mesotermitidae.

Without specimens of the winged adult, it is difficult to distinguish species in these two genera. In 1920⁷ I described a termite from southern Arizona as *Reticulitermes aureus* from deälated adults. This termite had been collected flying at night and I emphasized this biological fact and the unusually light color. Later I received winged adults; the wings are ciliate and it is plainly a *Leucotermes*; species of *Leucotermes* fly at night.

The soldiers of species of *Leucotermes* usually have the mandibles more slender and elongate than in species of *Reticulitermes*, where they are usually more robust and curved at the tip (that is, more S shaped), except in case of the species *R. humilis* Banks and *R. hoferi* Banks.

Species of both *Reticulitermes* and *Leucotermes* construct earth-like carton shelter tubes both attached and in some cases free; that is, constructed into the air and not supported except at the base.

The first form queen of species of *Leucotermes* is larger and less active than in species of *Reticulitermes*; a queen of *tenuis* from Panama measures 22 mm. in length and 4.5 mm. in width.

The genus *Leucotermes* should be placed in the family Rhinotermitidae, which will supplant Holmgren's family Mesotermitidae, which has no contained genus "Mesotermes." The shape of the pronotum is subcordate, as in this family, whereas it is saddle-shaped in the family Termitidae (Holmgren's Metatermitidae). The fact that the post-clypeus is three times as broad as long would place it in the subfamily Rhinotermitinae, according to Banks' key (1920, p. 10) (my term "post-clypeus" being equivalent to Banks' "clypeus"); however, the wing margins are ciliate as in *Coptotermes*, which should also be placed in the family Rhinotermitidae. The guts of species of

⁷ 1920. Snyder, T. E. Two New Termites from Arizona. Proc. Ent. Soc. Wash., vol. 22, No. 2, February, pp. 38-40 (pp. 39-40, A *Reticulitermes* flying at night in Arizona).

Leucotermes, moreover, contain pollyflagellate protozoa—not found in the guts of any of the Termitidae.

Species of *Leucotermes* are of great economic importance, being very destructive not only to the woodwork of buildings—as can be seen from the damage done on the island of St. Helena—but also to living vegetation. It is unfortunate that we have a species in the United States.

The following discussion of *Leucotermes tenuis* Hagen, *L. aureus* Snyder, *L. crinitus* Emerson Ms. and my three new species of *Leucotermes* is the result of an examination of Alfred Emerson's collection, the collection of the United States National Museum and that in the Museum of Comparative Zoology at Cambridge, Mass.

LEUCOTERMES TENUIS Hagen.

Undoubtedly several new species have been included under the specific name *tenuis*; Hagen (1858) records this species from Santo Domingo, Port aux Prince, Colombia, and Brazil (collected in Brazil in 1846). It has also later been reported from the Bahamas, Cuba, Panama, and British Guiana.

It is stated⁸ that this termite was accidentally introduced into the island of St. Helena from the coast of Guiana about 20 years since; that is, about 1843. This is interesting in view of the fact that McLachlan's typical specimens, collected by Melliss at St. Helena,⁹ while somewhat larger, are practically identical with a specimen of *L. tenuis* from Brazil; this latter specimen, although not from the type locality is designated by Alfred Emerson, of the University of Pittsburgh, and the writer as the type of *tenuis*; it has the type No. 212 in the Hagen collection in the Museum of Comparative Zoology, at Cambridge, Mass. McLachlan's specimens are also in the Hagen collection and I have compared them with specimens of *tenuis* from the Beaumont collection from Panama and specimens of *tenuis* collected by Emerson at Kartabo, British Guiana. While there is variation in size, all are the same species; the Panama specimens are slightly smaller than the type specimen.

However, a new, lighter colored species (*convexinotatus* Snyder) also occurs at Panama. Specimens from Cuba ("6/5, 18/5, and 11/6, Cayamas, E. A. Schwarz, Col.") are apparently identical with this new species, whereas another new species (*cardini* Snyder) occurs in the Bahamas, and was also found in Cuba (Ch. Wright, Col.); *L. aureus* Snyder occurs in southern Arizona and is close to *convexinotatus*; *L. longiceps* Snyder from Brazil is known only from the soldier caste.

⁸ Proc. Ent. Soc. London, 1863, p. 185.

⁹ Proc. Ent. Soc. London, 1869, p. 13.

Both of these new species *convexinotatus* and *cardini* (as well as *tenuis* Hagen) have the ocelli variably present or absent in specimens from the same colony and show variations in the size and shape of antennal segments and in wing venation (branching of the veins and area occupied by the cubitus and branches); the wing scale covers the meso-notum in both new species and the meso- and metanota are convex, while they are emarginate in *tenuis*. In *convexinotatus* the median vein runs nearer to the middle (more intermediate between the subcostal vein and cubitus) than in *tenuis* and *cardini*, where the median is nearer to the cubitus. In *convexinotatus* the cubitus and branches take up less area of the wing than in *tenuis* and *cardini*—that is, the distance between the cubitus and lower margin of the wing is less; there are also specific differences in the number of hairs on the surface of the wings (pl. 3). The soldiers of my three new species have the heads less hairy than in *tenuis*, but the soldier of *cardini* has a few more hairs on the head and pronotum than that of *convexinotatus*. The soldier of *L. crinitus* Emerson MS. has an extremely hairy head.

To summarize, it is evident that there is either a single extremely variable species involved, or a species in the process of evolving several nascent species, or a complex series of very closely related species, there being two extremes *tenuis* Hagen and *convexinotatus* Snyder with intergrading connecting species which display characters of either extreme.

In 1902¹⁰ Wasmann mentions the soldier of *Leucotermes flavipes*, subspecies *paraensis* from Para, Brazil; this is probably *L. tenuis* Hagen or a related species of *Leucotermes*; he also describes (p. 140) the species *insularis* from "Oceania," which may be my species *convexinotatus*, since soldiers from the Galapagos Islands are the same as *convexinotatus*. It is probable that the species *insularis* from the Cocos Islands should be the same as that found in the Galapagos and Central America. Wasmann's description is too meager to enable or warrant precise identification. Mr. A. Emerson has kindly loaned me specimens of soldiers collected by the Williams Galapagos Expedition.

A soldier in the Hagen collection¹¹ is labeled *Termes corticola* Bates. The head is very hairy (the hairs being long). The anterior margin of the pronotum is emarginate; the posterior margin is slightly concave. This specimen is from Obispo, Panama, and is probably *Leucotermes tenuis* Hagen. Hagen writes that the same soldier occurs in Bates' termites from Santarem, Brazil.

¹⁰ 1902. Wasmann, E. Termiten, Termitophilen und Myrmekophilen Gesammelt auf Ceylon, von Dr W. Horn, 1899, etc. Zool. Jahrbuch., vol. 17, Heft 1, pp. 99-164 (p. 119).

¹¹ Hagen, Linn. Ent., vol. 12, p. 203.

KEY TO AMERICAN SPECIES OF *LEUCOTERMES* SILVESTRI.*Winged adults.*

1. Wing surface densely hairy.....*crinitus* Emerson.¹²
 Wing surface with *many* hairs, posterior margin of meso- and metanota *emarginate* and *not* covered by wing scale.....*tenuis* Hagen.
 Wing surface with *few* hairs, posterior margin of meso- and metanota *convex* and covered by wing scale..... 2.
2. Cubitus vein and branches spread over more than half of width of wing, median vein near cubitus, hardly any hairs on wing surface.....*cardini*, new species.
 Cubitus and branches spread over less than half of width of wing, median intermediate between subcosta and cubitus..... 3.
3. Compound eye more than its long diameter from lateral margin of head.
*aureus* Snyder.
 Compound eye less than its long diameter from lateral margin of head.
*convexinotatus*, new species.

Soldiers.

1. Head densely hairy.....*crinitus* Emerson.¹²
 Head with *many* hairs.....*tenuis* Hagen.
 Head with *few* hairs..... 2.
2. Head very elongate.....*longiceps*, new species.
 Head not very elongate..... 3.
3. Head with *few* hairs.....*cardini*, new species.
 Head with *very few* hairs.....*convexinotatus*, new species.¹³

LEUCOTERMES CONVEXINOTATUS, new species.

Winged adult (pl. 1, fig. 7).—Head yellow-brown, darker between the eyes, paler posteriorly, not so dark as in *L. tenuis* Hagen; sub-elliptical, broadest at eyes, narrower than in *tenuis*, rounded posteriorly; with fairly dense light yellow long bristles and shorter hairs. Fontanelle not so large as in *tenuis*, a pale, slightly raised, round spot on a line just back of the eyes.

Antennae light yellow-brown, with 17 segments, pubescent; segments variable in size and shape; first segment elongate, cylindrical; second shorter and not so wide; third ring-like, about half the length of the second; fourth longer than third; the following segments become wider and more wedge-shaped toward apex; last segment elongate, slender, elliptical.

Compound eye black, not round, not very prominent or raised; separated from lateral margin of head by a distance less than its long diameter. Ocelli variably absent or present; when present elongate, and about the short diameter of an ocellus distant from eye.

Labrum light yellow, longer than broad, broadest near middle, somewhat tongue-shaped, broadly rounded in front, with long hairs on apex.

¹² The characters of this termite *Leucotermes crinitus* Emerson MS. are those used by Alfred Emerson in his description and the species is to be credited to Emerson.

¹³ It is very difficult to separate these two species from the soldier caste alone; *convexinotatus* has fewer hairs on the head than *cardini*.

Post-clypeus light yellow, prominent and bulging as in *tenuis*, over three times as wide as long; posterior margin markedly convex, border of head concave—more so than in *tenuis*; post-clypeus longer than in *tenuis* but not as broad; not strongly bilobed as in *tenuis*.

Pronotum same color as head, subcordate, wider than long, but not as wide as head, not emarginate posteriorly, but anterior margin indented in middle; with long bristles and short hairs on surface and margins; not as long as the wing scale.

Mesonotum not as long as and covered by wing scale, posterior margin convex (emarginate in *tenuis*). Metanotum also convex posteriorly, longer than metathoracic wing scale, which is about half the length of the mesothoracic wing scale.

Legs light yellowish, elongate, slender.

Wings gray-white or smoky, costal veins yellowish, margins ciliate, tissue punctate, fewer hairs on surface of wings than in *tenuis*, but more hairs than in *cardini* Snyder (pl. 3, figs. 14–15); in *tenuis* the hairs are arranged in rows, with fewer and shorter hairs on the hind wing (pl. 3, figs. 16–17); median vein runs nearer to middle (between subcostal vein and cubitus) than in *tenuis*, where the median is nearer to the cubitus; cubitus and branches take up less area of wing than in *tenuis*.

Abdomen with dorsum same color as head, ventrally paler, golden-yellow, densely covered with light yellow, short and longer hairs or bristles.

Measurements.—

	<i>L. convezinotatus.</i> Mm.	<i>L. tenuis</i> , ¹⁴ Mm.
Length of entire winged adult	9. 75–10. 25	9. 0 –9. 75
Length of entire deãlated adult.	5. 0	4. 7
Length of head (posterior to tip of labrum)..	1. 0 – 1. 3	1. 2 –1. 3
Length of pronotum	0. 47– 0. 50	0. 47–0. 55
Length of hind tibia	0. 77– 0. 80	0. 805
Length of anterior wing	7. 75	7. 50–7. 75
Length of wing scale	0. 62– 0. 70	0. 50
Width of head	0. 80	0. 802
Diameter of eye (long diameter)	0. 18– 0. 20	0. 17–0. 20
Width of pronotum	0. 67– . 70	0. 65
Width of anterior wing	1. 85– 1. 90	2. 00

Soldier (pl. 1, fig. 8).—Head light yellow-brown, broadest posteriorly, not twice as long as broad, with but few short hairs and longer bristles on head, lack of pubescence being distinctive specifically.

Antennae white, with tinge of yellow, 15 segments, pubescent; segments variable in size and shape; second segment short; third long, clavate; segments become wider toward apex.

¹⁴ Specimens from the Beaumont collection, Panama, being slightly smaller than the type from Brazil, which is in turn smaller than McLachlan's specimens collected by Melliss at St. Helena.

Labrum yellow, longer than broad, broadest near middle, somewhat tongue-shaped, narrowed toward apex where somewhat pointed, apex with bristles.

Mandibles castaneous-brown with reddish tinge, elongate, slender, curved inward near tip, with 4 rudimentary teeth at base of left mandible.

Gula at narrowest point (near middle) less than one-half the width at the front (near apex).

Pronotum white with a tinge of yellow, subcordate, not as broad as head, with pubescence.

Legs white with a tinge of yellow.

Abdomen white with a tinge of yellow, pubescent.

Measurements.—Length of entire soldier, 4.7 mm.; length of head with mandibles, 2.25–2.30 mm.; length of head without mandibles, 1.4 mm.; length of left mandible, 1 mm.; length of pronotum, 0.4 mm.; length of hind tibia, 0.62 mm.; width of head, 0.85–0.90 mm.; width of pronotum, 0.7 mm.

Described from a series of soldiers found with the typical winged adults.

Close to *L. tenuis* Hagen but paler, with more yellow and less brown color than in *tenuis*; the post-clypeus is not strongly bilobed and the wing has the median vein located differently than in *tenuis*. The most strikingly distinctive character is the convex posterior margin of both the meso- and metanotum—hence the specific name; also the fact that the wing scale covers the mesonotum—not the case in *tenuis*. The soldier is smaller, more slender, and has but few hairs on the head—a distinctive specific character; in *tenuis* the soldier has 17 segments to the antenna and the mandibles have the minute teeth or denticulations at the base of the left mandible larger and more prominent.

Type locality.—Colon, Panama.

Described from a series of winged and deälated adults collected at the type locality by engineers of the Western Electric Co., in wood-work of cable office, "Cable, 4/11/14," Hopk. U. S. No. 12817a; workers, soldiers, and nymphs also found with these adults.

Type, deälated adult.—Cat. No. 25083, U.S.N.M.

LEUCOTERMES CARDINI, new species.

Winged adult.—Head pale yellow-brown, darker between the eyes, paler posteriorly; subelliptical, widest at the eyes, rounded posteriorly; with dense short and longer hairs. Fontanelle a pale, slightly raised, round spot on a line just back of the eyes.

Antennae light yellow, with 17 segments, pubescent; segments become wider toward the apex, vary in size and shape; first segment elongate, cylindrical; second shorter than first, third ringlike, about

half the length of the second segment; fourth ringlike, longer than the third; last segment elongate, slender, elliptical.

Compound eyes black, not round, slightly projecting; eye separated from lateral margin of head by distance less than (or equal to?)¹⁵ its long diameter. Ocelli absent or present, separated from the eye by a distance about equal to the short diameter of an ocellus.

Labrum and post-clypeus as in *L. convexinotatus* Snyder.

Pronotum same color as head, subcordate, indented in middle anteriorly, but slightly emarginate posteriorly, with both long and short hairs.

Meso- and metanotum not emarginate posteriorly; mesonotum covered by the wing scale.

Legs light yellow, elongate, slender.

Wings smoky, costal veins yellow, margins of wings ciliate, tissue punctate, but few hairs on surface of wings; median vein nearer to cubitus than to subcostal vein, cubitus and branches take up a larger area of the wing than in either *tenuis* or *convexinotatus* (pl. 3, figs. 18-19).

Abdomen with the tergites slightly lighter colored than the head, sternites paler, densely covered with hairs.

Measurements.—Length of entire winged adult, 9.5-10 mm.; length of entire dealated adult; 4-5.5 mm.; length of head (to tip of labrum), 1.1-1.2 mm.; length of pronotum, 0.5 mm.; length of hind tibia, 0.800-0.802 mm.; length of anterior wing, 8 mm.; length of wing scale, 0.602-0.606 mm.; width of head (at eyes), 0.78-0.82 mm.; diameter of eye (long diameter) (0.16-0.185),¹⁶ 0.2 mm.; width of pronotum (at widest point), 0.7 mm.; width of anterior wing, 1.9-2 mm.

Soldier.—Head light yellow-brown, lighter posteriorly, not many hairs on head, but a few more than in *convexinotatus*.

Antennae light yellow, 15 segments, become wider toward apex. pubescent; first segment long and cylindrical; second shorter; third longer than second, clavate; fourth shorter than third; last segment elongate, slender and subelliptical.

Labrum and mandibles as in *convexinotatus*, latter somewhat shorter.

Gula over twice as wide at front as at narrowest point near the middle.

Pronotum white with a tinge of light yellow, subcordate, emarginate anteriorly and posteriorly, more hairs on margins than in *convexinotatus*.

Legs and abdomen as in *convexinotatus*.

¹⁵ Specimens appear to be immature (not completely colored); eye may not be as small as it appears to be.

¹⁶ Actual area where facets are colored: specimens do not appear to be completely mature, outline of eye larger—0.2 mm.

Measurements.—Length of entire soldier, 4.2 mm.; length of head with mandibles, 2.25 mm.; length of head without mandibles, 1.4 mm.; length of left mandible, 0.87–0.95 mm.; length of pronotum, 0.42 mm.; length of hind tibia, 0.62 mm.; width of head, 0.78–0.85 mm.; width of pronotum, 0.6 mm.

Close to *L. convexinotatus* Snyder but lighter colored, and with the other differences noted in both the winged adult and soldier, named in honor of the late Prof. Patricio Cardin, of the experiment station, Santiago de las Vegas, Cuba; Professor Cardin studied termites in Cuba.

Type locality.—Andros Island, Bahamas.

Described from a series of winged adults collected at the type locality on May 18; soldiers were found with these adults. Additional material collected on the same date is in the Museum of Comparative Zoology, at Cambridge, Mass.

Type, winged adult.—Cat. No. 25084, U.S.N.M.

LEUCOTERMES AUREUS Snyder.

Winged adult.—Head pale yellowish to light brownish, paler posteriorly, longer than broad, broadest at the eyes, sharply narrowed (rounding) posteriorly, with dense light yellow long and shorter hairs. Fontanelle in a depression on a line with hind border of eyes.

Antennae light yellow-brown, 16–17 segments, segments become broader toward apex, pubescent; first segment elongate, cylindrical; second shorter, not so broad as first; third short, ring-like; from fourth on segments become longer; last segment elongate, sub-elliptical.

Compound eyes black, large as in *L. cardini* Snyder, not round, not prominent or much raised, more than its long diameter from lateral margin of head. Ocellus separated from compound eye by a distance less than its short diameter.

Labrum light yellow, broadest near middle, with long hairs.

Post-clypeus pale yellow, prominent, bulging, plainly bilobed, posterior margin convex, border of head concave, over twice as broad as long.

Pronotum posteriorly darker colored than head, subcordate, sides narrowed posteriorly, anterior margin markedly emarginate, posterior margin slightly emarginate, with long hairs; broader than long, but not as broad as head; not as long as the wing scale; median line prominent.

Mesonotum not as long as and covered by wing scale; posterior margin convex; metanotum also convex posteriorly.

Legs light yellowish, elongate, slender.

Wings gray (smoky-white), costal area yellow-brown, punctate, ciliate. Fore and hind wing with but few hairs on their surfaces; more hairs on hind wing. In fore wing median vein intermediate between subcosta and cubitus, but slightly nearer cubitus; median unbranched or doubly branched to apex of wing; cubitus with 9-11 branches or sub-branches, variably does not or does reach apex of wing. Area of cubitus takes up less than half breadth of wing.

Abdomen dorsally yellow-brown, apex ventrally golden-yellow; with dense, light yellow, long and short hairs.

Measurements.—Length of entire winged adult, 10 mm.; length of entire dealated adult, 4.25-5.25 mm.; length of head (to tip of labrum), 1.35 mm.; length of pronotum, 0.50-0.55 mm.; length of hind tibia, 0.80-0.802 mm.; length of anterior wing, 7.75 mm.; length of anterior wing scale, 0.8 mm.; width of head, 0.86-0.90 mm.; diameter of eye (long diameter), 0.17-0.20 mm.; width of pronotum (at anterior corners), 0.7-0.8 mm.; width of anterior wing, 2-2.05 mm.

Close to *L. convexinotatus* Snyder but of lighter color, eyes further separated from lateral margin of head, ocelli nearer to eyes, and surface of wing not so hairy, etc.

This termite was described from dealated adults as *Reticulitermes aureus* by Snyder (1920).¹⁷ It is now redescribed from a series of winged adults from the type locality; these adults were collected on August 9, 1920, at a light at 7.30 o'clock in the evening, after a thunderstorm.

Type locality.—Sabino Canyon, Santa Catalina Mountains Arizona.

Type, dealated adult.—Cat. No. 22693, U.S.N.M.

LEUCOTERMES LONGICEPS, new species.

Soldier.—Head light yellowish-brown, slender, very elongate, over twice as long as broad, sides slightly concave at center, with but few scattered long hairs.

Antennae white with tinge of yellow, 17 segments, segments become broader toward apex, pubescent; third segment subclavate, shorter than second or fourth segments.

Labrum light yellow, pointed at apex, where long hairs, broadest in middle.

Mandibles dark castaneous brown to black, slender, curved in at tips.

Gula slender, elongate, twice as broad at front as at middle.

Pronotum white with tinge of yellow, subcordate, with long hairs, anterior and posterior margins emarginate; sides roundedly narrowed to posterior.

¹⁷ 1920. Snyder, T. E. Proc. Ent. Soc. Wash., vol. 22, no. 2, pp. 39-40, February.

Legs whitish with tinge of yellow, slender, elongate.

Abdomen whitish, with tinge of yellow, with dense, long hairs. Cerci elongate, prominent.

Measurements.—Length of entire soldier, 6.75 mm.; length of head with mandibles, 3.2 mm.; length of head without mandibles (to anterior), 2.2 mm.; length of head (to tip of labrum), 2.775 mm.; length of pronotum, 0.5 mm.; length of left mandible, 1.1 mm.; length of hind tibia, 0.708 mm.; width of head, 1 mm.; width of pronotum, 0.8 mm.

Whereas this termite is known only from the soldier caste, it appears from the length of the head to be a distinct species.

Type locality.—Coxipo, Cuyabá, Brazil.

Described from a single soldier with workers determined as *Leucotermes tenuis* Hagen by Silvestri and presented by him to the United States National Museum, No. 27. Other soldiers of *longiceps* are from Minas Geraes, Brazil (between Philadelphia and Alahó), Thayer Expedition.

Type, soldier.—Cat. No. 25689, U.S.N.M.

Genus SYNTERMES Holmgren.

An interesting South American genus, usually of large and striking species, which come above ground and harvest dead leaves; they live in the ground in the forest and are very shy, retreating to their deep underground galleries at the first alarm. Several of the 10 known species have been inadequately described and in a future paper on new termites from Bolivia and Brazil some of these species will be redescribed. All the castes of the described species have not as yet been found.

The galleries of some species are of large diameter, according to Dr. W. M. Mann, of the Bureau of Entomology, and these termites may utilize the burrows of rodents; one species in Bolivia (*S. chaqui-mayensis* Holmgren) has been found to inhabit earth cook ovens.

Winged, sexual adults of only nine species are known.

KEY TO NINE SPECIES OF THE GENUS SYNTERMES HOLMGREN.

Winged adults.

1. Anterior corners of pronotum *very* pointed at tip; post-clypeus fairly large, raised up..... 2.
- Anterior corners of pronotum nearly rectangular, somewhat rounded off; post-clypeus fairly flat..... 3.
- Anterior corners of pronotum strongly rounded..... 5.
2. Ocelli separated from eye by a distance less than the diameter of eye.

dirus Burmeister.

Ocelli separated from eye by distance more than diameter of eye. *snyderi* Emerson.

3. Eyes *very* large (long diameter 1.15 mm.); median vein nearer to cubitus.
magnoculus, new species.
 Eyes not very large (long diameter 0.95 mm.); median vein equally distant from
 subcosta and cubitus..... *grandis* Rambur.
 Eyes small; median vein nearer to cubitus..... 4.
4. Antennae with 19-20 segments, entire length 32-34 mm.; long diameter of eye
 0.58 mm..... *terrītus* Emerson.¹⁸
 Antennae with 19 segments, entire length 29 mm.; long diameter of eye 0.59 mm.
parallelus Silvestri.
5. Antennae with 21 segments..... *obtusus* Holmgren.
 Antennae with 20 segments..... 6.
6. Larger species, entire length 34.5-40 mm..... *peruanus* Holmgren.
 Smaller species entire length 30 mm., long diameter of eye 0.70 mm., ocelli separated
 from eye by distance equal to over half the eye diameter; median vein nearer to
 subcosta (Lassance, Peru)..... manuscript species of Emerson.
 Still smaller species entire length 28 mm., long diameter of eye 0.75 mm., ocelli
 separated from eye by a distance equal to one-half eye diameter, median vein
 nearer to cubitus..... *molestus* Burmeister.

KEY TO FIFTEEN SPECIES OF THE GENUS *SYNTERMES* HOLMGREN.*Soldiers.*

1. Thoracic nota with long, sharp lateral spines, frontal tube projecting..... 2.
 Thoracic nota without long, sharp lateral spines, three-cornered; sides produced
 to blunt points, frontal tube nearly flat (not raised up), small species..... 11.
2. Mandibles with prominent marginal teeth..... 3.
 Mandibles with marginal teeth not prominent..... 10.
3. Lateral spines of meso- and metanota usually very robust, more or less conical;
 large and robust species, total length 14-22 mm..... 4.
 Lateral spines of meso- and metanota relatively short, more or less cylindrical.. 9.
4. Mandibles relatively slender beyond marginal teeth..... 5.
 Mandibles relatively not slender beyond marginal teeth..... 8.
5. Head markedly hairy, many long hairs at base mandibles, meso- and meta-
 thoracic spines long and droop markedly toward posterior..... 6.
 Head not markedly hairy, thoracic spines relatively short..... 7.
6. 15 mm. in length, left mandible with marginal tooth not projecting much if any
 beyond inner margin of mandible..... *dirus* Burmeister.
 20 mm. in length, left mandible with marginal tooth projecting. *snyderi* Emerson.
7. Pronotum not wide, mandibles not markedly incurved near apex, left mandible
 with marginal tooth near apex of labrum, 14-19 mm. in length, tibia. 5+ mm.
 in length..... *grandis* Rambur.
 Pronotum relatively wider, mandibles markedly incurved near apex, left mandible
 with marginal tooth beyond apex of labrum, 15.5+ mm. in length.
magnoculus, new species.
8. Head hairy, mandibles robust (not slender), relatively short, marginal tooth on
 right mandible not near base, base of mandibles with many long hairs, 15-17
 mm. in length, tibia 5+ mm. in length..... *chaquimayensis* Holmgren.
 Head with few hairs, marginal tooth on right mandible near base opposite small
 basal tooth on left mandible, but few long hairs on base mandibles, 17+ mm.
 in length, tibia 6.75 mm. in length..... *emersoni*, new species.
9. Sides of head nearly parallel-oval, only slightly narrowed anteriorly, length of head
 with mandibles 8.5-9 mm., entire length 13.5 mm..... *hageni* Holmgren.
 Head broader, shorter and strongly narrowed anteriorly, length of head with
 mandibles 7-10 mm., entire length 15-17 mm..... *peruanus* Holmgren.

¹⁸ The characters of this termite *S. terrītus* Emerson MS. are those used by Alfred Emerson in his description and the species should be credited to Emerson.

angles to veins. In fore wing median vein nearly in middle between subcosta and cubitus, but slightly nearer to cubitus, branches to apex of wing, cubitus with 17 branches or sub-branches, does not reach apex of wing.

Wing stub shorter than pronotum, median and cubitus originate free within stub, with hairs on margins.

Abdomen with tergites dark brown, with reddish tinge; sternites yellow-brown; with long hairs.

Syntermes dirus Burmeister, type No. 204, Museum of Comparative Zoology, male winged adult from Brazil, Winthem, Col., has the head reddish-brown in color, not hairy. The fontanelle is a yellow depression, not as large as the diameter of an eye. The ocellus is separated from the eye by a distance (0.65 mm.) nearly equal to the diameter of an eye. The post-clypeus is yellow-brown and raised up. In a winged female from Rio de Janeiro, Brazil, identified as *dirus*, in the Hagen collection, the forewing is 35 mm. in length and 7.5 mm. in width; the length of the deilated adult is 19 mm.

Termes decumanus Erichson, type from British Guyana, Schomburgk Col. (Mus. Berol), in the Hagen collection, is labeled *Syntermes grandis* Rambur by Hagen. Hagen states that these specimens have been compared with and are identical with Rambur's type of *grandis*. The head is deep black, not hairy. The ocellus is separated from the eye by a distance (0.65 mm.) nearly equal to the diameter of an eye. The fontanelle is a large, reddish-brown, round spot. The post-clypeus is red-brown and not raised up.

The following comparative measurements show how the winged sexual adult of *S. magnoculus* Snyder differs from that of *dirus* and of *grandis*.

Measurements.

	<i>Syntermes magnoculus</i> Snyder (female).	<i>Syntermes dirus</i> Burmeister (male). ¹	<i>Syntermes grandis</i> Rambur (female). ²	<i>Syntermes molestus</i> Burmeister (male). ³
Length of entire winged adult.....	37.00 mm.	36.00 mm.	36.00 mm.	29.00 mm.
Length of entire deilated adult.....	15.00 mm.	16.00 mm.	15.00 mm.	12.00 mm.
Length of head (tip of mandibles to posterior margin).....	5.20 mm.	4.10 mm.	4.50 mm.	3.40 mm.
Length of pronotum.....	2.25 mm.	2.20 mm.	2.20 mm.	1.50 mm.
Length of hind tibia.....	6.80 mm.	6.00 mm.	6.90 (?) mm.	4.20 mm.
Length of anterior wing.....	33.00 mm.	30.00 mm.	32.50 mm.	22.00 mm.
Diameter of eye (long diameter).....	1.15 mm.	0.80 mm.	0.95 mm.	0.75 mm.
Width of head (between eyes).....	4.50 mm.	3.70 mm.	4.40 mm.	3.00 mm.
Width of pronotum.....	4.30 mm.	4.00 mm.	3.90 mm.	2.80 mm.
Width of anterior wing.....	7.00 mm.	7.00 mm.	6.0-7.0 mm.	6.00 mm.

¹ Type (paratype?) No. 204, Museum of Comparative Zoology, Cambridge, Mass., from Brazil, Winthem, Collector.

² Measurements made of a winged female of *Termes decumanus* Erichson, from British Guyana, Schomburgk Col. (Museum Berol), Museum of Comparative Zoology, which Hagen compared with Rambur's type of *grandis* and declared them to be identical (Linn. Ent., vol. 12, pp. 158-9).

³ A winged male labeled *molestus*, from the Amazon River, Brazil, Saunders Col., Hagen Collection, Museum of Comparative Zoology.

⁴ Broken; measurement taken from a specimen from Brazil.

Soldier (pl. 4, fig. 22).—Head light castaneous (yellow-brown) with reddish tinge anteriorly, shining (dull in *grandis*), broad, broadest at base, but slightly narrowed to anterior, with few scattered fairly long hairs.

Fontanelle opening projected into a short tube, near front of head. Post-clypeus not raised. Labrum light castaneous-brown, 3-lobed at apex, central lobe hyaline, with long hairs at apex.

Mandibles piceous, shining, elongate, slender and strongly incurved at tips, with stout reddish-brown base, but few short hairs on base. Left mandible with stout, arrow-head pointed, projecting marginal tooth at basal third of black portion (beyond tip of labrum), small tooth near base; right mandible with projecting sharp-pointed tooth near base, just below tooth on left mandible (near tip of labrum).

Antenna light yellow-brown, 20 segments, pubescent; second segment half length third, longer than fourth; fifth longer than fourth; sixth longer than fifth, not quite as long as third; segments from then on longer, more slender.

Pronotum yellow-brown, margins reddish, saddle-shaped, lateral spines short, slender, as are those on meso- and metanota.

Legs yellow-brown, tibia darker, slender, pubescent.

Abdomen yellow-brown; densely covered with hairs.

Measurements.—Length of entire soldier, 15.5 mm.; length of head with mandibles, 8.5 mm.; length of head without mandibles (to tip labrum), 6.9 mm.; length of head without mandibles (to anterior), 6 mm.; length of labrum (to central hyaline lobe), 1.5 mm.; length of pronotum, 1.6 mm.; length of left mandible, 3.2 mm.; width of head (at widest point), 6.2 mm.; width of labrum, 2 mm.; width of pronotum (to tip of spines), 4.3 mm.

This soldier was not collected with the winged adult but was found at the same locality in July. It is close to *grandis* (pl. 4, fig. 23),¹⁹ but has a larger pronotum, the marginal teeth on the mandibles are differently placed, and the thoracic spines are longer.

S. magnoculus Snyder is darker colored than *dirus*, and has a larger eye than either *dirus* or *grandis*.

Type locality.—"Chapada" (Brazil), "Oct."

Described from a single winged adult collected at the type locality by H. H. Smith, 30 years ago; this is in the Matto Grosso region of southern Brazil.

Type, female winged adult.—Cat. No. 14510, Museum of Comparative Zoology, Cambridge, Mass.; paratype in United States National Museum.

¹⁹ The specimens of *grandis* from which fig. 23 were drawn are from Santarem, Brazil.

SYNTERMES EMERSONI, new species.

Soldier (pl. 4, fig. 20).—Head light castaneous-brown, more reddish at front, shining, broadest at base, narrowed anteriorly, flatly arched, with scattered fairly long hairs, fewer hairs than in *S. dirus* (Klug) Burmeister²⁰ or *chaquimayensis* Holmgren.

Fontanelle opening projected into a short tube, near front of head. Post-clypeus short, not raised up as in *dirus*. Labrum piceous, short and broad, 3-lobed at apex; center lobe dark, usually hyaline (possibly due to age of pinned specimen).

Mandibles shining, piceous, with stout reddish-brown base, broad at base where there are a few long hairs, incurved and pointed at apex, with marginal teeth as in figure. The first marginal tooth on the left mandible is nearer to the tip than in *dirus*;²¹ close to *chaquimayensis* but longer and more slender, in the latter species the marginal teeth are nearly opposite.

Antennae reddish-brown, broken (9 segments remaining), with pubescence; third segment very long, longer than second or fourth (dividing?); fourth shorter than second, subclavate; fifth shorter than third, but longer than fourth; segments become longer after the fifth.

Pronotum yellow-brown, saddle-shaped (smaller in *dirus*, as is the pronotum in *grandis*), very slightly emarginate anteriorly, if emarginate, the lateral spines are shorter than in *dirus*, as they are in *grandis*. Meso- and metanota also with lateral spines.

Legs yellow-brown, elongate; tibiae darker, apical spines red-brown.

Abdomen light castaneous-brown, densely covered with long hairs.

The soldier of *S. emersoni* was compared with a paratype? (type) of *dirus*, collected by Winthem in Brazil, No. 204, Museum of Comparative Zoology, Cambridge, Mass.; with specimens of *dirus* collected by Emerson at Kartabo, British Guiana, which are larger than the type; and also with specimens of *chaquimayensis* collected by Bradley at Perene, Peru, and others collected by Mann at Huachi, Bolivia. Comparison was also made with a soldier of *grandis* Rambur, "coll. Rbr. Patria?," and larger specimens of *grandis* collected by the Thayer Expedition at Santarem and Tapajos Rivers in the collection of the Museum of Comparative Zoology.

In the paratype of *dirus* the head is hairy and the marginal tooth in the middle of the left mandible does not project much if any beyond the inner margin of the mandible; the marginal tooth said (in Hagen's redescription) to be at the base of the right mandible is not visible in the type; that is, the mandibles are similar to those of *silvestri* Holmgren.

²⁰ The species should be credited to Burmeister; Klug was curator of the Berlin Museum and his was merely a manuscript name without a description.

²¹ The shape and position of the marginal teeth on the mandibles in the genus *Syntermes* are good specific characters.

In other specimens (identified as *dirus* in the Hagen collection) from Rio de Janeiro, Brazil (Mus. Berol) the marginal tooth on the left mandible is near the line of division of the mandible at the base; the tooth on the right mandible is larger and projecting. Holmgren²² writes that specimens identified by Hagen as *dirus* have large, strong marginal teeth on the mandibles. From an examination of the paratype it is apparent that Holmgren is wrong and that the hairy headed, long spined specimens of *dirus* collected by A. Emerson in British Guiana are a new species. Mr. Emerson has described these as *S. snyderi*, since this paper went to the printer.

In the soldier of *grandis* from Rambur's collection²³ (not in very good condition), the head is not hairy, is yellow-brown, dull, with a tinge of red at the apex; the mandibles are saber-shaped, broad at the base but curved in and slender at the apex; the left mandible is slender and curved beyond the marginal tooth, which is blunt and is near the apex of the labrum (when the mandibles are crossed or together); the right mandible has the marginal tooth at about the middle; both marginal teeth are projecting.

Measurements.

	<i>Syntermes emersoni</i> Snyder.	<i>Syntermes dirus</i> Burmeister.		<i>Syntermes grandis</i> Rambur. ³
		Brazil. ¹	British Guiana. ²	
Total length of soldier.....	17+ mm....	15+ mm.....	19-22 mm.....	14+ mm.
Length of head with mandibles.....	10 mm.....	8.8 mm.....	9.5-9.7 mm.....	9 mm.
Length of head without mandibles (to tip of labrum).....	8.15 mm....	6.85 mm.....	7.5-7.9 mm....	7 mm.
Length of head without mandibles (to anterior of head).....	7.5 mm....	6 mm.....	6-6.5 mm.....	6 mm.
Length of labrum (to base central hyaline lobe).....	0.95 mm....	1.7 mm. (entire labrum).	1.3-1.5 mm. (entire labrum).	1 mm. (entire labrum).
Length of pronotum.....	1.9 mm....	1.5 mm.....	1.7-1.8 mm....	1.2 mm.
Length of hind tibia.....	6.75 mm....	6.2 mm.....	6-6.2 mm.....	5.5? mm.
Length of left mandible.....	3.5 mm....	3.1 mm.....	3.2-3.5 mm....	3.2 mm.
Width of head (at broadest part).....	7.5 mm....	6.2 mm.....	6.5-6.9 mm....	6.2 mm.
Width of labrum.....	1.65 mm....	1.4 mm.....	1.7 mm.....	1.4 mm.
Width of pronotum (to tips spines).....	5.4 mm....	4.5 mm.....	5.5-5.9 mm....	3.6 mm.
Length of spines on pronotum.....	1.1 mm....	0.7 mm.....	0.8-1 mm.....	(Short) 0.35 mm.

¹ Collected by Winthem in Brazil, No. 204, Museum of Comparative Zoology, Cambridge, Mass.

² Collected by A. Emerson at Kartabo, British Guiana.

³ "Coll. Rbr. Patria?" in the Hagen collection at the Museum of Comparative Zoology.

I take great pleasure in naming this termite after Alfred Emerson, of the department of zoology, University of Pittsburgh, who has done valuable taxonomic and biological work on termites.

Type locality.—Iguaripe (?), Brazil.

Described from a single soldier in the collection of the United States National Museum.

Type, soldier.—Cat. No. 25748, U.S.N.M.

²² Zool. Anzeig., vol. 37, pp. 545-6, 1911.

²³ Rambur did not describe the soldier of this species, so this is not a type, though from this collection. In Hagen's copy of Rambur's book he has crossed the locality "Senegal" and written "d'apres les types etiquettes de la main de M. Rambur de Cayenne."

SYNTERMES HAGENI Holmgren.

Soldier (pl. 4, fig. 21).—Head light castaneous-brown, somewhat darker (reddish-brown) toward front, shining, flatly arched, broadest near base, narrowed anteriorly but little, sides nearly parallel, oval, with few scattered long hairs, fewer than in *S. chaquimayensis* Holmgren or *dirus* Burmeister.

Fontanelle near front of head, opening projected into a short tube. Antennae yellow-brown, broken. Labrum reddish-brown, front with central lobe hyaline. Post-clypeus reddish-brown, somewhat raised up.

Mandibles shining black, elongate, pointed at tips where slender, stout, base reddish-brown, more slender than in *S. chaquimayensis*; with few long hairs; marginal teeth as in figure.

Pronotum yellowish-brown, saddle-shaped, anterior margin slightly emarginate, lateral spines shorter and stouter than in *dirus* or *chaquimayensis*.

Legs yellow-brown, elongate.

Abdomen light castaneous-brown.

Measurements.—Total length of soldier, 13.5 mm.; length of head with mandibles, 8.5 mm.; length of head without mandibles (to tip of labrum), 6.6 mm.; length of head without mandibles (to anterior of head), 6.1 mm.; length of labrum (to base central hyaline lobe), 0.8 mm.; length of pronotum (to tips spines), 1.2 mm.; length of left mandible, 3 mm.; width of head (at broadest part), 6 mm.; width of labrum, 1.3 mm.; width of pronotum, 4.2 mm.

Undoubtedly *hageni*, considered by Holmgren to²⁴ be a form of *S. dirus* Burmeister, is a distinct species. The specimens of *S. chaquimayensis* with which this soldier were compared were from Huachi, Bolivia, and those of *dirus* from Kartabo, British Guiana. Unfortunately Holmgren's description is meager, the only characters given being those used in a key.

Hageni is a smaller species than *dirus*, with the head not as yellowish as *dirus*, being more castaneous. It is only known from the soldier caste.

The single pinned soldier upon which this description is based was kindly loaned the writer by Alfred Emerson, of the department of zoology of the University of Pittsburgh; it is deposited in the Carnegie Museum, Pittsburgh, Pa., Acc. No. 3564. This soldier was collected at Entre Rios, Rio de Janeiro, Brazil, June 4, 1908, by J. D. Haseman.

²⁴ Holmgren, Nils. 1. Bemerkungen über einige Termiten-Arten. Zoolog. Anzeiger, vol. 37, No. 26, pp. 543-548, 13 June, 1911.

SYNTERMES COLOMBIANUS, new species.

Soldier (pl. 4, fig. 24).—Head pale, yellow-brown, slightly darker anteriorly, shining, flatly arched, broadest near base, narrowed slightly toward front, with few scattered, fairly long, light yellow hairs.

Fontanelle near front of head, opening projected into a short tube.

Antennae light castaneous-brown, elongate, slender, 19 segments, with long hairs; third segment subclavate shorter than second but longer than fourth, which is short and subclavate.

Labrum light yellow, 3-lobed, central hyaline lobe white, fleshy, tip of labrum with long hairs.

Post-clypeus yellow-brown, somewhat raised up.

Mandibles dark reddish-brown to piceous, base yellow to reddish-brown, few hairs on base, shining, slender and nearly straight, incurved at tips; left mandible with two blunt small teeth near base, do not project beyond margin of mandible; right mandible with no marginal teeth (trace of tooth at base located between the two teeth on the left mandible). (See figure.)

Gula more than half the width of the front at the middle.

Pronotum yellow-brown, saddle-shaped, anterior margin emarginate, with short blunt spines; meso- and metanota also with short spines, more pointed than those on pronotum, shorter than in *silvestri*.

Legs light yellow-brown, elongate, slender, pubescent.

Abdomen dirty gray with tinge of yellow-brown.

S. colombianus is a small species found in the Hagen collection at Cambridge, Mass., with *S. dirus* (Klug) Burmeister. N. Banks has kindly loaned me the specimen for study; *colombianus* is about the same size as *braziliensis* Holmgren, but, unlike that species, has spines on the thorax. It may be close to *bolivianus* Holmgren.

Measurements.—Total length of soldier, 10.5 mm.; length of head with mandibles, 6.5 mm.; length of head without mandibles (to tip labrum), 4.8 mm.; length of head without mandibles (to anterior), 4.2 mm.; length of pronotum, 0.9 mm.; length of left mandible, 2.5 mm.; length of labrum, 0.65 mm.; length of hind tibia, 3.5 mm.; width of head (at widest point), 3.4 mm.; width of pronotum (to tips spines), 2.25 mm.; width of labrum, 0.95 mm.

Type locality.—"Colombia, S. Amer."

Described from a single soldier in the Hagen collection labeled "*S. dirus*, Winthem, collector, Colombia, S. Amer."

Type, soldier.—Cat. No. 14511, Museum of Comparative Zoology, Cambridge, Mass.

Genus *NASUTITERMES* Banks.

In 1920 Nathan Banks adopted the generic name *Nasutitermes* for a species of the genus *Eutermes* Fritz Müller. In 1912 Nils Holmgren subdivided the genus "*Eutermes*" into 20 subgenera, based not only on differences in the winged adults but also to differentiate the various forms of nasuti or soldiers. Species in these subgenera not only differ taxonomically but also in biology, and they have been adopted by the writer.

Species of the genus *Nasutitermes* are widely distributed throughout the world's tropical and subtropical regions; there are a great number of species and some species are apparently quite variable and seem to intergrade.

Most species are wood borers and are destructive to timber and the woodwork of buildings.

Many species of *Nasutitermes* construct carton tree nests which sometimes contain several first-form queens. In some species second-form queens have been found, and in case of large distended queens from the Solomon Islands there is a series of intermediate queens (pigmented) ranging from second-form queens with short wing pads to queens with long wing pads, like first-form nymphs.

NASUTITERMES COLUMBICUS Holmgren.

Winged adult.—Head dark brownish-black, shining; longer than broad, rounded posteriorly, with long hairs. Fontanelle small, narrow, slit-like with a forked tip, between the eyes.

Antenna yellow-brown, 16 segments, pubescent; first segment elongate, cylindrical; second shorter and narrower than first; third approximately one-half the length of the second, narrower, ring-like, with more color; fourth longer than third, more ring-like; fifth longer than fourth; segments become longer toward apex; last segment elongate and suboval.

Eye purplish, small but prominent (bulging), close to lateral margin of head (separated by a distance less than half an eye diameter). Ocellus small, elongate, separated from eye by a distance equal to approximately twice its short diameter, fairly deeply inset.

Labrum yellow-brown, broader than long, broadly rounded anteriorly but truncate and slightly emarginate at tip, with long hairs.

Post-clypeus yellow-brown, over three times as broad as long, bilobed, not bulging, posterior margin not markedly concave.

Pronotum same color as head, not twice as broad as long, slightly emarginate anteriorly (but margin nearly straight), anterior corners elevated, sides rounded, slope fairly sharply to posterior margin where more emarginate than anteriorly, pronotum subtriangular, with long hairs.

Meso- and metanota lighter colored than pronotum, slightly angularly emarginate posteriorly.

Legs yellow-brown.

Wing brown-black, costal veins darker, tissue punctuate and with hairs, margin ciliate, median vein close to cubitus, branched 4 times before reaching apex, but reaches apex, cubitus with 7-10 branches or sub-branches.

Wing scale about the same length as pronotum, with long hairs.

Tergites of abdomen darker colored than meso- and metanota, but slightly lighter colored than pronotum; sternites lighter colored than tergites—lighter at middle of segments; abdomen with numerous short hairs.

Measurements.—Length of entire winged adult, 15 mm.; length of entire dealated adult, 10 mm.; length of head, 1.75 mm.; length of pronotum, 0.74-0.80 mm.; length of hind tibia, 1.7 mm.; length of anterior wing, 11.5 mm.; width of head (at eyes), 1.55 mm.; diameter of eye (long diameter), 0.307 mm.; width of pronotum, 1.28-1.30 mm.; width of anterior wing, 3.78 mm.

N. guayanae described by Holmgren in 1910 from South America (upper Surinam) is a longer and lighter colored adult than the form *columbicus* from Colombia, which I consider to be a good species, although close to *guayanae*; the distance of the ocelli from the eyes is different. It was described²⁵ from the nasutus caste and the winged adult has remained unknown until found at Panama with nasuti and workers.

This species, *columbicus* Holmgren, does not construct a regular spherical carton "niggerhead" nest in trees, but will cover over infested posts with material of the same consistency of the usual carton nest, forming an irregular shaped mass or nest.

Described from several winged adults ready for the flight, collected with nasuti and workers by J. Zetek and I. Molino, on April 28, 1921, at Frijoles, Canal Zone, Panama (Z. 1404), in a rotten log at avocado plantation. These specimens are deposited in the United States National Museum.

Subgenus SUBULITERMES Holmgren.

As yet this subgenus of the genus *Nasutitermes* Banks, established by Holmgren in 1912, contains but few known species, which, however, occur in South America and Asia; two species which occur in Africa are doubtfully placed in *Subulitermes* by Holmgren.

The soldiers of the American species have pear-shaped, light colored heads but slightly constricted with the dorsal profile of the head

²⁵ 1910 (1909). Holmgren, N. Versuch einer Monographie des amerikanischen *Eutermes*-Arten. Mitteil. Naturh. Mus. Hamburg, vol. 27, 2 Beiheft, pp. 254-256 [*Nasutitermes*] *Eutermes guayanae* described; p. 256, new form *columbicus* described from "Columbien."

nearly in a straight line; the nasus is cylindrical, but slender. The mandibles of the soldier caste, as a rule, are absent. The postclypeus is large.

NASUTITERMES (SUBULITERMES) ZETEKI, new species.

Soldiers (pl. 4, figs. 25-26).—Head pale yellowish, nasutiform, pear-shaped, elongate, but narrow, tapers anteriorly, where slightly thicker (higher), with dense long and short hairs; nasus castaneous-brown, elongate, narrow, straight, with dense short hairs even to apex and on both dorsal and ventral surfaces. Mandibles absent.

Antennae white with tinge of yellow, 11 segments, pubescent, segments become broader and longer toward apex; first segment elongate, broad, cylindrical; second shorter than first; third subclavate, slender, slightly longer than second or fourth, also slightly narrower; fourth subclavate, slightly longer than second; last segment elongate, slender and subelliptical.

Pronotum white with tinge of yellow at anterior margin, saddle-shaped, not nearly as broad as head, with long hairs.

Legs white with tinge of yellow, fairly elongate, slender, pubescent.

Abdomen grayish-white with tinge of yellow, with dense short light yellow hairs on both dorsal and ventral surfaces and long hairs at each side at the base of each segment.

Measurements.—Length of entire soldier, 2.2-3.1 mm.; length of head with nasus, 0.95-1.1 mm.; length of head without nasus, 0.6-0.7 mm.; length of nasus, 0.35-0.38 mm.; length of pronotum, 0.11 mm.; length of hind tibia; 0.45-0.50 mm.; width of head, 0.42-0.46 mm.; width of pronotum, 0.27 mm.

This small, hairy, species of *Subulitermes* is the first to be found in Central America; it differs from the two known South American species as well as from undescribed species from South America in the collection of the United States National Museum. *S. zeteki* is smaller and has more longer hairs on the head than either *S. microsoma* Silvestri or *incola* Holmgren. It also differs from 6 undescribed species from South America, which will be described by A. Emerson and F. Silvestri; only one other of these 2 described and 6 undescribed species of *Subulitermes* from America consistently has 11 segments to the antennae.

Winged adult unknown.

Type locality.—Summit, Canal Zone, Panama.

Described from a series of soldiers found with workers at the type locality by J. Zetek and I. Molino (Z. 1731), on July 29, 1922, abundant, in the trunk and petiole of an oil palm (*Eleas melanococca*)

Named in honor of J. Zetek, of the Bureau of Entomology.

Type, soldier.—Cat. No. 25766, U.S.N.M.

AMITERMES WHEELERI Desneux.

Winged adult (pl. 1, fig. 9.)—Head dark brown to blackish, slightly longer than broad, rounded posteriorly, with dense, fairly long, light yellow hairs. Fontanelle white, prominent but not as large as an ocellus, elongate, wider at base (trowel-shaped), base on a line connecting eyes posteriorly.

Antennae yellow-brown, 14 segments, longer than head, segments become longer, broader, and more clavate toward apex, pubescent; first segment elongate, cylindrical; second shorter and narrower than first; third shorter than second, ring-like to slightly clavate; fourth longer than third, clavate; last segment elongate and sub-elliptical.

Eye black, nearly round, projecting, separated from the lateral margin of the head by a distance equal to less than half a diameter. Ocellus prominent, elongate, deeply inset, with projecting rim, separated from eye by a distance less than its short diameter.

Labrum yellowish, longer than broad, broadest at middle, broadly rounded at apex, with long hairs.

Post-clypeus pale yellow-brown, bulging, bilobed, posterior margin concave, over twice as wide as long.

Pronotum approximately the same color as the head, broadest anteriorly, not twice as broad as long, anterior margin nearly straight, to slightly convex, anterior corners rounded and slightly raised (elevated), sides gradually taper toward posterior, posterior margin slightly emarginate; pronotum with long hairs.

Meso- and metanota lighter colored than pronotum, emarginate at acute angles posteriorly.

Legs yellow-brown, tarsi lighter.

Wings white, costal veins yellow-brown, membrane punctate, margins ciliate; median vein near cubitus branched in fore wing before reaching apex, cubitus with about 8 branches in fore wing, 10 in hind wing (pl. 4, figs. 27-28).

Wing scale is slightly shorter in length than the pronotum; with hairs.

Abdomen with dorsum lighter colored than pronotum, ventrally paler, with dense, fairly long, light yellow hairs.

Measurements.—Length of entire winged adult, 8.5 mm.; length of entire de-alated adult, 6.25 mm.; length of head (to tip of labrum), 0.905 mm.; length of pronotum, 0.4 mm.; length of hind tibia, 0.6 mm.; length of anterior wing, 6 mm.; length of wing scale, 0.307 mm.; width of head (at eyes), 0.805 mm.; diameter of eye, 0.101-0.106 mm.; width of pronotum, 0.701 mm.

This termite is more slender than is *Amitermes tubiformans* Buckley, the fontanelle is narrower, and the wings are not as long in proportion to the length as in *tubiformans*.

The winged adult of *Amitermes wheeleri* Desneux has hitherto been unknown, the specific description being based upon the soldier caste;²⁶ the above-described winged adults were found with soldiers by C. H. Gable, at San Antonio, Tex., on July 12, 1921, Hopk. U. S. No. 16552. They were flying at 8.15 in the morning, so this species (as is also *A. tubiformans*) is not a nocturnal flying termite.

Described from several winged adults. These specimens are deposited in the United States National Museum.

AMITERMES BEAUMONTI Banks.

Winged adult.—Brown-black, shining, slightly longer than broad, rounded posteriorly, with dense, long, light yellow hairs. Fontanelle indistinct, a linear slit in a depression between the eyes.

Antennae dark yellow-brown, 15 segments, segments become broader toward apex, pubescent; first segment elongate, cylindrical; second shorter (approximately half length of first) and narrower than first, ring-like; third shorter than second, clavate; fourth broader and longer than third; last segment narrower, elongate and subelliptical, pointed at apex. Antennae approximately the same length as the head.

Eye black, large, nearly round, prominent and projecting; very close to lateral margin of head. Ocellus elongate, fairly deeply set in head (with prominent overhanging rim), separated from the compound eye by a distance equal to its short diameter.

Labrum yellow, longer than broad, somewhat tongue-shaped, tapers toward apex, where rounded, with fairly long hairs.

Post-clypeus light yellow-brown, bulging, bilobed, not quite twice as broad as long, posterior margin strongly concave.

Pronotum about the same color as the head, nearly twice as broad as long, broadest anteriorly, emarginate anteriorly, posterior margin nearly straight, anterior corners high; rounded sides gradually slope to posterior, general shape semicircular, with long hairs.

Meso- and metanota lighter colored than pronotum, mesonotum not covered by wing scale, both meso- and metanota are angularly emarginate posteriorly.

Legs light yellow-brown; hind tibiae broken.

Wings dusky gray iridescent, costal veins darker brown, tissue punctate, margins ciliate; median vein runs straight to apex, close to cubitus, which is nearly in the center of the wing, cubitus parallel to the median vein, with 10 to 11 branches or sub-branches, cubitus reaches apex of wing.

Wing scale not as long as the pronotum, with long hairs.

²⁶ 1905. Desneux, J. Variétés Termitologiques II, Termites du Texas. Ann. Soc. Ent. Belg., vol. 49 Bruxelles (p. 340, *Amitermes wheeleri* described from the soldier caste, type locality Belton, Tex.).

Abdomen about same color as mesonotum, lighter ventrally, not half as long as the wings (in dry pinned specimens), with dense, long, light yellow hairs.

Measurements.—Length of entire winged adult, 8.5 mm.; length of entire deälated adult, 4.5 mm.; length of head, 1 mm.; length of pronotum, 0.407 mm.; length of anterior wing, 6.5 mm.; width of head (at eyes), 0.901 mm.; diameter of eye (long diameter), 0.207 mm.; width of pronotum, 0.802 mm.; width of anterior wing, 1.85 mm.

This winged adult has been hitherto unknown; the specific description of *Amitermes beaumonti* Banks was based upon the soldier caste alone. Banks believes that this may be the winged adult of *beaumonti*.²⁷ However, the specimens were not found with soldiers.

The three specimens upon which this description is based were found flying at Trinidad River, Panama, on May 6, 1911, collector August Busck. They are deposited in the United States National Museum.

Genus ANOPLOTERMES Fritz Müller.

Twenty-eight species of *Anoplotermes* are known; 11 are from Africa and 17 are Neotropical.

The winged adults of Nearctic, Antillean, and Central American species have the fontanelle either indistinct or absent; species from South America and other parts of the world have the fontanelle large and prominent. The meso and metanota are elongate and the posterior margin is emarginate.

The mandibles of the winged adults in some species are very elongate, which is interesting in view of the fact that the soldier caste is absent in all species. Species of *Anoplotermes* construct large mound nests in South America.

In some species of the subgenus *Speculitermes* Wasmann the workers are darkly colored and the fontanelle is large, round, and prominent; the third segment of the antennae of the winged adult usually is large (approximately equal to the fourth)—not small as in *Anoplotermes* s. s. These species of *Speculitermes* live in earth nests in the crotches of trees near the ground, whereas some Central American species of *Anoplotermes* do not construct earth nests or mounds.

Twelve species of *Anoplotermes* have been described from America, but only one species of *Speculitermes* is known. I have recently examined the types of *A. ater* Hagen and *A. fumosus* Hagen at the Museum of Comparative Zoology, Cambridge, Mass.

A. ater, female (type No. 208, M. C. Z.), of Brazil, is a small, dark-black species, with short mandibles; the eyes are prominent

²⁷ 1918. Banks, N. The Termites of Panama and British Guiana. Bull. Amer. Mus. Nat. Hist., vol. 23, art. 17, New York, November (p. 664, *Amitermes beaumonti* described from soldier caste from specimens in Beaumont collection from Panama).

and projecting; the post-clypeus is light-brown, slightly bulging, is bilobed, and the posterior margin is convex, it is over twice as broad as long. The fontanelle is a small indistinct spot in a depression, at the back of the eyes, it is nearer the posterior than in *A. fumosus*; the epicranial suture is less distinct than in *fumosus*. The mandibles are reddish to black at the tip but yellow-brown at the base, they project slightly beyond the labrum. The ocelli are large and prominent and are separated from the eyes by a distance equal to about their long diameter.

A. fumosus, female (type No. 218, M. C. Z.), of Vera Cruz, Mexico, is a larger species than *ater*, is dark-brown, and also has longer mandibles; the eyes are prominent and projecting; the post-clypeus is lighter colored than the head, is prominent and projecting, being twice as broad as long, and is bilobed—more so than in *ater*. The mandibles project slightly beyond the labrum. The ocelli are separated from the eyes by a distance equal to about their diameter. The fontanelle is an indistinct spot at the base of the epicranial suture, just back of the ocelli, at the middle of the eyes.

A. tenebrosus Kollar, female (type No. 422, from Ypanema, Province of St. Paulo, Brazil, is larger than any of the preceding American species of *Anoplotermes*. The head is dull brown-black in color, and hairy; the eyes are large and prominent; the mandibles are long. The ocelli are separated from the compound eyes by a distance nearly equal to their long diameter. The fontanelle is a small yellow raised point. The post-clypeus is dark-brown, raised up and one-third as long as wide. The pronotum is lighter colored than the head. The hind tibiae are yellow-brown and elongate.

The following measurements of *A. tenebrosus* are given for comparison with *A. hondurensis* Snyder, *fumosus* and *ater*.

Measurements.—Length of entire winged adult, 14.5+ mm., female; length of entire deälated adult, 5.5+ mm., female; length of head, 1.35 mm.; length of pronotum, 0.65 mm.; length of left mandible, 0.65–0.70 mm.; length of hind tibia, 1.4 mm.; length of fore wing, 13 mm.; diameter of eye, 0.35 mm.; width of head, 1.3 mm.; width of pronotum, 1.15 mm.; width of fore wing, 3.2 mm.

A key to seven American species of *Anoplotermes* is herewith appended.

KEY TO SEVEN AMERICAN SPECIES OF *ANOPLOTERMES* FRITZ MÜLLER.

1. Large, females²⁸ 13–16 mm. in length, mandibles elongate (0.6–0.7 mm.), eyes and post-clypeus bulging..... 2.
- Small, females 7.50–12 mm. in length, mandibles short, eyes not so projecting, post-clypeus over twice as broad as long..... 6.

²⁸ There is a marked difference in length of winged males and females in the genus *Anoplotermes*.

2. Head and pronotum broad..... 3.
Head and pronotum not broad..... 5.
3. Ocelli separated from eyes by a distance greater than their diameter, post-clypeus less than twice as broad as long..... *schwarzi* Banks.
Ocelli separated from eyes by a distance equal to or slightly less than their diameter..... 4.
4. Post-clypeus one third as long as broad..... *tenebrosus* Hagen.
Post-clypeus one half as long as broad..... *hondurensis*, new species.
5. Ocelli separated from eyes by a distance slightly less than their diameter, post-clypeus twice as broad as long..... *fumosus* Hagen.
6. Length 12 mm., head blackish, mandibles short (0.55 mm.), post-clypeus slightly bulging, nearly three times as broad as long..... *ater* Hagen.
Length 7.50 mm., head gray-black, mandibles very short (0.37 mm.), post clypeus not bulging, nearly three times as broad as long..... *parvus* Snyder.
Length 11 mm., head dark-brown, mandibles very short (0.45 mm.), post-clypeus projecting, over twice as broad as long..... *gracilis* Snyder.

ANOPLOTERMES HONDURENSIS, new species.

Winged adult.—Head dull dark brown to blackish, broader than long (to base of post-clypeus), with dense short and long, light yellow hairs. Fontanelle indistinct spot in broad depression between the eyes.

Antennae light brown, 15 segments, segments become broader and longer toward apex, with dense, long, light yellow hairs; first segment long, cylindrical; second shorter, somewhat clavate; third shorter than second, narrow, clavate; fourth longer and broader than third; last segment elongate, subelliptical.

Eye, black, nearly round, projecting, separated from lower margin of head by a distance equal to less than its diameter. Ocellus deeply inset, with projecting upper rim, large, nearly round, separated from eye by a distance equal to its long diameter (distant slightly less than its diameter in *A. fumosus* Hagen and *ater* Hagen).

Labrum light yellow, elongate, broadest at middle, narrows to apex where rounded, with long, light yellow hairs, not as long as mandibles.

Post-clypeus light brown, bilobed, projecting, twice as broad as long, posterior margin concave.

Mandibles yellow, castaneous brown to black at tips, very long (0.7 mm.), extend beyond labrum, longer and with longer marginal teeth than in *fumosus* where the left mandible is 0.6–0.7 mm. in length, also longer than in *gracilis* Snyder, where mandible is 0.45 mm. in length.

Pronotum dark brown, not twice as broad as long, narrower than head, medianally and anteriorly deeply, angularly indented, anterior margin concave, posterior margin convex, sides roundedly narrowed toward posterior margin, with dense short and long, light yellow hairs. Meso- and metanota emarginate posteriorly, whereas the

meso- and metanota are only a little emarginate posteriorly in *fumosus*; narrowly emarginate in *ater*.

Legs yellow with tinge of brown.

Wings gray, veins yellow-brown, costal veins darker, wing margins ciliate, tissue of wing punctate; median vein slightly nearer to cubitus than to subcosta, reaches apex of wing (doubly or singly branched or not branched); cubitus does not reach apex of wing; with 10-12 branches or sub-branches to lower margin, not parallel to but converges to lower margin of wing posteriorly (pl. 5, figs. 31-32).

Wing scale shorter than pronotum.

Abdomen with dorsum slightly lighter colored than pronotum, with dense short and long light yellow hairs.

Measurements.

	<i>A. hondurensis</i> , new species.	<i>A. fumosus</i> , Hagen type.	<i>A. fumosus</i> , Hagen. ¹	<i>A. ater</i> , Hagen type.	<i>A. ater</i> , Hagen. ²
Length of entire winged adult....	11-12 mm., males; 13.5 mm., female. ³	14 mm., female.	12.5 mm., female.	12 mm., female.	12 mm., female.
Length of entire deilated adult....	6-6.5 mm., males; 7 mm., female.	6 mm., female.	6 mm., female.	5 mm., female.	6.5 mm., female.
Length of head (tip of mandibles to posterior margin).	1.55 mm.....	1.35 mm. (to tip of labrum).	1.23-1.30 mm.	1.35 mm. (to tip of labrum).	1.27 mm.
Length of pronotum.....	0.6 mm.....	0.6 mm.....	0.57 mm.....	0.55 mm.....	0.57 mm
Length of hind tibia.....	1.25 mm.....	1.2 mm.....	1.23 mm.....	1.15 mm.....	1.03 m.
Length of anterior wings.....	10.75 mm.....	11 mm.....	11.37 mm.....	10.5 mm.....	10.05 mm.
Length of left mandible.....	0.7 mm.....	0.7 mm.....	0.6 mm.....	0.55 mm.....	0.55 mm.
Width of head (between eyes).....	1.25 mm.....	1.1 mm.....	1.1 mm.....	1.2 mm.....	1.07 mm.
Diameter of eye.....	0.27-0.3 mm.	0.35 mm.....	0.25-0.27 mm.	0.3 mm.....	0.25 mm.
Width of pronotum.....	1.1 mm.....	0.9+ mm. (turned down).	0.93+ mm. (turned down).	1 mm.....	1 m.
Width of anterior wing.....	2.55 mm.....	3 mm.....	2.8 mm.....	2.9 mm.....	2.50 mm.

¹ Specimens from Harlingen, Tex.

² Specimens from Coxipo, Cuyabá. No. 63, determined by F. Silvestri, which were kindly presented by him to the United States National Museum. The head is brown colored—lighter than in the type; the post-clypeus is more bulging than in the type.

³ There is considerable difference in the size of the sexes, the female often being much larger.

Mandibles longer than in *ater* Hagen and *fumosus*, post-clypeus more bulging and broader in proportion to its length than in *ater*; a larger and darker species than is *gracilis* Snyder, eyes more projecting, ocelli separated from eyes by a greater distance; darker and broader than *fumosus*; there are also differences in wing venation (pl. 5, figs. 29-32).

Type locality.—La Ceiba, Honduras.

Described from a series of winged adults collected at the type locality by F. J. Dyer, the American consul, May 19, 1916, Nos. 6655 and 6664.

Type, winged female adult.—Cat. No. 25692, U.S.N.M.

DESCRIPTION OF PLATES.²⁹

PLATE 1.

Soldier of *Kaloterms approximatus*, a new Hawaiian *Kaloterms*, new Antillean *Glyptoterms*, a new *Leucoterms*, and deälated adult of *Amiterms wheeleri*.

- FIG. 1. *Kaloterms approximatus* Snyder. Soldier, head and pronotum.
 2. *Glyptoterms pubescens* Snyder. Soldier, three-quarters view head and pronotum.
 3. *Glyptoterms pubescens* Snyder. Soldier, dorsal view mandibles.
 4. *Glyptoterms pubescens* Snyder. Soldier, dorsal view pronotum.
 5. *Glyptoterms pubescens* Snyder. Soldier, dorsal (outline) view head.
 6. *Kaloterms marjoriae* Snyder. Venation of hind wing.
 7. *Leucoterms convexinotatus* Snyder. Deälated adult, head and thorax.
 8. *Leucoterms convexinotatus* Snyder. Soldier, head and pronotum.
 9. *Amiterms wheeleri* Desneux. Deälated adult, head and thorax.

PLATE 2.

Deälated adult and work of a new Antillean *Glyptoterms*.

- FIG. 10. *Glyptoterms pubescens* Snyder. Deälated adult, dorsal view entire insect.
 11. *Glyptoterms pubescens* Snyder. Burrows in try, sound, hard coffee tree wood; longitudinal view. Natural size.
 12. *Glyptoterms pubescens* Snyder. Burrows in dry, sound, hard coffee tree wood; end view. Natural size.
 13. *Glyptoterms pubescens* Snyder. Pellets of impressed, excreted wood. Greatly enlarged.

PLATE 3.

Wing venation of species of *Leucoterms*.

- FIG. 14. *Leucoterms convexinotatus* Snyder. Venation of fore wing.
 15. *Leucoterms convexinotatus* Snyder. Venation of hind wing.
 16. *Leucoterms tenuis* Hagen. Venation of fore wing.
 17. *Leucoterms tenuis* Hagen. Venation of hind wing.
 18. *Leucoterms cardini* Snyder. Venation of fore wing.
 19. *Leucoterms cardini* Snyder. Venation of hind wing. The median vein usually does not turn up to the subcostal vein.

PLATE 4.

Soldiers of new and known species of *Synterms*, a new *Subuliterms* and wings of *Amiterms wheeleri*.

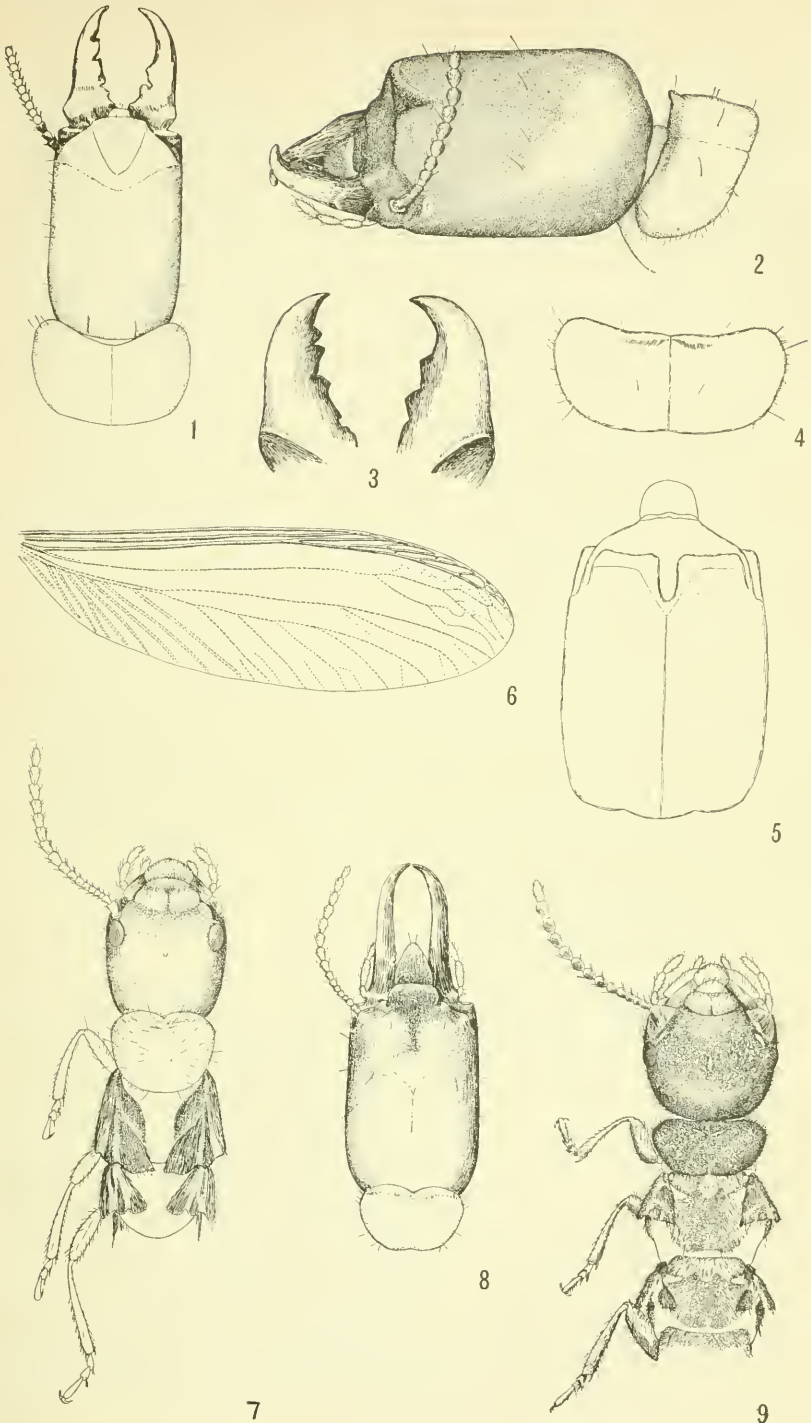
- FIG. 20. *Synterms emersoni* Snyder. Soldier, dorsal view of head and thorax.
 21. *Synterms hageni* Holmgren. Soldier, dorsal view of head and thorax.
 22. *Synterms magnoculus* Snyder. Soldier, dorsal view of head and thorax.
 23. *Synterms grandis* Rambur. Soldier, dorsal view of head and thorax, right mandible inset.
 24. *Synterms colombianus* Snyder. Soldier, dorsal view of head and thorax.
 25. *Subuliterms zeteki* Snyder. Nasutus, lateral view of head and pronotum.
 26. *Subuliterms zeteki* Snyder. Nasutus, dorsal view (outline) of head and pronotum.
 27. *Amiterms wheeleri* Desneux. Fore wing.
 28. *Amiterms wheeleri* Desneux. Hind wing.

²⁹ Drawings by Miss Eleanor T. Armstrong, of the Bureau of Entomology.

PLATE 5.

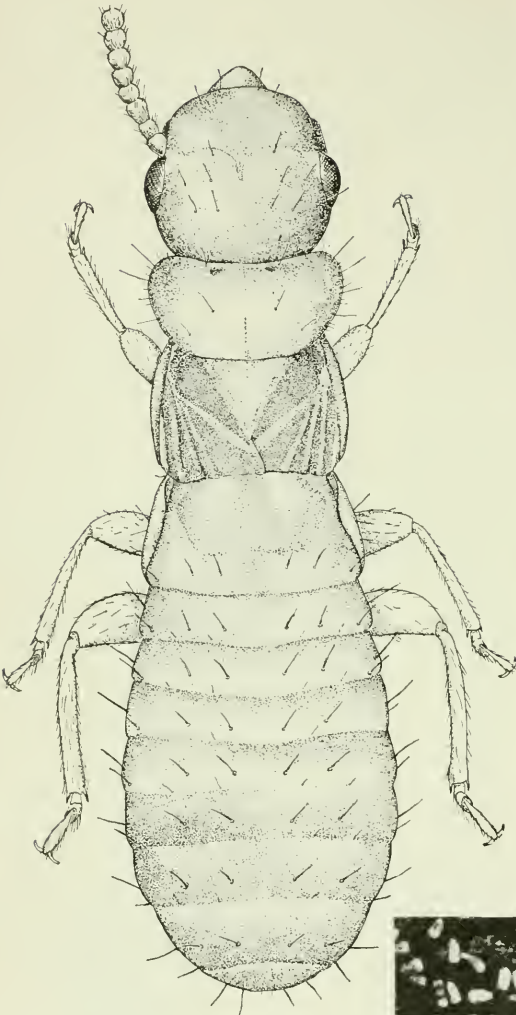
Wings of a new Honduran *Anoplotermes* and *A. fumosus*.

- FIG. 29. *Anoplotermes fumosus* Hagen. Venation of fore wing.
30. *Anoplotermes fumosus* Hagen. Venation of hind wing.
31. *Anoplotermes hondurensis* Snyder. Venation of fore wing.
32. *Anoplotermes hondurensis* Snyder. Venation of hind wing.



SOLDIER OF *KALOTERMES APPROXIMATUS*, A NEW HAWAIIAN *KALOTERMES*, NEW ANTILLEAN *GLYPTOTERMES*, A NEW *LEUCOTERMES*, AND DEALATED ADULT OF *AMITERMES WHEELERI*.

FOR EXPLANATION OF PLATE SEE PAGE 39.



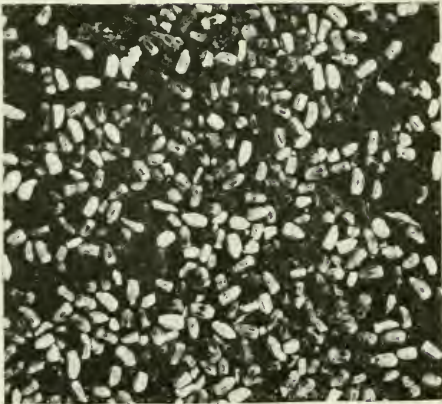
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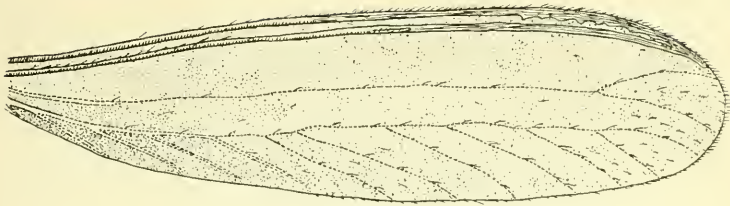
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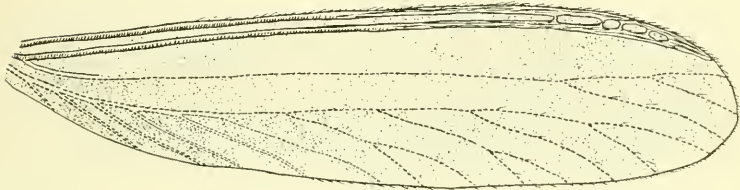
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DE-LATED ADULT AND WORK OF A NEW ANTILLEAN GLYPTOTERMES.

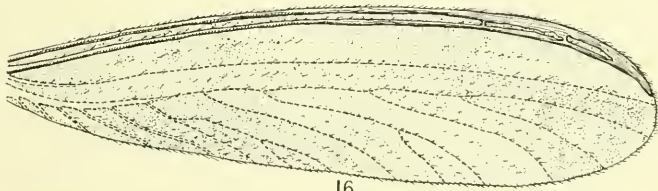
FOR EXPLANATION OF PLATE SEE PAGE 39.



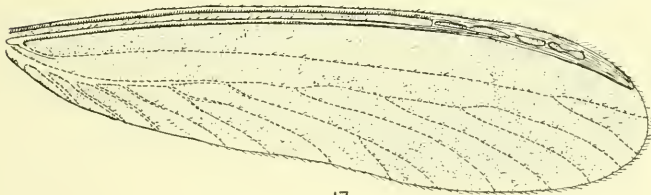
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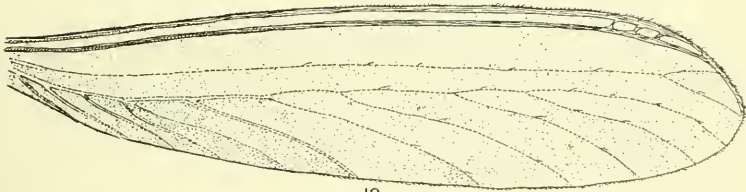
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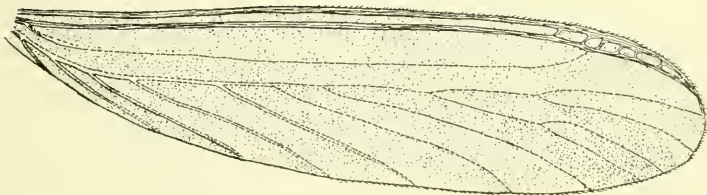
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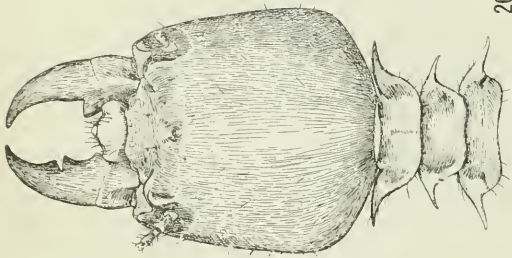
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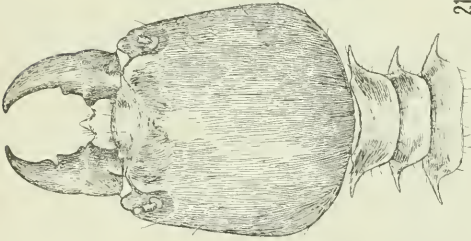
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WING VENATION OF SPECIES OF LEUCOTERMES.

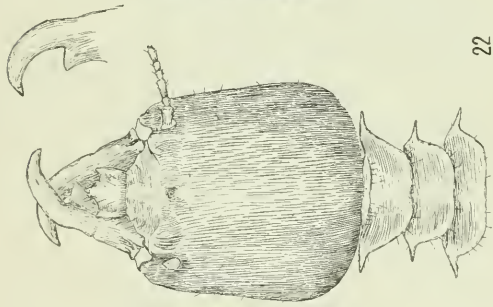
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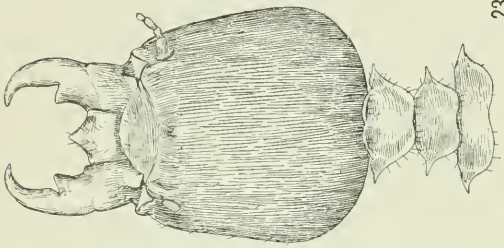
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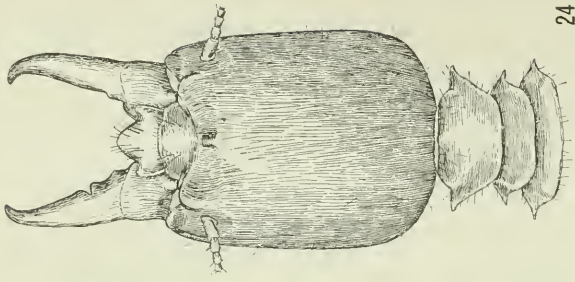
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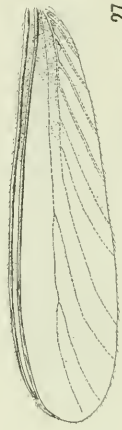
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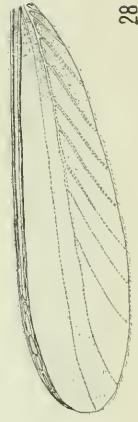
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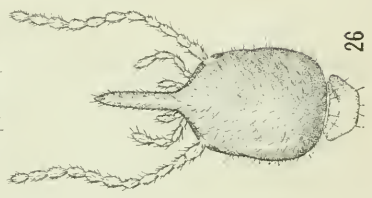
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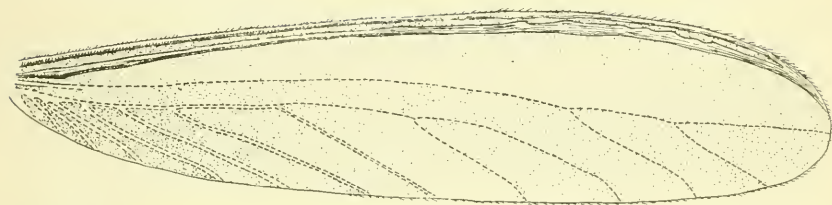
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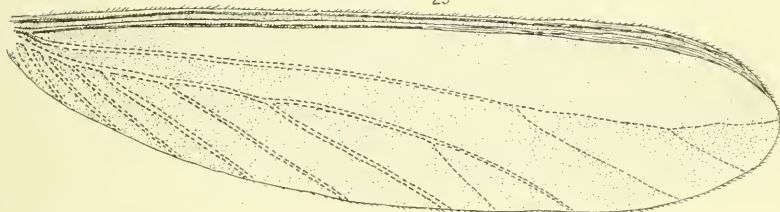
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SOLDIERS OF NEW AND KNOWN SPECIES OF SYNTERMES, A NEW SUBULITERMES, AND WINGS OF AMITERMES WHEELERI.

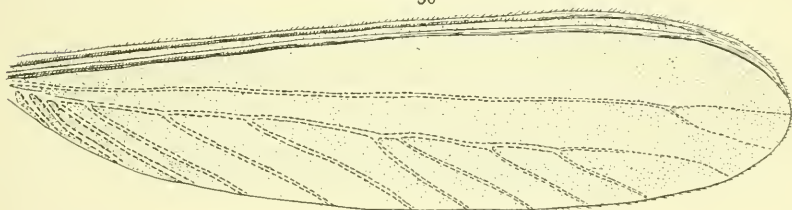
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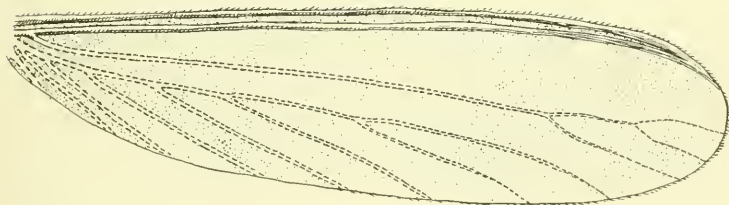
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32

WINGS OF A NEW HONDURAN ANOPLOTERMES AND *A. FUMOSUS*.

FOR EXPLANATION OF PLATE SEE PAGE 40.

STUDIES ON LARVAE OF CRABS OF THE FAMILY PINNOTHERIDAE.

By O. W. HYMAN,

Of the College of Medicine, University of Tennessee.

The material on which the original portion of this paper is based has been collected at Beaufort, North Carolina, during several summers.

All of the first zoeal stages originally described in this paper have been obtained by hatching them in the laboratory. Ovigerous females were collected and, if the form was abundant, those whose eggs were in an advanced stage of development selected. The stage of development may be determined readily by observing the depth of color of the yolk mass. In newly laid eggs the yolk is deeply colored and it becomes progressively lighter as the embryos develop. When the females have been selected they are placed in finger bowls filled with sea water. It is best to place not more than three females together and to have a bit of shell in each bowl. The crabs are less excited when they can hide. The eggs hatch at nightfall and the zoeas will live for about a week if the water is changed daily and the bowl kept in a cool place.

The second zoeal forms have been secured by collecting large numbers of the first zoeas from the tow and keeping them in finger bowls until a few have molted.

The writer wishes to express his appreciation of the courtesies extended to him by the Bureau of Fisheries and especially by Charles Hatsel, the acting director of the station. I also acknowledge with gratitude the assistance that has been given me unfailingly by Dr. Waldo L. Schmitt and Miss Mary J. Rathbun, of the United States National Museum.

THE PINNOTHERID ZOEAE.

The zoeas of the Pinnotheridae do not form a well-defined, homogeneous group as in some other families. The only feature that is common to them all and serves to distinguish them from the zoeas of other families, is the minute size of the antenna. This is so small in *Pinnotheres ostreum* that it hardly can be discovered and is only 0.2 mm. long and quite slender in *P. maculatus* in which it is largest.

In other families the arrangement and size of the spines of the carapace form distinguishing features of the zoeas. Among the Pinnotherids there is no uniformity in this respect. In *P. holothuriae* there is not a vestige of any of the carapace spines (fig. 48) while in *Disso-*

dactylus mellitae all the spines are present and prominent (fig. 30). The telson while characteristic in some families, is variable in the Pinnotherids. *Dissodactylus* and *Pinnotheres maculatus* have the bicornuate telson that is commonly found in the Brachyuran zoea (figs. 28 and 37). In *Pinnixa chaetoptera* also the cornua are elongated and cylindrical but the telson bears a median deltoid process on its posterior margin (fig. 47). In all the other known zoeas (except that of *Pinnixa sayana* (fig. 62) the median process is present and the cornua are likewise reduced to short, thick processes (figs. 17, 18, 50, and 51).

KEY TO KNOWN ZOEAS.

- a.¹ Telson bicornuate, without median process.
 - b.¹ Fifth abdominal segment expanded and produced posteriorly as lappets
Pinnixa sayana.
 - b.² Fifth abdominal segment not expanded.
 - c.¹ Prominent dorsal tubercle on first abdominal segment
Dissodactylus mellitae.
 - c.² No dorsal tubercle on first abdominal segment
Pinnotheres maculatus.
- a.² Telson bicornuate with median deltoid process.....*Pinnixa chaetoptera*.
- a.³ Telson not bicornuate, with three deltoid teeth posteriorly.
 - b.¹ No spines on carapace or vestiges only.
 - c.¹ Pigment spot on second maxilliped.....*Pinnotheres ostrum*.
 - c.² No pigment on second maxilliped.....*Pinnotheres holothuriae*.
 - b.² Dorsal spine only absent.....*Pinnotheres pisum*.
 - b.³ All spines present.....*Pinnotheres veterum*.

PIGMENTATION.

The pigmentation of the zoeas is constant for each species and is helpful in classification. In all the known species, the color of the pigment is light brown when fully expanded and black in contraction. The following table gives the pigmentation of the known forms. The notes on the pigmentation in the older descriptions probably are incomplete.

	<i>P. ostrum</i> .	<i>P. holothuriae</i> .	<i>P. pisum</i> .	<i>P. veterum</i> .	<i>P. maculatus</i> .	<i>P. chaetoptera</i> .	<i>P. sayana</i> .	<i>D. mellitae</i> .
Anterior rostral base.....	×	×			×	×		×
Posterior rostral base.....	×				×	×		×
Interorbital.....	×				×	×	×	×
Supracardiac.....	×	×	×			×	×	×
Subcardiac.....	×				×		×	×
Lateral to stomach.....	×				×			×
Lateral to first abdominal segment.....	×	×						×
Postero-ventral lobe.....	×	×			×	×	×	×
Labrum.....	×	×			×	×		×
Mandible.....	×	×			×	×		×
Basipodite first maxilliped.....	×	×			×	×		×
Basipodite second maxilliped.....	×				×	×		×
Dorso-lateral first abdominal segment.....					×	×		×
Ventral first abdominal segment.....	×							×
Ventro-lateral second abdominal segment.....	×	×			×	×		×
Ventro-lateral third abdominal segment.....	×	×			×	×		×
Ventro-lateral fourth abdominal segment.....	×	×			×	×	×	×
Ventro-lateral fifth abdominal segment.....	×	×			×	×	×	×
Telson.....	×	×	×				×	×

METAMORPHOSIS.

The complete history of metamorphosis has not been followed in any species. The present paper carries the description of the first two zoeal stages of *P. ostreum* while Smith describes the transformation of the last zoeal stage into a megalops in *P. chaetoptera* and Faxon the transformation of the last zoeal stage directly into the young crab in *P. sayana*. When these observations are considered together, it seems probable that the Pinnotherids have at least three—probably four—zoeal stages followed either by a megalops and then the young crab or else by the crab stages directly. This generalisation must be put forward with considerable reserve as it is known that, among the Crustacea, closely related species of the same genus may present developmental histories that are quite different.

PINNOTHERES OSTREUM Say.

The zoeas of this species are among the most abundant in tows taken at Beaufort. They are recognised at once by the absence of the spines of the carapace. They are comparatively small and are active and rapid swimmers. When they come into contact with other bodies, the abdomen is flexed under the cephalothorax and the larva forms an almost perfect sphere. All of the appendages are covered except the maxillipeds.

Cephalothorax.—The dorsal and lateral spines of the carapace are wanting and the rostral spine is reduced to an exceedingly minute tubercle (fig. 1). The eyes are large and well-developed.

Cephalic appendages.—The antennules are very minute and are carried folded under the anterior border of the carapace so that usually only the terminal hairs are seen (fig. 5). The antennae are still more minute. They may be discovered after careful dissection. The mandibles, maxillules, and maxillae are of the usual brachyuran type (figs. 7, 9, 11).

Thoracic appendages.—The endopodite of the first maxilliped is composed of five segments. The sensory hair on its terminal segment is very small and is not plumose. The endopodite of the second maxilliped has two segments (figs. 13 and 15).

Abdomen.—The segments of the abdomen are progressively flattened and broadened as they approach the broad, plate-like telson. The posterior border of the telson is produced into three deltoid teeth. The marginal spines lie between the median and lateral spines (fig. 17).

FIRST ZOEAL.

The first zoea has been described by Birge in a brief note. He gives accurate outline drawings of the zoea and its appendages. This stage is readily distinguished by the four swimming hairs at

the tips of the exopodites of the first and second maxillipeds. The larva is 1.3 mm. long and 0.5 mm. through the carapace (figs. 1 and 2).

SECOND ZOEÆ.

The second zoea is distinguished most readily from the first by the presence of six swimming hairs on the maxillipeds (figs. 4, 14, and 16). The length of the larva is now 1.6 mm. and its width 0.6 mm. The increase in size is largely in the cephalothorax (figs. 3 and 4). The maxillule (fig. 10) bears an epipodital hair. The epipodital process of the maxilla has begun its transformation and is now tripartite (fig. 12). On the abdomen the telson alone is slightly changed. Its median tooth is relatively larger (fig. 18).

PINNOTHERES HOLOTHURIAE Semper.

The description of this zoea here given is from Semper who gives a figure (fig. 48) and a very brief note in his book.

The first zoea resembles that of *P. ostreum* very closely indeed. There is not even a vestige of any of the spines of the carapace. The only other distinction between the two species is the absence of certain pigment spots in *P. holothuriae*. As Semper's figure was published in 1881 it is possible that he did not record all of the pigment spots.

PINNOTHERES PISUM Latreille.

This was the first of the Pinnotherid larvae to be described. Thompson has an interesting paper on the natural history of peacrabs and gives two figures and a few meagre notes on the larvae.

The dorsal spine of the carapace is wanting but the rostral and lateral spines are well developed (figs. 49 and 50). This peculiar condition is vouched for by Bell. As far as can be determined from Thompson's rude figures, the appendages offer no peculiarities. The abdomen expands into a flattened plate posteriorly as in *P. ostreum*. The telson resembles that of *P. ostreum* closely. Its distal border is produced into three deltoid teeth between which lie three spines on each side.

PINNOTHERES VETERUM Bosc.

The zoeas of this form as well as of a *Pinnotheres* taken from *Ascidia mentula* were hatched by Gourret. No description was given and only one figure, that of the telson (fig. 51). The abdomen is only slightly broadened as is the telson also. The three teeth are longer and narrower than in *P. ostreum* and are more like the cornua of other brachyuran telsons.

PINNOTHERES MACULATUS Say.

This form is common in the tow at Beaufort, occurring throughout the summer. It is strikingly different from the other known larvae of *Pinnotheres* and would hardly be referred to the genus unless

actually secured by hatching. The spines and telson both differ strikingly from those of the other known forms.

Cephalothorax.—All of the spines of the carapace are present and are well developed. The dorsal and rostral spines are very long, measuring 0.6 mm. (fig. 19). The lateral spines are smaller, 0.35 mm. (fig. 20). The relative lengths of the dorsal and lateral spines are helpful in distinguishing this zoea from that of *Dissodactylus mellitae*. In the latter the dorsal spine is smaller and the lateral spine larger than in *P. maculatus*.

Appendages.—These are typically brachyuran (figs. 21–27). The antennae are quite small and consist of a single ramus. They are larger, however, than those of any other known zoea of *Pinnotheres*.

Abdomen.—The abdomen is cylindrical and very different from those of other larvae of *Pinnotheres*. The telson is typically bicornuate and carries the usual six spines along its posterior border (fig. 28). This departure from the typical form of the *Pinnotheres* larva was mentioned by Faxon in a footnote. He secured his information from tracings sent to him by Smith. A telson corresponding exactly with this form is figured by Fritz Müller and assigned to a *Pinnotheres*.

DISSODACTYLUS MELLITAE Rathbun.

This zoea is common enough in the tow at Beaufort. It is large and robust, not suggesting the tiny adult crab. The zoea resembles that of *Pinnotheres maculatus* rather closely but may be distinguished by the dorsal protuberance on the first abdominal segment as well as by the shorter dorsal spine (figs. 29 and 30).

Cephalothorax.—All of the carapace spines are present and are well developed. The lateral spines especially are large and stout.

Appendages.—There is nothing peculiar about the appendages (figs. 31–36). The antennae are minute and uniramous. The sensory hair on the terminal segment of the endopodite of the first maxilliped is plumose.

Abdomen.—The abdomen resembles that of *P. maculatus* very closely. The horns of the telson are almost parallel with each other (fig. 37).

PINNIXA CHAETOPTERANA Stimpson.

The first zoea of this species has been described by Faxon and by Smith. The following description is based on material taken at Beaufort. The description corresponds with those formerly given. The pigmentation is given in the table on page 2.

The zoea is distinguished by its comparatively small spines and, especially, by the enlarged fifth abdominal segment and median process of the telson. The transformation of the last zoea into a megalops is given by Smith but he does not give description of either.

FIRST ZOEÆ.

The first zoea is distinguished from later stages by the four swimming hairs on the maxillipeds (figs. 39 and 45).

Cephalothorax.—All three carapace spines are present but they are small and slender, measuring only 0.3 mm. (figs. 38 and 39). The eyes are rather small.

Appendages.—All of the cephalic appendages except the mandibles are rather small. The antennules and antennae (figs. 40 and 41) are especially minute and slender.

Abdomen.—The first four segments are cylindrical but the fifth segment is expanded laterally into wings that extend backward, overlapping the telson. This feature is characteristic of the known zoeas of the *Pinnixas*. The telson has the bicornuate condition so often found in brachyuran larvae but is distinguished in this species by the presence of a large deltoid tooth projecting medially from its posterior border (fig. 47).

MEGALOPS.

This was reared from the last zoeal stage by Smith, but he gives neither description nor figure of either. Smith was unable to rear the megalops to the crab stage.

PINNIXA SAYANA Stimpson.

The early stages of this species have not been recorded, but the last zoeal stages of a *Pinnixa* commonly found off the New England coast have been referred to this species by Smith and Faxon. The last zoea passes directly into the crab stage. The descriptions given here are taken from Faxon, as are the figures.

The carapace is armed with long frontal, dorsal, and lateral spines. The natatory feet are very short in proportion to the size of the body, the inner branch of the second pair rudimentary, as usual with Brachyuran zoeae (fig. 53). The third pair of maxillipeds and the five following pairs of thoracic feet are folded under the carapace. On dissecting them out from the body, they are seen to be quite perfectly formed, as shown by Figure 57. The third maxillipeds (fig. 56) possess their three constituent parts and a gill at their base.

The abdomen (fig. 62) is short, its penultimate segment expanded into two lobes, which extend backward on each side of the terminal segment. The terminal segment is ovate, produced posteriorly into a long spine on either side. Between the lateral spines and a small median sinus are three short, finely feathered setae on each side.

There are four pairs of simple abdominal appendages.

There is a black pigment spot at the base of the dorsal spine, one near the base of each lateral spine, and several on the abdominal somites.

From tip of frontal spine to posterior border of carapace, 2.5 mm. From tip to tip of lateral spines, 2 mm. Length of frontal spine, 1 mm.

FIRST CRAB.

In the first crab stage (figs. 63 and 64), which immediately follows the last zoea stage just described, the carapace measures less than 1 mm. in length by 1.5 mm. in breadth. The front is nearly straight, the branchial regions expanded laterally so as to form a

prominent shoulder at the point where they meet the hepatic areas. A row of small irregularly disposed spines on the sides of the carapace. The second and third pairs of maxillipeds (figs. 70 and 71) have the same structure as in adult *Pinnixae*, the terminal segment of the inner limb being articulated with the penultimate segment near the proximal end of the latter, in such fashion as to form a sort of didactyle claw.

The chelae are didactyle, the dactylus closing against a long process of the antecedent segment. The following pairs of ambulatory appendages are extremely long, the last pair being much smaller than the rest, as in the adults of this genus.

The abdomen is small, closely folded against the sternum, and is not used as a swimming organ. It carries four pairs of appendages (fig. 65), which consist of a basal segment which supports two branches. The outer branch is much larger than the inner, and bears about nine setae on its border. The telson is broader than long, its posterior margin regularly convex and fringed with setae.

Blotches of dark pigment, of dendritic forms, occur on the carapace, sternum, and abdomen, arranged as represented in Figures 63 and 64.

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EXPLANATIONS OF PLATES.

PLATE 1.

FIGS. 1-10. Zoeas of *Pinnotheres ostreum*.

- FIG. 1. Lateral view of first zoea.
2. Frontal view of first zoea.
3. Frontal view of second zoea.
4. Lateral view of second zoea.
5. Antennule, first zoea.
6. Antennule, second zoea.
7. Mandible, first zoea.
8. Mandible, second zoea.
9. Maxillule, first zoea.
10. Maxillule, second zoea.

PLATE 2.

FIGS. 11-18. Zoeas of *Pinnotheres ostreum*.

- FIG. 11. Maxilla, first zoea.
12. Maxilla, second zoea.
13. First maxilliped, first zoea.
14. First maxilliped, second zoea.
15. Second maxilliped, first zoea.
16. Second maxilliped, second zoea.
17. Abdomen and telson, first zoea.
18. Abdomen and telson, second zoea.

FIGS. 19 and 20. Zoeas of *Pinnotheres maculatus*.

- FIG. 19. Lateral view of first zoea.
20. Frontal view of first zoea.

PLATE 3.

FIGS. 21-28. First zoea of *Pinnotheres maculatus*.

- FIG. 21. Antennule.
22. Antenna.
23. Mandible.
24. Maxillule.
25. Maxilla.
26. First maxilliped.
27. Second maxilliped.
28. Abdomen and telson.

FIGS. 29-37. First zoea of *Dissodactylus mellitae*.

- FIG. 29. Lateral view of zoea.
30. Frontal view of zoea.
31. Antennule.
32. Antenna.
33. Mandible.
34. Maxillule.
35. Maxilla.
36. First and second maxillipeds.
37. Abdomen and telson.

PLATE 4.

FIGS. 38-47. First zoea of *Pinnixa chaetoptera*.

- FIG. 38. Frontal view of zoea.
 39. Lateral view of zoea.
 40. Antennule.
 41. Antenna.
 42. Mandible.
 43. Maxillule.
 44. Maxilla
 45. First maxilliped.
 46. Second maxilliped.
 47. Abdomen and telson.

PLATE 5.

FIG. 48. Lateral view of first zoea of *Pinnotheres holothuriae* (from Semper).

FIGS. 49 and 50. First zoeas of *Pinnotheres pisum* (from Thompson).

- FIG. 49. Lateral view of zoea.
 50. Frontal view of zoea.

FIG. 51. Terminal segments of abdomen and telson of first zoea of *Pinnotheres veterum* (from Gourret).

FIGS. 52-58. Last zoeas of *Pinnixa sayana* (from Faxon).

- FIG. 52. First maxilliped.
 53. Second maxilliped.
 54. Frontal view of zoea.
 55. Posterior view of zoea.
 56. Third maxilliped.
 57. Third maxilliped, cheliped, and ambulatory appendages.
 58. Maxilla.

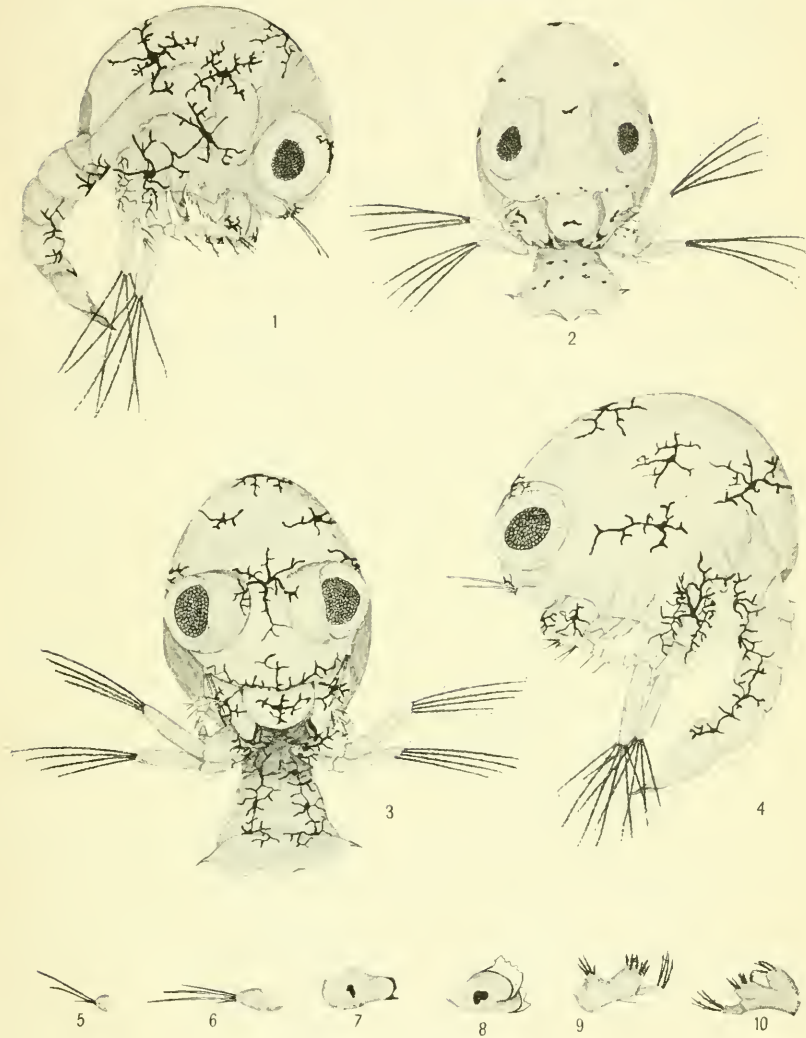
PLATE 6.

FIGS. 59-62. Last zoeas of *Pinnixa sayana* (from Faxon).

- FIG. 59. Maxillule.
 60. Antennule, *a*, and antenna, *b*.
 61. Labium.
 62. Terminal segments of abdomen and telson.

FIGS. 63-71. First crab stage of *Pinnixa sayana* (from Faxon)

- FIG. 63. Dorsal view of crab.
 64. Ventral view of crab.
 65. Ventral view of abdomen.
 66. Antennule.
 67. First maxilliped.
 68. Left chela of adult male of *P. chaetoptera*.
 69. Right chela of adult female of *P. chaetoptera*.
 70. Second maxilliped.
 71. Third maxilliped.



LARVAE OF CRABS.

FOR EXPLANATION OF PLATE SEE PAGE 8



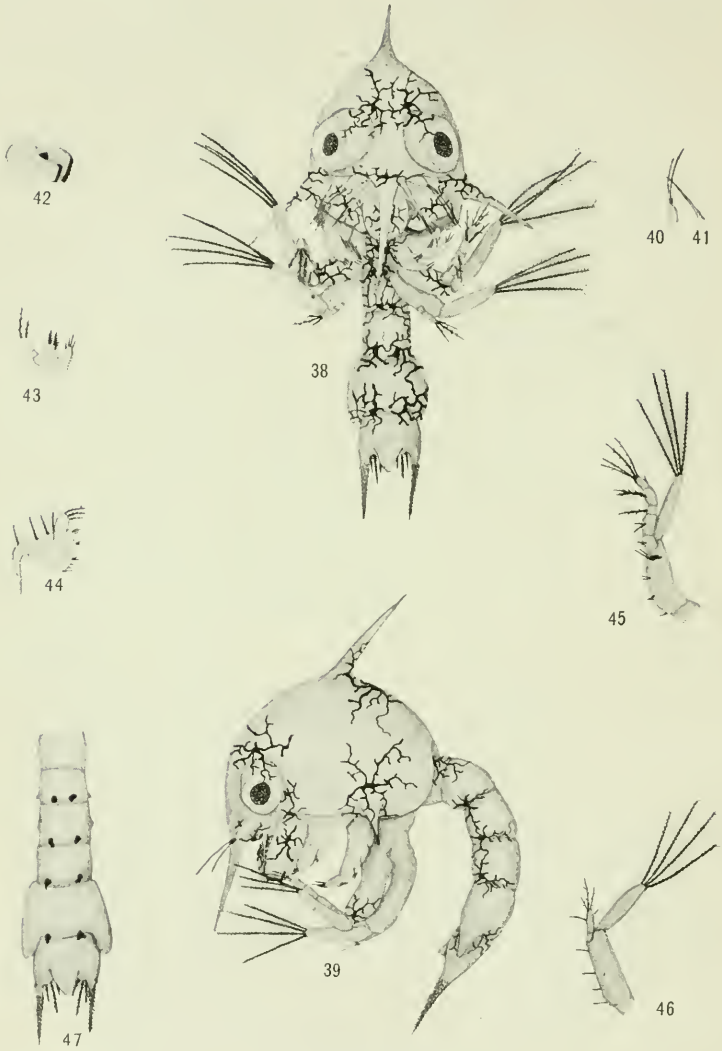
LARVAE OF CRABS.

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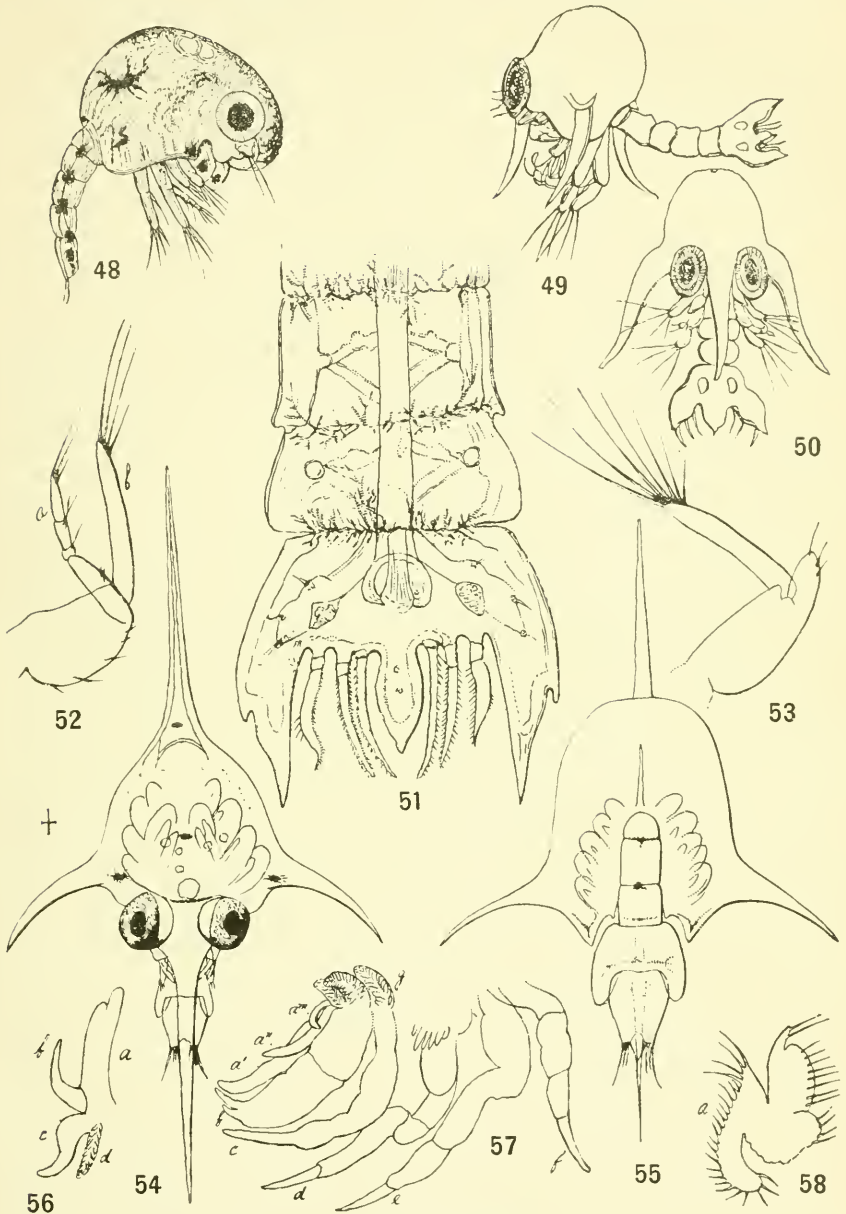
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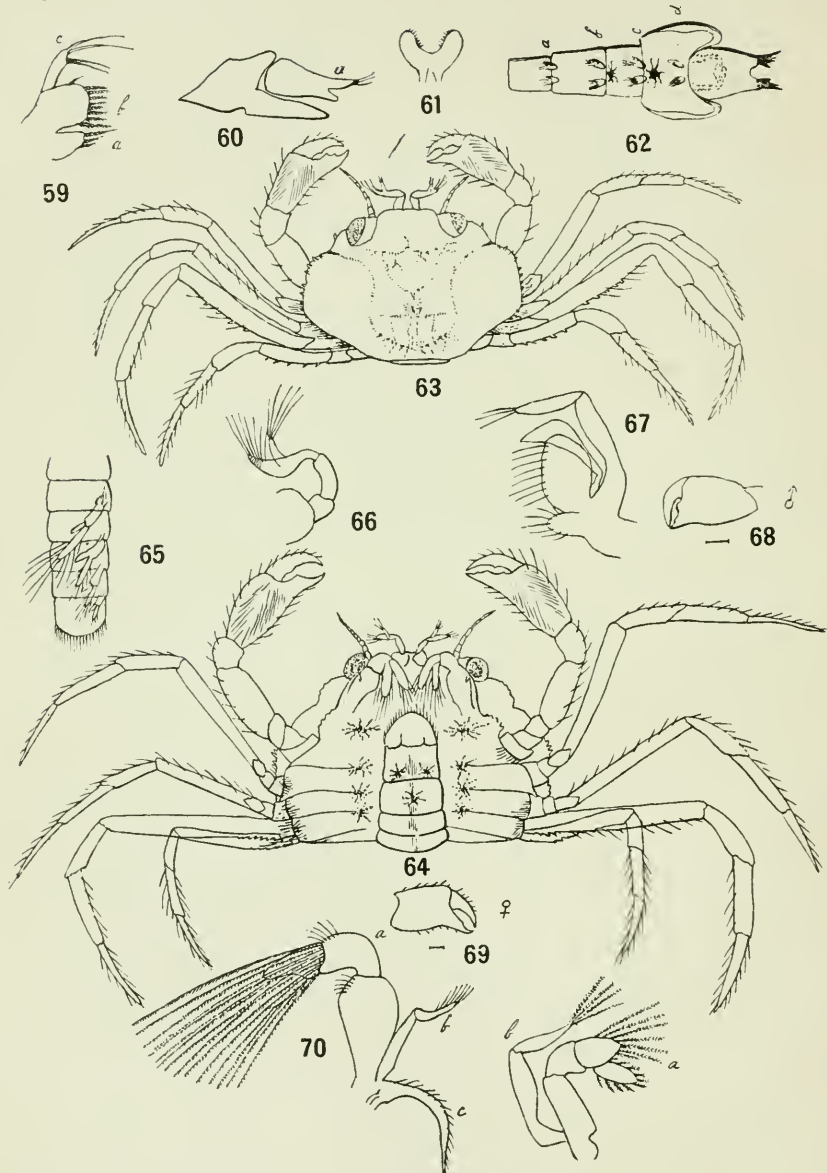
LARVAE OF CRABS.

FOR EXPLANATION OF PLATE SEE PAGE 9.



LARVAE OF CRABS.

FOR EXPLANATION OF PLATE SEE PAGE 9.



LARVAE OF CRABS.

FOR EXPLANATION OF PLATE SEE PAGE 9.

A SYNOPSIS OF THE SPECIES OF BOECKELLA AND PSEUDOBOECKELLA WITH A KEY TO THE GENERA OF THE FRESH-WATER CENTROPAGIDAE.

By C. DWIGHT MARSH,

Of the United States Department of Agriculture.

The fresh-water genera of Centropagidae are of a great deal of interest because of the rather restricted distribution of many of the species, and a thorough study of these animals from a morphological standpoint is likely to throw much light on their phylogeny and furnish valuable data for the theories of geographical distribution. For this study it is not only helpful but also necessary to have a synopsis giving the species characteristics in a fairly complete but brief form. Giesbrecht and Schmeil's Copepoda Gymnoplea, published in 1898, did this in an admirable manner; many publications have been issued since 1898, however, and new species and genera have been added. The author has had in mind the preparation of synopses of the fresh-water genera of copepods, and the present paper is a contribution to that end. This publication has resulted from a personal need of a synopsis of the genera *Boeckella* and *Pseudoboeckella*.

It is perhaps not necessary to go into a discussion of the morphological relations of *Boeckella* and *Pseudoboeckella*. This has been done at some length by Ekman, 1905, and the author accepts his conclusions. *Pseudoboeckella* Mrazek differs from *Boeckella* DeGuerne and Richard by the fact that the endopodite of the right fifth foot of the male is always 3 segmented with the distal segment armed with setae. It is possible that the differences between *Boeckella* and *Pseudoboeckella* should hardly be considered of generic value, but the distinction is a convenient one, and it seems wise to use the two generic names.

KEY TO THE GENERA OF THE CENTROPAGIDAE OF FRESH WATER.

	Endopodites of feet 1-5, 2 segmented.....	Calamoecia Brady.
	Endopodites of feet 1-4, 1 segmented.....	2
	Endopodites of feet 1, 1 segmented; 2-4, 2 segmented.....	3
1.	Endopodites of feet 1-4, 3 segmented.....	4
	Endopodites of feet 1-5, 3 segmented.....	6
	Endopodites of feet 1, 2 segmented; 2-4, 3 segmented, endopodites female fifth feet, 2 segmented.....	8

2. { Abdomen of male symmetrical, fifth feet of female without endopodites, exopodites of 3 segments, the distal terminating in a long spine **Heterocope** Sars.
 { Abdomen of male asymmetrical, fifth feet of female without endopodites, exopodites of 3 segments, the distal not terminating in a spine.... **Epischura** Forbes.
3. { Exopodites of feet 1-4, 3 segmented; in female fifth feet endopodites 2 segmented..... **Brunella** Smith.
 { Exopodites of feet 1, 1 segmented; 2-4, 2 segmented; female fifth feet without endopodites **Eurytemora** Giesbrecht.
4. { First antennae 20-22 segmented..... **Pseudodiaptomus** Herrick.
 { First antennae 25 segmented..... 5
 { Female fifth feet without endopodites, male fifth feet with terminal hook on right foot only and the hook is turned outward instead of inward. **Poppella** Richard.
5. { Female fifth feet with endopodites, male fifth feet with terminal hooks on both exopodites 9
 { Female fifth feet with endopodites, male fifth feet with terminal hook on right exopodite only, fourth feet with a long curved spine on inner distal angle on first basal segment **Gladiferens** Henry.
6. { Exopodites of second antennae, 5 segmented, 2, 3, and 4 being short. **Parabroteas** Mrazek.
 { **Limnocalanus** Daday, **Gigantella** Ekman, **Parabroteas** Ekman.
 { Exopodites of second antennae, 6 segmented, 2-5 being short. **Sinocalanus** Burckhardt.
7. { Exopodites of second antennae 7 segmented, 1, 3, 4, 5, and 6 being short..... 7
 { Furca short..... **Osphranticum** Forbes.
 { Furca long..... **Limnocalanus** Sars.
8. { In the male fifth feet both exopodites terminate in an elongated hook; in the female fifth feet the exopodites are distinctly 3 segmented. **Metaboeckella** Ekman.
 { **Boeckella** (dilatata) Sars.
 { In the male fifth feet only the right exopodite terminates in an elongated hook, in the female fifth feet the third segments of the exopodites are either rudimentary or wanting..... **Diaptomus** Westwood.
 { **Hemidiaptomus** Sars, **Paradiaptomus** Sars.
9. { Endopodites of right fifth foot of male rudimentary, 1-3 segmented, without setae..... **Boeckella** DeGuerne and Richard.
 { Endopodite of right fifth foot of male, 3 segmented, with setae. **Pseudoboeckella** Mrazek.

Genus BOECKELLA DeGuerne and Richard.

- Syn. { *Boeckia* THOMPSON, 1883.
 { *Boeckella* (part) DEGUERNE and RICHARD, 1889.—SARS, 1894, 1896, 1901, 1903, 1904 (part).—(part) GIESBRECHT and SCHMEIL, 1898.—MRAZEK, 1901.—(part) DADAY, 1901.
 { *Boeckellopsis* MRAZEK, 1901.
 { *Pseudoboeckella* DADAY, 1902, 1905.—EKMAN, 1905.
 { *Hemiboeckella*, SARS, 1911.

KEY TO SPECIES OF BOECKELLA.

1. { Terminal segments of exopodites of fifth feet of female armed with 2 spines. **minuta** Sars.
 { Terminal segments of fifth feet of female armed with 3 spines..... 2
 { Terminal segments of fifth feet of female armed with 6 spines..... 6
 { Terminal segments of exopodites of fifth feet of female armed with 7 spines or setae..... 7

- { Right endopodite of male fifth feet of 1 segment..... 3
 2. { Right endopodite of male fifth feet of 2 segments..... 4
 { Right endopodite of male fifth feet of 3 segments..... 5
 { First antennae reach to second abdominal segment, right endopodite of male fifth feet very short, digitate..... *gracilis* Daday.
 3. { First antennae extend to end of furca, right endopodite of male fifth feet equals the first two segments of the exopodite, is pointed and curved inward.
 occidentalis Marsh.
 { The first antennae extend to end of furca, the last thoracic segment of the female is only slightly produced, the left endopodite of the male fifth feet is of one segment..... *gracilipes* Daday.
 4. { The first antennae reach the end of the furcal setae, the last thoracic segment of the female reaches the end of the first abdominal segment, the left endopodite of the male fifth feet is of 2 segments..... *poopoensis* Marsh.
 { Lobes of last thoracic segment in female reach to third abdominal segment.
 bergi Richard.
 5. { Lobes of last thoracic segment of female do not exceed one-half of first abdominal segment..... *michaelseni* Mrazek.
 { The first antennae reach one-half the length of the furcal setae, the endopodite of the right male fifth foot is 1 segmented..... *insignis* Smith.
 6. { The first antennae reach to the furca, the endopodite of the right male fifth foot is 3 segmented..... *Hemiboeckella searli* Sars.
 { Right endopodite of male fifth feet of 1 segment..... 8
 7. { Right endopodite of male fifth feet of 2 segments..... 13
 { Right endopodite of male fifth feet of 3 segments..... 14
 { In male fifth feet the inner margin of the second basal segment of the left foot is serrate, the left endopodite is irregularly curved..... *coronaria* Henry.
 8. { In male fifth feet there is a rather prominent serrate lamella on the inner surface of the second basal segment of the left foot..... 9
 { In male fifth feet, the second basal segment of the left foot has no serrate margin and bears no serrate lamella..... 11
 { First antennae of female extend to or beyond the furca, the right endopodite of the male fifth feet has a process or tubercle on the inner surface near the base..... 10
 9. { First antennae of female extend to third abdominal segment, the right endopodite of the male fifth feet does not have an inner process or tubercle..... *triarticulata* Thompson.
 { The lobes of the last thoracic segment in the female extend one half the length of the first abdominal segment..... *oblonga* Sars.
 10. { The lobes of the last thoracic segment in the female exceed the first abdominal segment, the left endopodite of the male fifth feet is 1 segmented. *orientalis* Sars.
 { The lobes of the last thoracic segment in the female exceed the first abdominal segment, the left endopodite of the male fifth feet is 2 segmented.
 fluvialis Henry.
 { The left endopodite of the male fifth feet is short..... 16
 11. { The left endopodite of the male fifth feet equals in length the first segment of the exopodite..... 12
 { The left endopodite of the male fifth feet is wanting..... *asymmetrica* Searle.

- In the female the antennae reach the furca, the lobes of the last thoracic segment are short and turned out.....*symmetrica* Sars.
12. In the female the antennae extend to end of furca, the lobes of the last thoracic segment turn back and reach one half the length of the first abdominal segment.....*tenera*¹ Sars.
- In the female the antennae extend to the furca, the lobes of the last thoracic segment extend one-half the length of the first abdominal segment. .*longiseta* Smith.
13. In the female the antennae extend to the abdomen, or to the second abdominal segment, the lobes of the last thoracic segment extend to the second abdominal segment; in the male the hook of the exopodite of the right fifth feet is cleft at tip.....*pseudocheles* Searle.
- Lobes of last thoracic segment of female extend nearly to end of furca. *nyoraensis* Searle.
14. Lobes of last thoracic segment of female do not exceed second abdominal segment..... 15
- In the male there is a spine on the inner surface of the first basal segment of the right fifth foot, the endopodite of the left fifth foot is small and broad, its breadth being to its length as 5 to 6.....*saycei* Sars.
15. There is no spine on the first basal segment of the male right fifth foot, the endopodite of the left foot is small and narrow, its breadth being to its length as 3 to 5.....*propinqua* Sars.
- The right endopodite of the male fifth feet is short and rounded at tip.*rubra* Smith.
16. The right endopodite of the male fifth feet is elongated, pointed, and bears near base a short curved spine.....*robusta* Sars.

BOECKELLA ASYMMETRICA Searle.

1914. *Boeckella asymmetrica* SEARLE, p. 192, pl. 10, figs. 1-4.

Female.—The first antennae extend beyond the furcae. The sides of the last thoracic segment consist of two lobes each, which extend back to the second abdominal segment. The two sides are asymmetrical. The abdomen is asymmetrical, projecting to the right.

Male.—In the fifth feet the right endopodite is 1 segmented and extends one-third the length of the second segment of the exopodite; the left endopodite is lacking. Figure 1 shows the fifth feet of the male.

Length.—Male, 0.75 mm.; female, 1.45 mm.

Melbourne, Australia.

BOECKELLA BERGI Richard.

1897. *Boeckella bergi* RICHARD, pp. 322-325, fig. 2.

1898. *Boeckella bergi* GIESBRECHT and SCHMEIL, p. 61.

1901. *Boeckella bergi* SARS, pp. 6-10, pl. 1, figs. 1-15.

1901. *Boeckellopsis bergi* MRAZEK.

1902. *Pseudoboeckella bergi* DADAY, pp. 220-224, pl. 4, figs. 6-19.

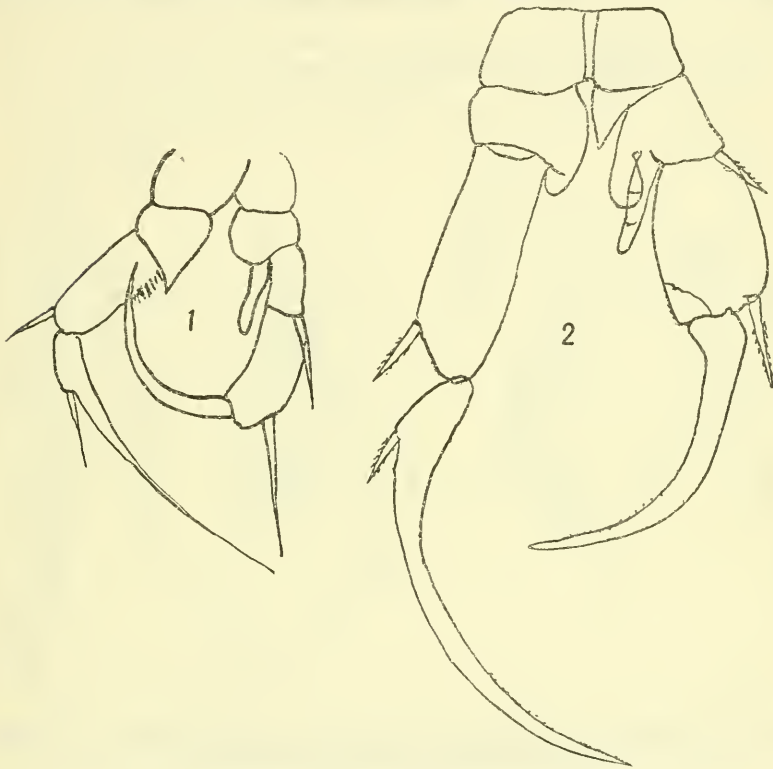
1905b. *Boeckella bergi* EKMAN, p. 602.

Female.—The first antennae extend to the furcae, or to their ends. The sides of the last thoracic segment, consisting of 2 lobes each, extend back to second or third abdominal segment. The first

¹ In the opinion of the author, there is no sufficient reason for separating *symmetrica* and *tenera*. The male fifth feet are about as near identical as two individuals can be.

abdominal segment is asymmetrical, projecting to the left. The exopodite of the second antenna consists of 7 segments, 1, 3, 4, and 5 being short. The terminal segments of the exopodites of the fifth feet are armed with 3 spines.

Male.—The sides of the last thoracic segment are not lobed and are asymmetrical. In the fifth feet the second basal segments have lamellae on the inner side; the right endopodite is 3 segmented and extends one-half the length of the second segment of the exopodite;



FIGS. 1-2.—1, *BOECKELLA ASYMMETRICA* SEARLE, FIFTH FEET OF MALE, AFTER SEARLE. 2, *B. BERG RICHARD*, FIFTH FEET OF MALE, AFTER SARS.

the left endopodite is of 1 segment and is minute. Figure 2 shows the fifth feet of the male.

Length.—Male, 1.45-1.8 mm.; female, 1.8-2 mm.

Argentina; Patagonia.

BOECKELLA CORONARIA Henry.

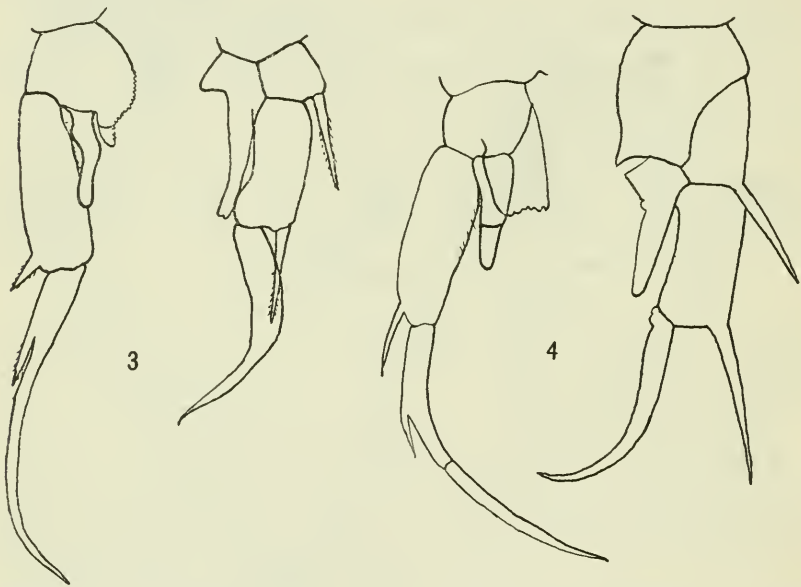
1922. *Boeckella coronaria* HENRY, pp. 557-558, pl. 55, figs. 1-7.

Female.—The first antennae extend to the middle of the furca. The sides of the last cephalothoracic segment flare out somewhat and project back beyond the middle of the first abdominal segment;

the inner lobes are acute. The terminal segments of the exopodites of the fifth feet bear 7 spines.

Male.—The right endopodite of the fifth feet is 1 segmented and extends to the end of the second segment of the exopodite; it has a blunt-pointed projection on its inner surface near the base; the distal end is blunt, with a slight indentation. The inner margin of the second basal segment of the left foot is denticulate; the left endopodite is 1 segmented, is of an irregular curved form, and extends two-thirds the length of the first segment of the exopodite. Figure 3 shows the fifth feet of the male.

Length.—Female, 1.5 mm.; male, 1.3 mm.
New South Wales.



FIGS. 3-4.—3, *BOECKELLA CORONARIA* HENRY, FIFTH FEET OF MALE, $\times 212$, AFTER HENRY. 4, *B. FLUVIALIS* HENRY, FIFTH FEET OF MALE, $\times 153$, AFTER HENRY.

BOECKELLA FLUVIALIS Henry.

1922. *Boeckella fluvialis* HENRY, p. 557, pl. 56, figs. 1, 2, and 4-6.

Female.—The first antennae extend nearly to the end of the furcal setae. The sides of the last cephalothoracic segment extend backward, the projections being slender and acute, and reach the end of the first abdominal segment; the inner lobes are short and rounded with a short pointed projection in the middle. The terminal segments of the exopodites of the fifth feet bear 7 spines.

Male.—In the male fifth feet the right endopodite is 1 segmented and reaches the end of the second segment of the exopodite; it has a blunt-pointed projection on its inner surface near the base; the distal

end is round and tapering. On the second basal segment of the left foot is a rectangular lamella which is serrate on its distal margin. The left endopodite is 2 segmented and about two-thirds the length of the first segment of the exopodite; the inner margin of the first segment of the exopodite is sparsely ciliate. Figure 4 shows the fifth foot of the male.

Length.—Female, 1.8 mm.; male, 1.7 mm.

New South Wales.

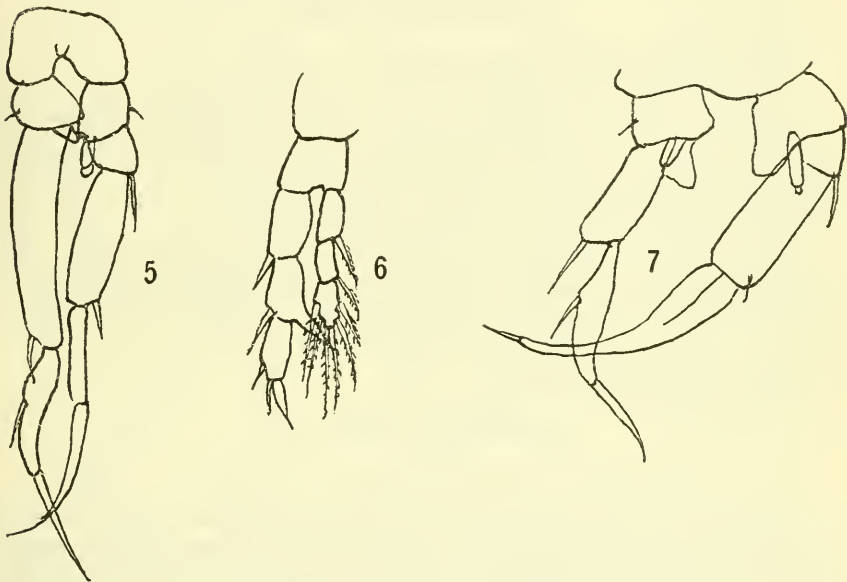
BOECKELLA GRACILIPES Daday.

1901. *Boeckella gracilipes* DADAY, pp. 348, 349.

1902. *Pseudoboeckella gracilipes* DADAY, pp. 224–227, pl. 5, figs. 1–7.

1905. *Boeckella gracilipes* EKMAN, p. 603.

1906. *Boeckella gracilipes* MARSH, p. 183, pl. 17, figs. 6 and 7.



FIGS. 5-7.—5, *BOECKELLA GRACILIPES* DADAY, FIFTH FEET OF MALE, $\times 165$. 6, *B. GRACILIPES* DADAY FIFTH FOOT OF FEMALE, $\times 165$. 7, *B. GRACILIS* DADAY, FIFTH FEET OF MALE, AFTER DADAY.

Female.—The first antennae extend to the end of the furca. The last thoracic segment projects only slightly, the sides not distinctly divided. The terminal segments of the exopodites of the fifth feet are armed with 3 spines.

Male.—In the fifth feet the right endopodite consists of 2 segments and equals in length the first segment of the exopodite. The left endopodite is of one segment and is minute. Figure 5 shows the fifth feet of the male, and Figure 6 the fifth feet of the female.

Length according to Daday.—Male, 0.8 mm.; female, 0.8 to 1.1 mm.

Length according to Marsh.—Male, 1.28 mm.; female, 1.485 mm.

Argentina; Lake Titicaca.

BOECKELLA GRACILIS Daday.

1902. *Pseudoboeckella gracilis* DADAY, pp. 227-231, pl. 9, figs. 1 and 9-17.

1905b. *Boeckella gracilis* EKMAN, p. 602.

Female.—The first antennae extend to the second abdominal segment. The sides of the last thoracic segment are not lobed and project somewhat. The terminal segments of the exopodites of the fifth feet are armed with 3 spines.

Male.—Both endopodites of the fifth feet are 1 segmented and small; the second basal segments of both feet bear a cuticular projection on the inner distal angle. Figure 7 shows the fifth feet of the male.

Length.—Male, 1.4 to 1.6 mm.; female, 1.7 to 2.2 mm.

Argentina.

BOECKELLA INSIGNIS Smith.

1909. *Boeckella insignis* SMITH, p. 85, pl. 17, figs. 4-12.

Female.—The first antennae extend to one-half the length of the furcal setae. The exopodites of the second antennae consist of 6 segments, 1, 3, 4, and 5 being short. The projections of the last thoracic segment are short. The terminal segments of the exopodites of the fifth feet are armed with 6 spines or setae.

Male.—In the fifth feet the right endopodite consists of one segment and equals in length one-half the second segment of the exopodite; the left endopodite is very short, 1 segmented, and ciliated. Figure 8 shows the fifth feet of the male.

Length.—Female, 2 mm.

Tasmania.

BOECKELLA LONGISETA Smith.

1909. *Boeckella longiseta* SMITH, pp. 85-86, pl. 17, figs. 13-17.

Female.—The first antennae extend to the furcae. The sides of the last thoracic segment are lobed and extend to one-half the length of the first abdominal segment. The terminal segments of the exopodites of the fifth feet are armed with 7 spines or setae.

Male.—In the fifth feet the right endopodite is 2 segmented and extends to one-half the length of the second segment of the exopodite. The left endopodite is rudimentary or wanting; in figure not separated. Figure 9 shows the fifth feet of the male.

Length.—Female, 1.5 mm.

Tasmania.

BOECKELLA MICHAELSENI Mrazek.

1901. *Boeckellina michaelсени* MRAZEK, pp. 11-12, figs. 10, 33, 36, 47, 48.

1901. *Boeckella pygmaca* DADAY, pp. 349-350.

1902. *Pseudoboeckella pygmaca* DADAY, pp. 231-233, pl. 5, figs. 8-12.

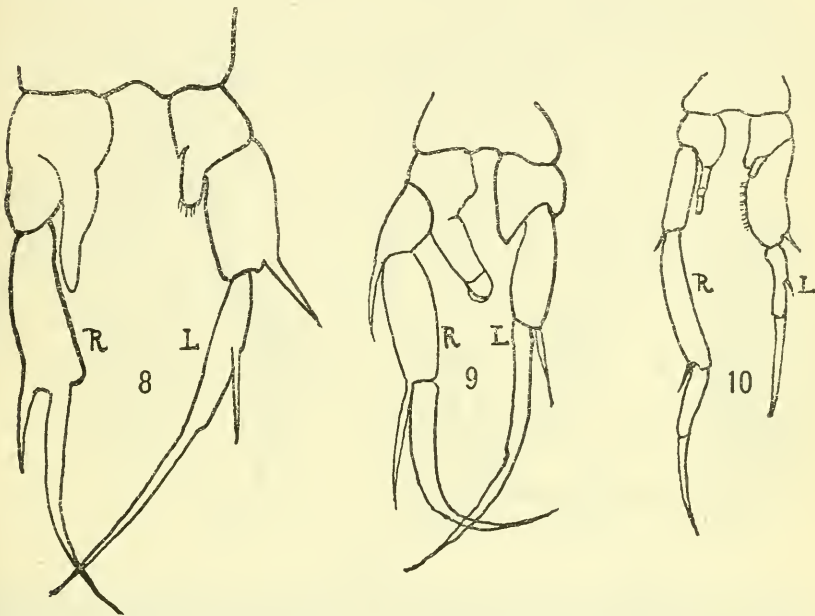
1905. *Pseudoboeckella anderssonorum* EKMAN, pp. 10-14, figs. 3-5.

1905b. *Boeckella michaelсени* EKMAN, p. 603.

1914. *Boeckella michaelсени* SCOTT, pp. 1 and 2, pl. 1, figs. 4-6.

Female.—The first antennae extend to or beyond the furca. The sides of the last thoracic segment are not lobed and do not reach beyond one-half first abdominal segment. The terminal segments of the exopodites of the fifth feet are armed with 3 spines.

Male.—In the fifth feet the right endopodite is 3 segmented (2 segmented in *pygmaea* Daday and *michaelseni* Scott) and nearly or quite equals the first segment of the exopodite; the left endopodite is 1 segmented and rudimentary; the first segment of the left exopodite is convex and spinose on the inner side. Figure 10 shows the fifth feet of the male.



FIGS. 8-10.—8, *BOECKELLA INSIGNIS* SMITH, FIFTH FEET OF MALE, AFTER SMITH. 9, *B. LONGISETA* SMITH, FIFTH FEET OF MALE, AFTER SMITH. 10, *B. MICHAELSENI* MRAZEK, FIFTH FEET OF MALE, $\times 120$, AFTER MRAZEK.

Length.—Male, 1 mm.; female, 1.15 mm.

Tierra del Fuego; Argentina; Falkland Islands.

BOECKELLA MINUTA Sars.

1896. *Boeckella minuta* Sars, pp. 71-74, pl. 8, figs. 5-7.

1898. *Boeckella minuta* GIESBRECHT and SCHMEIL, p. 62.

1908. *Boeckella minuta* Sars, pp. 10-11, pl. 2, figs. 1-4.

1919. *Boeckella minuta* HENRY, p. 31.

1922. *Boeckella minuta* HENRY, p. 558.

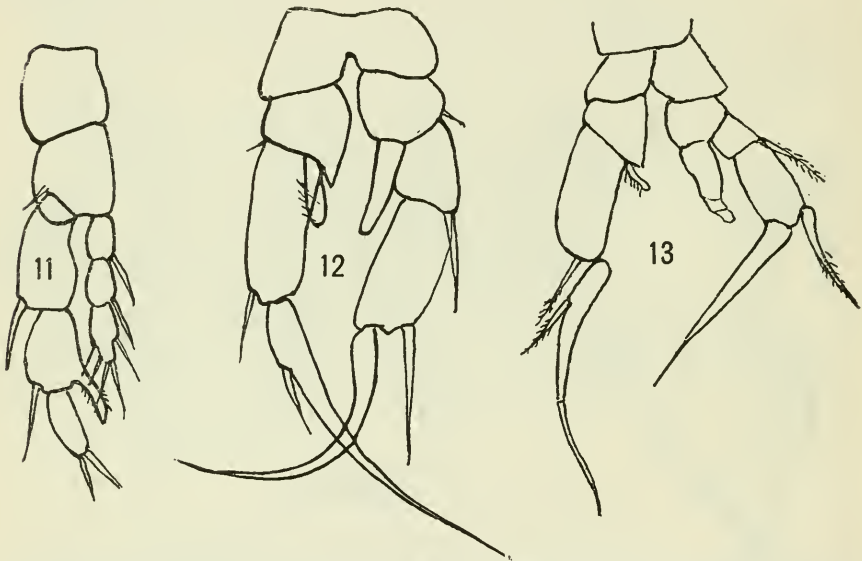
Female.—The first antennae extend to the furca. The sides of the last cephalothoracic segment are produced backward nearly the length of the first abdominal segment and have small inner lobes.

The abdomen is asymmetrical, the first segment projecting to the left. In the fifth feet the terminal segments of the exopodites are armed with 2 spines.

Male.—In the fifth feet the right endopodite is 1 segmented and does not reach the middle of the second segment of the exopodite; the second basal segment of the left foot is produced on the inner angle; the left endopodite is 1 segmented and less than one-half the length of the first segment of the exopodite. Figure 11 shows the fifth foot of the female, and Figure 12 the fifth feet of the male.

Length.—Male, 1.28 mm.; female, 1.3 mm.

Southern Australia.



FIGS. 11-13.—11, *BOECKELLA MINUTA* SARS, FIFTH FOOT OF FEMALE, $\times 150$, AFTER SARS. 12, *B. MINUTA* SARS, FIFTH FEET OF MALE, $\times 150$, AFTER SARS. 13, *B. NYORAENSIS* SEARLE, FIFTH FEET OF MALE, AFTER SEARLE

BOECKELLA NYORAENSIS Searle.

1912. *Boeckella nyoraensis* SEARLE, 197, pl. 4, figs. 1-4.

Female.—The first antennae extend beyond the furca. The sides of the last cephalothoracic segment project backward nearly to the end of the furca; the projections have inner lobes, the left triangular and acute, the right with parallel sides and rounded tip. The first abdominal segment is asymmetrical. In the fifth feet, the terminal segments of the exopodites bear 7 spines.

Male.—In the fifth feet the right endopodite is 3 segmented and nearly equals in length the first two segments of the exopodite. The left endopodite is minute, slender and 1 segmented. Figure 13 shows the fifth feet of the male.

Length.—2.6 mm.

Nyora, Victoria.

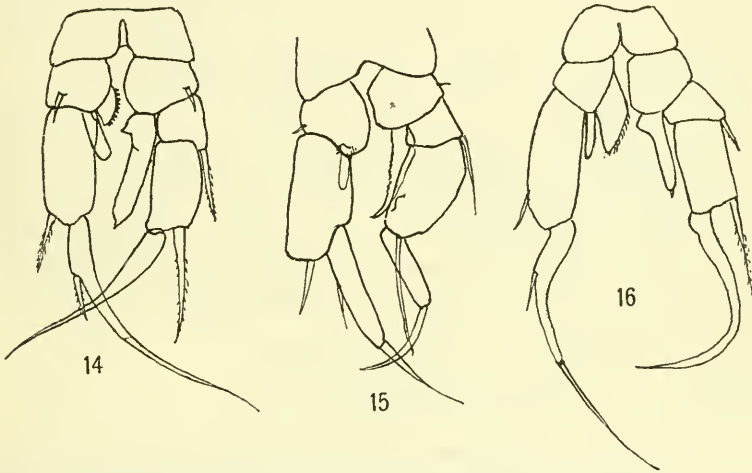
BOECKELLA OBLONGA Sars.

1908. *Boeckella oblonga* Sars, pp. 6 and 7, pl. 1, figs. 5-8.

1922. *Boeckella oblonga* HENRY, pp. 556-557.

Female.—The first antennae extend to the furca. The sides of the last cephalothoracic segment have prominent and acute inner lobes and project back about two-thirds the length of the first abdominal segment. The abdomen is asymmetrical, the right side being the more prominent. The terminal segments of the exopodites of the fifth feet are armed with 7 spines.

Male.—Both endopodites of the fifth feet are 1 segmented. The right endopodite extends to the end of the second segment of the exopodite and bears on the inner margin near the base a prominent tubercle. The second basal segment of the left foot has on the inner



FIGS. 14-16.—14, *BOECKELLA OBLONGA* Sars, FIFTH FEET OF MALE, $\times 114$, AFTER Sars. 15, *B. OCCIDENTALIS* Marsh, FIFTH FEET OF MALE, $\times 110$. 16, *B. ORIENTALIS* Sars, FIFTH FEET OF MALE, AFTER Sars.

surface a serrate lamella. The left endopodite is one-half the length of the first segment of the exopodite. Figure 14 shows the fifth feet of the male.

Length.—Female, 2 mm.

Southern Australia.

BOECKELLA OCCIDENTALIS Marsh.

1906. *Boeckella occidentalis* Marsh, pp. 179-183, pl. 18, figs. 1, 3-6.

Female.—The first antennae extend to the end of the furca. The last segment of the cephalothorax projects backward and has inner lobes. The abdomen is symmetrical. The terminal segments of the exopodites of the fifth feet bear 3 spines. The exopodites of the second antennae consist of 7 segments, 1, 3, 4, 5, and 6 being short.

Male.—In the fifth feet the right endopodite is 1 segmented, pointed, and curved inward, and reaches the end of the second seg-

ment of the exopodite. The left endopodite is 1 segmented and less than one-half the first segment of the exopodite. The second segment of the right exopodite bears on the inner surface near the distal end a rather prominent tubercle. Figure 15 shows the fifth feet of the male.

Length.—Female, 1.505 mm.; male, 1.43 mm.

Lake Titicaca and Lake Poopo.

BOECKELLA ORIENTALIS Sars.

1903. *Boeckella orientalis* Sars, pp. 196–197, pl. 9, figs. 1–15.

1905b. *Boeckella orientalis* EKMAN, p. 602.

Female.—The first antennae reach the furca. The last cephalothoracic segment is produced backward on the sides beyond the first abdominal segment; it has inner lobes, the left one being acute and the right one rounded. The exopodites of the second antennae are 7 segmented, the second and seventh segments being long. The terminal segments of the exopodites of the fifth feet bear 7 spines.

Male.—In the fifth feet the right endopodite is 1 segmented, pointed, has a blunt-pointed projection on the inner side near the base, and nearly equals in length the first two segments of the exopodite. The left endopodite is 1 segmented, nearly equaling in length one-half the first segment of the exopodite. The second basal segment of the left foot bears on its inner side a serrate lamella which extends distad to the end of the endopodite. Figure 16 shows the fifth feet of the male.

Length.—Female, 1.7 mm.; male, 1.4 mm.

Mongolia.

BOECKELLA POOPOENSIS Marsh.

1906. *Boeckella poopoensis* MARSH, pp. 183–187, pl. 17, fig. 5; pl. 18, fig. 2.

Female.—The first antennae extend to the end of the furcal setae. The sides of the last cephalothoracic segment have inner lobes and project backward the length of the first abdominal segment. The exopodites of the second antennae consist of 5 segments. The terminal segments of the exopodites of the fifth feet are armed with 3 spines. The third segment of the endopodites of the fifth feet bear 5 setae.

Male.—In the fifth feet each of the second basal segments bears a blunt spine near the inner distal angle. The endopodites are 2 segmented; the right reaches one-half the length of the second segment of the exopodite and the left one-half the length of the first segment of the exopodite. Figure 17 shows the fifth feet of the male.

Length.—Male, 1.4 mm.; female, 1.53 mm.

Lake Poopo.

BOECKELLA PROPINQUA Sars.

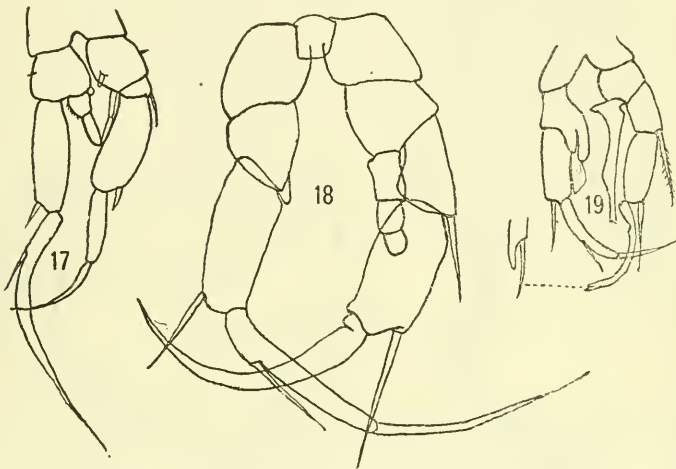
1904. *Boeckella propinqua* Sars, pp. 636-638, pl. 35, figs. 10a-h.

1905b. *Boeckella propinqua* EKMAN, p. 602.

1906. *Boeckella propinqua* BRADY, p. 696.

Female.—The first antennae extend beyond the furca. The exopodites of the second antennae are composed of 7 segments. The last cephalothoracic segment projects backward on the sides the length of the first abdominal segment; the projections have inner lobes which are rounded. The first abdominal segment is asymmetrical. In the fifth feet the terminal segments of the exopodites are armed with 7 spines.

Male.—In the fifth feet the right endopodite consists of 3 segments and extends to about one-third the length of the second



FIGS. 17-19.—17, *BOECKELLA POOSENSIS* MARSH, FIFTH FEET OF MALE, $\times 44$. 18, *B. PROPINQUA* Sars, FIFTH FEET OF MALE, $\times 56$, AFTER Sars. 19, *B. PSEUDOCHÉLES* SEARLE, FIFTH FEET OF MALE, AFTER SEARLE.

segment of the exopodite. The left endopodite is 1 segmented and very short. Figure 18 shows the fifth feet of the male

Length.—Female, 1.4 mm.

New Zealand.

BOECKELLA PSEUDOCHÉLES Searle.

1912. *Boeckella pseudocheles* SEARLE, p. 198, pl. 5, figs. 1-9.

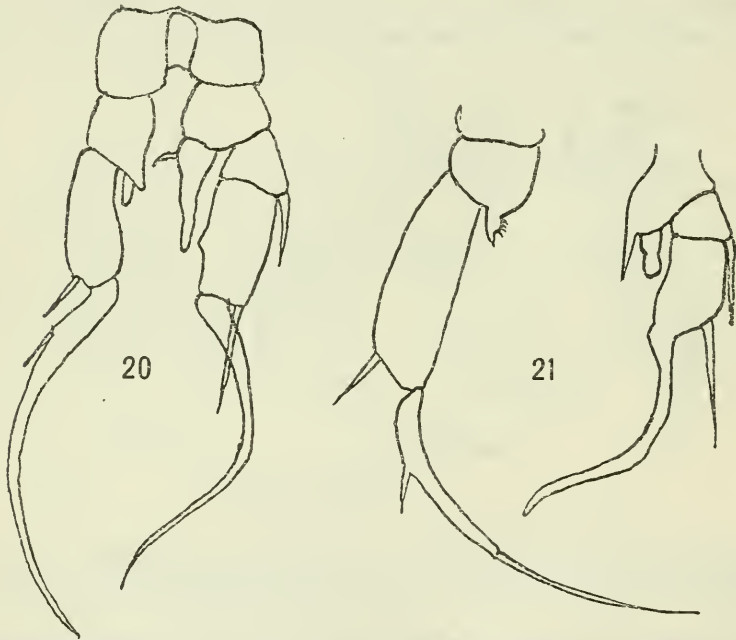
1912. *Boeckella pseudocheles* Sars, pp. 12-13, pl. 8, figs. 10-15.

1922. *Boeckella pseudocheles* HENRY, p. 559.

Female.—The first antennae are slightly longer than the cephalothorax. The sides of the last cephalothoracic segment flare outward and project backward to the second abdominal segment: they have inner lobes which are acute. The terminal segments of the exopodites of the fifth feet have 7 spines.

Male.—In the right fifth foot the terminal hook of the exopodite is divided at the tip, making an imperfect chela. The endopodite is 2 segmented, angular; the proximal segment has a blunt internal projection near the base and the distal segment is notched at the end; the endopodite exceeds in length the first two segments of the exopodite.

The second segment of the left exopodite, as shown by Sars, has 2 spines instead of 1 as is customary in this genus. The second basal segment of the left fifth foot has a smooth lamella projecting from its inner surface. The endopodite is 1 segmented, short, and lamelli-form. Figure 19 shows the fifth feet according to Searle.



FIGS. 20-21.—20, *BOECKELLA ROBUSTA* SARS, FIFTH FEET OF MALE, AFTER SARS. 21, *B. RUBRA* SMITH FIFTH FEET OF MALE, AFTER SMITH.

Length.—Male, according to Searle, 2.5 mm.; female, according to Sars, 2.35 mm.

Southern Australia.

BOECKELLA ROBUSTA Sars.

- 1896. *Boeckella robusta* SARS, pp. 66-71, pl. 8, figs. 1-4.
- 1898. *Boeckella robusta* GIESBRECHT and SCHMEIL, p. 61.
- 1905b. *Boeckella robusta* EKMAN, p. 602.
- 1909. *Boeckella robusta* SMITH, p. 87.
- 1922. *Boeckella robusta* HENRY, p. 558.

Female.—The first antennae extend to the abdomen. The last cephalothoracic segment is produced backward somewhat beyond the first abdominal segment; the projections have small inner lobes

which are pointed. The first abdominal segment is slightly asymmetrical. In the fifth feet the terminal segments of the exopodites are armed with 7 spines.

Male.—In the fifth feet the right endopodite is 1 segmented, pointed, and extends nearly to the end of the second segment of the exopodite; it bears on the inner margin near the base a short curved spine. The left endopodite is 1 segmented and very short. Figure 20 shows the fifth feet of the male.

Length.—Female, 3.2 mm.

Southern Australia.

BOECKELLA RUBRA Smith.

1909. *Boeckella rubra* SMITH, p. 86, pl. 18, figs. 1-5.

Female.—The first antennae extend to the furca. The last cephalothoracic segment extends back three-fourths the length of the first abdominal segment; it has inner lobes which are rounded at the tip. The terminal segments of the exopodites of the fifth feet have 7 spines.

Male.—In the fifth feet the right endopodite is 1 segmented and extends about one-half the length of the second segment of the exopodite. The left endopodite is very short, 1 segmented, and pointed. Figure 21 shows the fifth feet of the male.

Length.—Female, 0.7 mm.

Tasmania.

BOECKELLA SAYCEI Sars.

1908. *Boeckella saycei* SARS, pp. 8-9, pl. 1, figs. 9-13.

Female.—The first antennae reach nearly the end of the furca. The sides of the last cephalothoracic segment are divergent and produced backward to the third abdominal segment; they have inner lobes which are small with rounded tips. In the fifth feet the terminal segments of the exopodites are armed with 7 spines.

Male.—In the right fifth foot the second basal segment has a short broad spine on its inner margin; the endopodite is 3 segmented, exceeding in length the first segment of the exopodite. The left endopodite is short and lamelliform. Figure 22 shows the fifth feet of the male.

Length.—Female, 1.5 mm.

Southern Australia.

BOECKELLA SEARLI Sars.

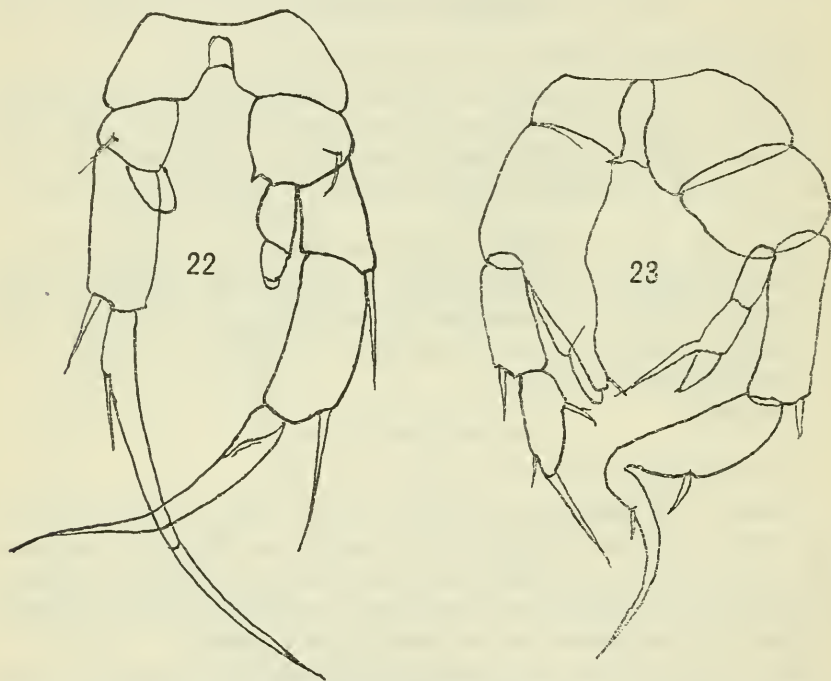
1912. *Hemiboeckella searli* SARS, pp. 13-18, pl. 9, figs. 1-14

1922. *Hemiboeckella searli* HENRY, pp. 560-561.

Female.—The first antennae extend to the abdomen. The sides of the last cephalothoracic segment have no inner lobes and project back very slightly. The first abdominal segment is slightly asymmetrical. The exopodites of the second antennae consist of 7 seg-

ments, 1, 2, 4, 5, and 6 being short. The terminal segments of the exopodites of the fifth feet are armed with 6 spines.

Male.—In the fifth feet the right endopodite is 3 segmented, the second segment having on its inner distal angle an acute cuticular projection extending twice the length of the third segment. The left endopodite is 2 segmented, the second segment bearing on its inner side a seta-like projection. The second basal segment of the left foot has on its inner distal angle a broad cuticular process reaching to the middle of the second segment of the exopodite; the second segment of the exopodite has a small external spine and a rather



FIGS. 22-23.—22, *BOECKELLA SAYCEI* SARS, FIFTH FEET OF MALE $\times 170$, AFTER SARS. 23, *B. SEARLI* SARS, FIFTH FEET OF MALE, AFTER SARS.

strong curved spine about midway of its inner border. Figure 23 shows the fifth feet of the male.

Length.—Male, 1 mm.; female, 1.6 mm.

Southern Australia.

Sars makes the new genus *Hemiboeckella* for this species, but I see no good reason for separating it from *Boeckella*.

BOECKELLA SYMMETRICA Sars.

1908. *Boeckella symmetrica* Sars, pp. 9-10, pl. 1, figs. 14-17.

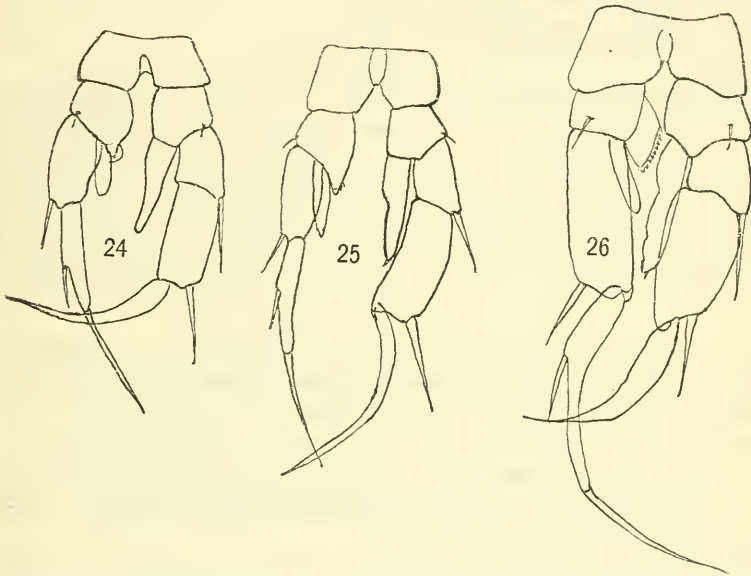
Female.—The first antennae extend to the furca. The lateral extensions of the last cephalothoracic segment are very short and pro-

ject from the body at very nearly right angles; they have inner lobes which are acute. The terminal segments of the exopodites of the fifth feet have 7 spines.

Male.—In the fifth feet the right endopodite is 1 segmented, conical in form, and extends three-fourths the length of the second segment of the exopodite. The second basal segment of the left foot has on the inner distal angle a small, smooth lamella. The left endopodite is 1 segmented, rounded at the end, and nearly equals in length the first segment of the exopodite. Figure 24 shows the fifth feet of the male.

Length.—Female, 1.6 mm.

Southern Australia.



FIGS. 24-26.—24, *BOECKELLA SYMMETRICA* SARS, FIFTH FEET OF MALE, $\times 114$, AFTER SARS. 25, *B. TENERA* SARS, FIFTH FEET OF MALE, AFTER SARS. 26, *B. TRIARTICULATA* THOMPSON, FIFTH FEET OF MALE, $\times 87$, AFTER SARS.

BOECKELLA TENERA Sars.

1912. *Boeckella tenera* Sars, pp. 10-12, pl. 8, figs. 6-9.

Female.—The first antennae extend to the end of the furca. The sides of the last cephalothoracic segment are produced backward nearly one-half the length of the first abdominal segment; the left side is much larger than the right; they have inner lobes which are small and spiniform. The terminal segments of the exopodites of the fifth feet have 7 spines.

Male.—In the fifth feet the right endopodite is 1 segmented, pointed, and extends about one-half the length of the second segment of the exopodite. The second basal segment of the left foot has on

its inner distal angle a denticulate lamellar projection. The left endopodite is 1 segmented and equal in length to the first segment of the exopodite. Figure 25 shows the fifth feet of the male.

Length.—Female, 1.8 mm.

Southern Australia.

BOECKELLA TRIARTICULATA Thompson.

1883. *Boeckia triarticulata* THOMPSON, p. 95, pl. 6, figs. 1-9.

1889. *Boeckella triarticulata* DEGUERNE and RICHARD, p. 103, figs. 57-58.

1894. *Boeckella triarticulata* SARS, p. 49, pl. 7, figs. 1-8; pl. 8, figs. 1-9.

1896. *Boeckella triarticulata* SARS, p. 66.

1898. *Boeckella triarticulata* GIESBRECHT and SCHMEIL, p. 61.

1905b. *Boeckella triarticulata* EKMAN, p. 602.

1906. *Boeckella triarticulata* BRADY, p. 695.

1908. *Boeckella triarticulata* SARS, pp. 5-6, pl. 1, figs. 1-4.

1922. *Boeckella triarticulata* HENRY, p. 556.

Female.—The first antennae extend to the third abdominal segment. The exopodites of the second antennae are 7 segmented, segments 1, 3, 4, 5, and 6 being short. The sides of the last cephalothoracic segment are divergent and extend back to the second abdominal segment; they have inner lobes which are small, acute, and bent outward. The first abdominal segment is asymmetrical. The terminal segments of the exopodites of the fifth feet have 7 spines.

Male.—In the fifth feet the right endopodite is 1 segmented, rounded at the tip which is armed with a short spine, and nearly equals in length the first two segments of the exopodite. The second basal segment of the left foot bears on its inner margin a serrate lamella. The left endopodite is 1 segmented, rounded at tip, and one-half the length of the first segment of the exopodite. Figure 26 shows the fifth feet of the male.

Length.—According to Thompson, 2.54 mm.; according to Sars, 1894, male, 1.67 mm.; female, 2.1 mm.; according to Sars, 1908, female, 2.5 mm.

Australia; New Zealand.

Genus PSEUDOBOECKELLA Mrazek.

Syn. { *Diaptomus* (part) LÜBBOCK, 1855.
 Boeckella (part) DEGUERNE and RICHARD, 1889.—POPPE and MRAZEK, 1895.—
 (Part) GIESBRECHT and SCHMEIL, 1898.—DADAY 1901 (part), 1902 and 1905.—
 EKMAN, 1905.
 Pseudoboeckella MRAZEK, 1901.—EKMAN, 1905b.
 Paraboeckella MRAZEK, 1901.

KEY TO SPECIES OF PSEUDOBOECKELLA MRAZEK.

- The terminal segments of the exopodites of the fifth feet of the female have 3 spines 2
 The terminal segments of the exopodites of the fifth feet of the female have 5 spines. silvestri Daday.
 1. The terminal segments of the exopodites of the fifth feet of the female have 6 spines valentini Scott.
 The terminal segments of the exopodites of the fifth feet of the female have 7 spines 5
 2. The left endopodite of the male fifth feet consists of 1 segment. braziliensis Lubbock.
 The left endopodite of the male fifth feet consists of 2 segments 3
 3. In the left fifth foot of the male the second segment of the exopodite has 2 spines on the external border dubia Daday.
 In the left fifth foot of the male the second segment of the exopodite has 1 spine on the external border 4
 4. The second segment of the left exopodite of the fifth feet of the male has a small spine on the internal side at the base of the hook setosa Daday.
 The second segment of the left exopodite of the fifth feet of the male does not have a small spine on the inner side at the base of the hook longicauda Daday.
 5. In the 3-segmented endopodite of the right male fifth foot the second and third segments are slender, the third segment is terminated with 2 spines; the left endopodite is 2 segmented brevicaudata Mrazek.
 In the 3-segmented endopodite of the right male fifth foot the second and third segments are not especially slender and the third is armed with 4 stout spines; the left endopodite is 2 segmented poppei Mrazek.

PSEUDOBOECKELLA BRAZILIENSIS Lubbock.

1854. *Diaptomus braziliensis* LUBBOCK, pp. 236-240, pl. 15, figs. 3-8.

1889. *Boeckella braziliensis* DEGUERNE and RICHARD, pp. 100-102, figs. 54-56 (from Lubbock).

1901. *Pseudoboeckella braziliensis* MRAZEK, pp. 5-6, pl. 1, figs. 11 and 13; pl. 2, figs. 24 and 30.

1905b. *Pseudoboeckella braziliensis* EKMAN, p. 600.

Not *Pseudoboeckella braziliensis* POPPE and MRAZEK, nor DADAY.

Female.—The first antennae extend to the last cephalothoracic segment. The sides of the last cephalothoracic segment extend back nearly to the second abdominal segment; they do not have inner lobes and their inner margins are nearly straight. The terminal segments of the exopodites of the fifth feet have 3 spines.

Male.—In the fifth feet the hook in both exopodites bears a small spine on the inner side; in the right foot the spine is situated at about one-third the length of the hook and in the left at about one-half. In the right endopodite the three segments are approximately equal in length and the whole endopodite equals the first 2 segments of the exopodite. The left endopodite is short and composed of 1 segment. Figure 27 shows the fifth feet of the male.

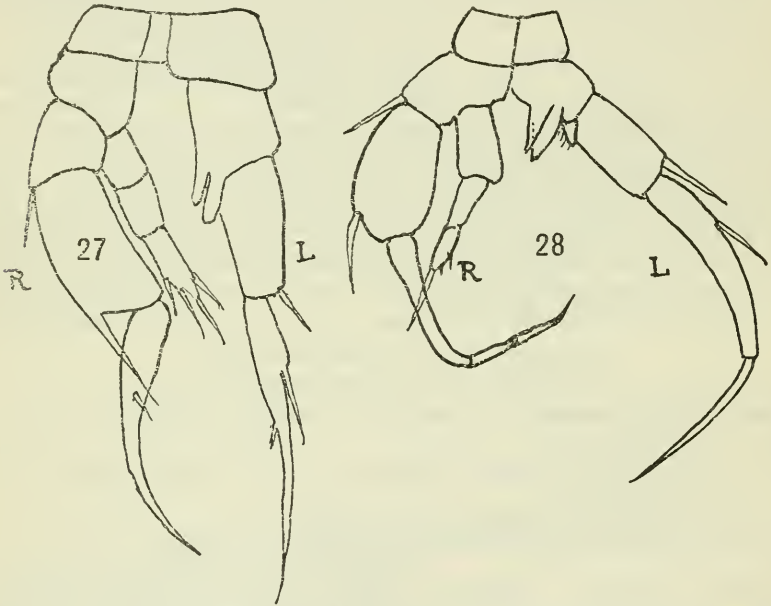
Length.—Male, 1.6 mm.; female, 2 mm.

Patagonia; Tierra del Fuego.

PSEUDOBOECKELLA BREVICAUDATA Mrazek.

1901. *Paraboeckella brevicaudata* MRAZEK, pp. 8-11, figs. 7, 12, 21, 26, and 27.
 1905a. *Boeckella vexillifera* EKMAN, pp. 16-20, figs. 7-12.
 1905b. *Pseudoboeckella brevicaudata* EKMAN, pp. 600-601.
 1905b. *Pseudoboeckella brevicaudata*, var. *vexillifera* EKMAN, p. 601.
 1914. *Pseudoboeckella brevicaudata* SCOTT, T., pp. 4-5, pl. 1, figs. 1, 7, and 10.
 1921. *Pseudoboeckella brevicaudata* RÜHE, pp. 56-61, fig. 20, *a-e*, fig. 21, *a-d*.

Female.—The first antennae extend to the third or fourth cephalothoracic segment. The sides of the last cephalothoracic segment are asymmetrical, the left side being the larger; there are no inner lobes, but the inner margins are sinuate; they extend backward according



FIGS. 27-28.—27, *PSEUDOBOECKELLA BRAZILIENSIS* LUBBOCK, FIFTH FEET OF MALE, AFTER MRAZEK. 28, *P. BREVICAUDATA* MRAZEK, FIFTH FEET OF MALE, AFTER MRAZEK.

to Ekman's figure one-half the length of the first abdominal segment, according to Rühle's figure beyond the first abdominal segment. The terminal segments of the exopodites of the fifth feet have 7 spines.

Male.—In the fifth feet the second segment of the right exopodite is slender, somewhat curved, and bears on its distal end a curved hook whose general position is approximately at right angles with the second segment. The right endopodite is 3 segmented, the first segment being nearly as broad as long, and the second and third segments long and slender; the third segment bears at the tip 2 spines, one long and one short; these 2 spines are shown in the figures of Ekman and Scott, but only 1 in the figures of Mrazek and Rühle; Mrazek, Ekman, and Rühle show also on this third segment 2 small lateral spines. Scott shows no lateral spines; if we may assume

slight errors in some of the figures, it would seem probable that the armature of this segment, typically at least, consists of 2 terminal spines, one long and one short, and 2 lateral spines on the inner margin. The left exopodite is 2 segmented, the second segment bearing a lateral spine and a terminal scythe-shaped hook; the endopodite is short and 1 segmented. The second basal segment of the right foot also bears a hook-like projection on its anterior distal margin, which is nearly as large as the endopodite. Figure 28 shows the fifth feet of the male.

Length.—According to Ekman, male 2–2.55 mm., female 2.9–3 mm.; according to Scott, female 2 mm.; according to Rühle, male 2–2.55 mm., female 2.1–3.1 mm.; and according to Mrazek, male 18 mm., female 21 mm. It seems probable that Mrazek's figures of size are a misprint and that they should be, male 1.8 mm., female 2.1 mm.

Patagonia; Tierra del Fuego; Falkland Islands; Kerguelen Island; New Amsterdam Island.

This has by some been considered identical with *Centropages brevicaudatus* Brady, 1875 and 1879, but Brady's description is so brief and incomplete that identification of his form is impossible.

PSEUDOBOECKELLA DUBIA Daday.

1901. *Boeckella dubia* DADAY, p. 345.

1902. *Boeckella dubia* DADAY, pp. 236–239, pl. 6, figs. 1 and 2.

1905b. *Boeckella dubia* EKMAN, p. 600.

Female.—The first antennae extend to the last cephalothoracic segment. The sides of the last cephalothoracic segment extend back to the end of the first abdominal segment and are acute and slightly lobed on the inner margin. The terminal segments of the exopodites are armed with 3 spines.

Male.—In the fifth feet the right endopodite is 3 segmented and longer than the first 2 segments of the exopodite. There is a cuticular extension of the inner distal angle of the second basal segment of the left foot, covering about one-half the first segment of the endopodite. The second segment of the left exopodite bears 2 spines. The left endopodite is 2 segmented, the distal segment bearing at its outer end a spine; with the spine the endopodite equals in length the first segment of the exopodite. Figure 29 shows the fifth feet of the male.

Length.—Male, 2.6 mm.; female, 2.5–3 mm.

Patagonia.

PSEUDOBOECKELLA LONGICAUDA Daday.

1901. *Boeckella longicauda* DADAY, pp. 346–347.

1902. *Boeckella longicauda* DADAY, pp. 243–247, pl. 6, figs. 10, 14, and 16.

1905b. *Pseudoboeckella longicauda* EKMAN, p. 600.

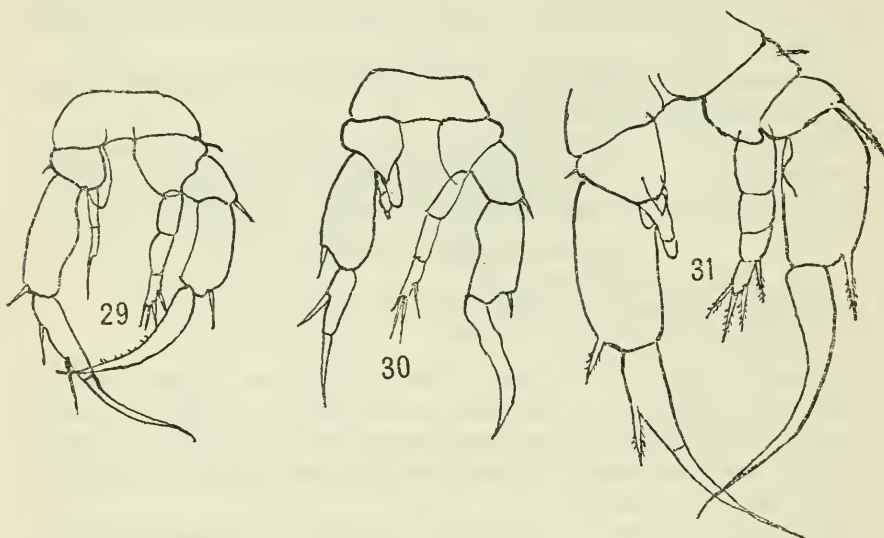
Female.—The first antennae extend to the last cephalothoracic segment. The sides of the last cephalothoracic segment extend

backward one-half the length of the first abdominal segment; the ends are turned slightly outward and are acute; the inner margin is sinuate. The terminal segments of the exopodites bear 3 spines.

Male.—The right endopodite of the fifth feet is slender, 3 segmented, and equal in length to the first 2 segments of the exopodite. The second basal segment of the left foot bears on its inner distal angle a cuticular projection which is as long as the endopodite. The left endopodite is 2 segmented, somewhat less than one-half the length of the first segment of the exopodite, and its terminal segment is tipped with a small blunt spine. Figure 30 shows the fifth feet of the male.

Length.—Male, 2.6–2.8 mm.; female, 3.6–3.8 mm.

Patagonia.



FIGS. 29–31.—29, *PSEUDOBOECKELLA DUBIA* DADAY, FIFTH FEET OF MALE, AFTER DADAY. 30, *P. LONGICAUDA* DADAY, FIFTH FEET OF MALE, AFTER DADAY. 31, *P. POPPEI* MRAZEK, FIFTH FEET OF MALE, AFTER POPPE AND MRAZEK.

PSEUDOBOECKELLA POPPEI Mrazek.

1895. *Boeckella braziliensis*, POPPE and MRAZEK, pp. 13–16, figs. 1–11.

1898. *Boeckella braziliensis* GIESBRECHT and SCHMEIL (part), p. 60.

1901. *Pseudoboeckella poppei* MRAZEK, p. 6.

1901. *Boeckella entzii* DADAY, pp. 345–346.

1902. *Boeckella entzii* DADAY, pp. 239–243, pl. 6, figs. 3–9.

1905b. *Pseudoboeckella poppei* EKMAN, p. 600.

1909. *Pseudoboeckella poppei* SARS, pp. 22–29, pl. 3, figs. 1–16.

Female.—The last segment of the cephalothorax projects back fully one-half the length of the first abdominal segment; the sides do not have inner lobes, but the inner margins are sinuate. The first abdominal segment is somewhat asymmetrical, projecting more to the left side. The terminal segments of the exopodites of the fifth feet have 7 spines.

Male.—The lobes of the last cephalothoracic segment are much smaller than in the female. In the fifth feet the right endopodite consists of 3 segments and the terminal segment is armed with 4 spines. The left endopodite is 2 segmented and is very small. Figure 31 shows the fifth feet of the male.

Length.—As given by Daday for *entzii*, male, 2.2–3 mm.; female, 2.6–3.5 mm. The other authors do not give the size.

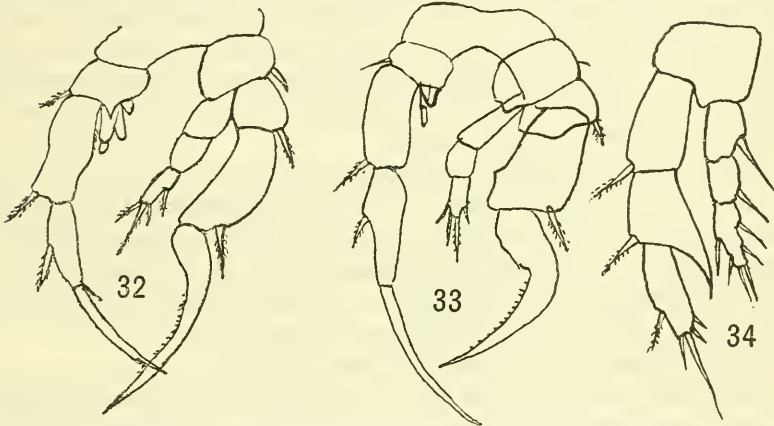
South Georgia; Patagonia.

PSEUDOBOECKELLA SETOSA Daday.

1901. *Boeckella setosa* DADAY, p. 347.

1902. *Boeckella braziliensis* DADAY, pp. 247–251, pl. 6, fig. 15; pl. 7, figs. 1–6.

Female.—The first antennae equal in length the cephalothorax. The sides of the last cephalothoracic segment are produced backward



FIGS. 32–34.—32, PSEUDOBOECKELLA SETOSA DADAY, FIFTH FEET OF MALE, AFTER DADAY. 33, P. SILVESTRI DADAY, FIFTH FEET OF MALE, AFTER DADAY. 34, P. SILVESTRI DADAY FIFTH FOOT OF FEMALE, AFTER DADAY.

nearly to the second abdominal segment; they do not have interior lobes, but are sinuate on the inner margins. The terminal segments of the exopodites of the fifth feet have 3 spines.

Male.—The endopodite of the right fifth foot equals in length the first 2 segments of the exopodite; the terminal segment is armed with 4 spines. The left endopodite of the fifth feet is 2 segmented and about one-half the length of the first segment of the exopodite. The second segment of the left exopodite has 1 spine on the external border and also a small spine on the internal side at the base of the hook. Figure 32 shows the fifth feet of the male.

Length.—Male, 1.6–2 mm.; female, 1.8–2.2 mm.

Patagonia.

Daday, 1902, makes *B. setosa* a synonym of *B. braziliensis* Daday and *D. braziliensis* Lubbock. It seems probable that *setosa* Daday

and *braziliensis* Daday are the same. *B. braziliensis* Daday, however, is not *D. braziliensis* Lubbock, for the endopodite of the left fifth foot of the male in Lubbock's species is 1 segmented, but in Daday's 2 segmented. Moreover Mrazek's figure shows a small spine on the inner side of the hook of the exopodite of the male fifth foot, and this does not appear in Daday's figure. It seems best, therefore, to use *setosa* as the name of the species.

PSEUDOBOECKELLA SILVESTRI Daday.

1901. *Boeckella silvestri* DADAY, p. 348.

1902. *Boeckella silvestri* DADAY, pp. 251-255, pl. 7, figs. 7-15.

1905a. *Boeckella entzii* EKMAN, pp. 15-16, pl. 1, fig. 6.

1905b. *Pseudoboeckella entzii* EKMAN, p. 600.

Female.—The first antennae reach the end of the first abdominal segment. The sides of the last cephalothoracic segment project backward, reaching beyond the first abdominal segment; the left side is larger than the right; the inner margins are sinuate, but there are no inner lobes. The first segment of the abdomen is asymmetrical, projecting to the left. The terminal segments of the exopodites of the fifth feet are armed with 5 spines.

Male.—In the fifth feet the hook of the right exopodite is sharply curved, is really sickle shaped. The right endopodite is 3 segmented, reaching to the end of the second segment of the exopodite; the terminal segment is armed with 4 spines. The left endopodite is very short and composed of 2 segments. Figure 33 shows the fifth feet of the male and Figure 34 a fifth foot of the female.

Length.—Male, 1.8-2.2 mm.; female, 2-2.5 mm.

This is the only described species in which the terminal segments of the exopodites of the female fifth feet have 5 spines. Ekman gives no description of *B. entzii* and has only one figure; that figure, however, is of the female fifth foot and shows the terminal segment of the exopodite with five spines. In lack of further description it would seem that it should be considered identical with Daday's *silvestri*.

Daday reported *silvestri* from Patagonia. Ekman reported his *entzii* from Louis Philippe Land, Southern Georgia, and the Falkland Islands. If the preceding identifications are correct, it must have a fairly wide distribution.

PSEUDOBOECKELLA VALLENTINI T. Scott.

1914. *Pseudoboeckella valentini* T. SCOTT, pp. 5-7, pl. 1, figs. 2, 8, and 11.

Female.—The first antennae reach the third segment of the abdomen. The sides of the last cephalothoracic segment are straight, that is flare outward very little, rounded at the tips, and have inner lobes. The hook of the second segment of the exopodites of the fifth feet is long, extending beyond the end of the third segment, and is

slightly recurved at the tip. The terminal segments of the exopodites have 6 spines.

Male.—In the fifth feet the second basal segment of the right foot in addition to the spine at the outer distal angle has a 2-pointed spine at the inner distal angle. The right endopodite is 1 segmented, exceeds the first segment of the exopodite in length, has 2 stout curved spines at the inner distal angle and upon the tip and extending along the inner side 5 shorter stout curved spines. There is also a straight acute spine near the proximal end on the inner margin. The left endopodite in Scott's figure does not seem to be separated from the second basal segment; it is 1 segmented or perhaps rudimentary. Figure 35 shows the fifth feet of the male.

Length.—Female, 1.6 mm.

Falkland Islands.

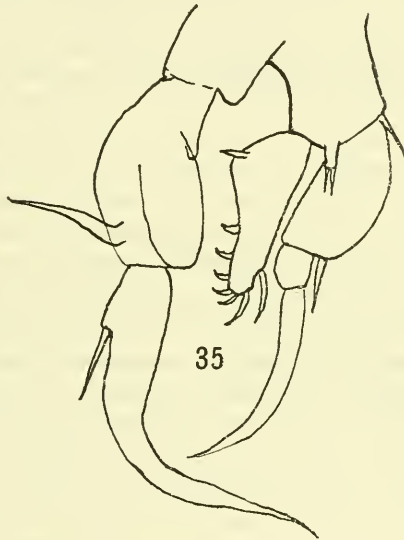


FIG. 35.—PSEUDOBOECKELLA VALLENTINI SCOTT, FIFTH FEET OF MALE, AFTER SCOTT.

DISTRIBUTION OF THE SPECIES OF BOECKELLA AND PSEUDOBOECKELLA.

The distribution of the fresh-water Centropagidae is a matter of a good deal of interest, as they are much more restricted in their habitats than some other forms of the Copepoda; for example, many of the species of the Cyclopidae are world-wide in their distribution while many of the species of the Centropagidae are found only over somewhat limited areas. The morphological differences, due to environment, make it possible in the case of the species of the Centropagidae to make some conjectures in regard to their phylogeny.

Both *Boeckella* and *Pseudoboeckella* are genera of the southern continents. Only one species, *B. orientalis*, is found north of the

equator, and, as stated later, the author is inclined to think that there must be some mistake about this species.

The genus *Boeckella* occurs in Australia, Tasmania, New Zealand, in South America from Tierra del Fuego to Lake Titicaca, and in the Falkland Islands. There are 8 species in Australia, 3 in Tasmania, 2 in New Zealand, 6 in South America, 1 in the Falklands, and 1 in Mongolia. One species, *B. triarticulata*, has been found in both Australia and New Zealand. With this exception, of Australia, New Zealand and Tasmania, each has its peculiar species. The South American species are all distinct from those of Australia, New Zealand, and Tasmania. One South American species, *B. michaelsoni*, has been found in the Falkland Islands. With this exception none of the South American species has been found away from the continent. *B. gracilipes* and *B. occidentalis* have been found in Lake Titicaca and *B. occidentalis* and *B. poopuensis* in Lake Poopo. The others were found in Patagonia and Argentina.

B. orientalis found in Mongolia bears a surprisingly close resemblance to *B. oblonga* found in Australia. The differences as shown in Sars's figures are that the lobes of the last cephalothoracic segment of the female are longer in *B. orientalis* and of a somewhat different form from those in *B. oblonga*, and in the left fifth foot of the male the serrate lamella of the second basal segment is longer. It may be a fair question whether the differences should be considered more than varietal. In that case we are faced with the fact that a genus which, with this single exception, is confined to the southern continents, and there has developed into somewhat localized species, has one species common to southern Australia and Mongolia. This would hardly seem possible, and one can not help conjecturing whether the locality labels of the collections might not have been misplaced.

Of the 8 species of *Pseudoboeckella* all but one are found in Patagonia; this one, *P. vallentini*, has been found only in the Falklands. Two species, *P. poppei* and *P. silvestri*, occur not only in Patagonia but in South Georgia, and *P. silvestri* has been found also in Louis Philippe Land and the Falkland Islands. *P. brevicaudata* has a rather surprising distribution, for besides occurring in Patagonia and Tierra del Fuego it has been collected in Kerguelen and New Amsterdam Island. It certainly is strange that this species should be found in the islands in the Indian Ocean but not on any of the islands near South America. Of course, in any discussion of the distribution of these forms, it should be remembered we are speaking only of the localities in which the species have been found, and that the islands bordering the Antarctic have been very imperfectly explored for their invertebrate fauna.

In regard to the manner in which these species were distributed, it should be said that while there is no impossibility, theoretically,

of birds carrying them in mud attached to their feet, there is little evidence that this actually occurs, while observed facts seem to indicate that the ordinary means of distribution of fresh-water copepods is by water transportation. It seems most probable, therefore, that the genera traveled from the Antarctic Continent, and the species have become differentiated in the various localities.

It may be noted that inasmuch as in the development of the Centropagidae there is a tendency to reduction of the endopodites of the fifth feet of the male, from a phylogenetic standpoint *Pseudo-boeckella* would be considered more primitive than *Boeckella*.

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THE HETERONEREIS PHASE OF A NEW SPECIES OF A POLYCHAETOUS ANNELID FROM URUGUAY.

By AARON L. TREADWELL,

Of the Department of Zoology, Vassar College, Poughkeepsie, New York.

The following description is of the heteronereis phase of a new species of *Nereis* sent me for identification by the United States National Museum. The specimens were collected by the well-known Uruguayan naturalist, Dr. F. Felippone, of Montevideo, in the course of an expedition to the eastern coast of the Republic, off Punta del Este, Maldonado. He says: "The animal was not known to the sailors. I captured it by placing an electric light (100 candlepower) 40 centimeters below the surface of the ocean. Within five minutes thousands of animals appeared on the water moving rapidly about." Since paragnaths are found on all eight of the proboscis areas, the species belongs in the subgenus *Neanthes*. The collection contained only one male and a considerable number of females.

NEREIS (NEANTHES) AUSTRALIS, new species.

The single male was 37 mm. in length, with a width of 3 mm. in the anterior unmodified portion. Females varied considerably in size, depending in part on the degree of distension of the body by the sex products. One female, the largest of the collection, was 95 mm. long and 6 mm. wide in the median region.

The prostomium (fig. 1) narrows abruptly at about the middle of its length, so that it is roughly divided into two rectangular areas, the outer one nearly square in outline, the inner one about twice as long as wide. The eyes are prominent, those of the anterior pair lying near the margin, while the posterior ones are at the posterolateral angles. The antennae are about one-half as long as the prostomium, separated by less than their own width from one another. The basal joints of the palps are large, extending to the apex of the antennae, while the terminal joints are very small. The two ventral tentacular cirri (only the anterior one is shown in the figure) are short, hardly reaching to the apex of the prostomium. In the specimen drawn the anterior dorsal cirrus on the right side reached to somite 8 while on the left it was much shorter, apparently due to injury. The two posterior dorsal tentacular cirri extend to somite 10.

The appearance of somite 1 varies with the degree of protrusion of the pharynx, for in some specimens it was very much narrower than somite 2 while in others it was more as is represented in Figure 1. In most cases there is a gradual slope backward from the anterior border of somite 1 to that of somite 2. It is short as compared with other species of this genus, being never more than one-third its length longer than somite 2. Somite 2 gradually widens to somite 3, and this increase continues to the region of somites 6 to 8. The distension of the body with sex products or its collapse after they are extruded make measurements behind this region of little value.

In life the dorsal surface must have been dark brown in color. In the preserved material the dorsal surface of the prostomium, palps, and anterior somites, and the ceratophores of the tentacular cirri are dusky brown. The remainder of the body is colorless. A row of clear spots runs across the dorsal surface of each somite a short distance posterior to its anterior margin.

A parapodium from the anterior region of the male is shown in Figure 2. On the notopodium are two cirruslike lobes, one above and one below, and a cirruslike presetal lip. The dorsal cirrus is relatively smaller than in many heteronereids and has the characteristic swelling toward its apex. In the neuropodium there is a cirruslike postsetal lobe and an asymmetrically pointed anterior one with a larger triangular lobe ventral to these two. The ventral cirrus is very small and placed near the base of the parapodium. There is a single black acicula in each half of the parapodium.

A parapodium from the sexual region of the male (fig. 3) has in the notopodium two cirruslike presetal lobes, the postsetal being short and rounded. On the dorsal surface is a rounded flat lobe, and the dorsal cirrus arises between the base of this and the dorsal one of the two presetal lobes. It has about ten lobulations along its ventral border. The neuropodium has two presetal lobes, one broad and fan-shaped with a deep notch in the dorsal border of its base, the other much more slender and cirruslike. On the ventral border of the neuropodium are two lobes, of which the ventral one is the larger and the ventral cirrus arises between the two. It is much smaller than the dorsal cirrus and lobulated along its dorsal border.

The parapodia of the female agree in general with those of the male, except that all lobes and lips are heavier and blunter. In the anterior region the dorsal cirrus does not have the expansion toward the apex, but is uniformly tapered.

In the anterior region of the male are two kinds of setae, both compound. One form (fig. 4) has a very long slender terminal joint, toothed along one margin. These make up all of the notopodial tuft, and the dorsal and ventral parts of the neuropodial. In

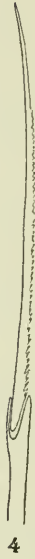
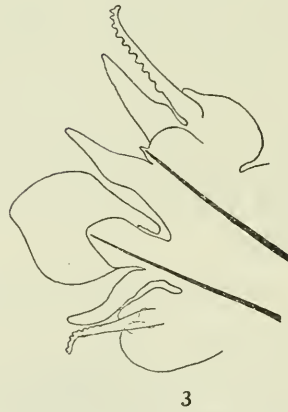
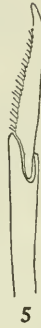
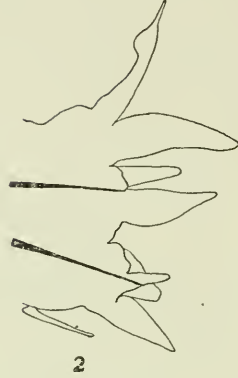
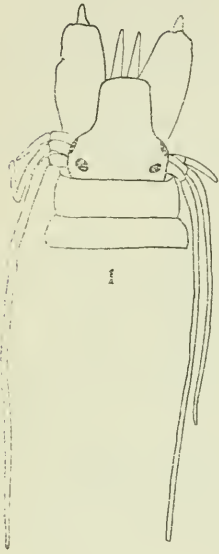
the latter tuft, occupying the middle region, is a smaller group of setae with terminal joints shorter than in the other type, with blunt ends and long marginal teeth (fig. 5). Both forms of setae have camerated shafts. In the sexual region of the male I found only one type of seta, having the broad flat, paddle-shaped terminal joint with one margin toothed, which is characteristic of heteroneurids. The form and arrangement of setae in the female is essentially like that in the male, except that in among the paddle-shaped setae of the sexual portion I found a few of the long type, like Figure 5. There would be one or two of these in each half of the parapodium. I did not determine whether they are present in all of the sexual parapodia but they appeared in those from near the middle of the body. I could find none of these in the sexual region of the male, but the material at hand was not sufficient to enable me to decide whether this is a sex difference.

The jaws are rather heavy, translucent-brown in color each with about 10 teeth. Paragnaths are arranged as follows: I, 3 or 4; II, about 20 arranged in approximately 3 diagonal rows; III, about 30 on either side, arranged in the form of a curved triangle, 4 or 5 paragnaths wide at the base and narrowing toward the apex, the terminal 2 rows made up of one paragnath each; IV, about 30 in 4 (approximately) transverse rows; V, usually 3 in a longitudinal row, but 2 specimens had only 1 each; VI, a circular patch of about 9 on either side; VII, a single row on either side, which toward the ventral end becomes double and merges gradually into VIII, which has 3 transverse rows, of which the 2 anterior are of much larger paragnaths than are found in the posterior one.

The male holotype (Cat. No. 19095 U.S.N.M.) and female paratypes (Cat. No. 19096 U.S.N.M.) are in the collections of United States National Museum.

EXPLANATION OF PLATE.

- FIG. 1.—Anterior region of female $\times 10$.
2.—Parapodium from anterior region of male $\times 28$.
3.—Parapodium from the sexual region of male $\times 28$.
4.—Seta from anterior region of male $\times 250$.
5.—Second form of seta from anterior region of male $\times 250$.



NEREIS (NEANTHES) AUSTRALIS, NEW SPECIES

FOR EXPLANATION OF PLATE SEE PAGE 3

NEW SPECIES OF TWO-WINGED FLIES FROM WESTERN
NORTH AMERICA BELONGING TO THE FAMILY
TIPULIDAE.

By CHARLES P. ALEXANDER,

Of the Massachusetts Agricultural College, Amherst.

The new species described in this paper were included in very extensive collections made in Alaska by Dr. J. M. Aldrich, and in Western United States, British Columbia and Alaska, by Dr. Harrison G. Dyar. The two collections taken together, which belong to the United States National Museum, constitute one of the most important series of these flies that has yet been brought together from this region. In the present paper a part of the undescribed forms are included. It is hoped that detailed records of all the included species can be brought together and published in a second report on these flies. All types have been deposited in the collection of the United States National Museum.

ORMOSIA DECUSSATA, new species.

Allied to *O. longicornis* (Doane); antennae of male elongate, the flagellar segments attenuated; general coloration of mesonotum brown, the pleural region pale reddish grey; wings with the stigma and costal region pale brown; cell 1st M_2 open; anal veins convergent; male hypopygium with the outer angles of the gonapophyses produced into elongate, curved spines that are feebly decussate at their extreme tips.

Male.—Length about 4.5 mm.; wing, 5.7 mm.

Rostrum and palpi dark brown. Antennae of the male elongate, brown, a little shorter than the body, the flagellar segments attenuated apically. Head greyish brown.

Mesonotum pale greyish brown, the humeral region of the praescutum obscure yellow. Pleura pale reddish grey, the dorso-pleural region more yellowish. Halteres obscure yellow, the knobs darker. Legs with the coxae and trochanters yellow; remainder of the legs brownish yellow, the terminal tarsal segments dark brown. Wings with a pale grey suffusion the stigma and the costal and subcostal cells brownish; veins brown. Venation: r at fork of R_{2+3} ; basal

deflection of R_{4+5} about one-half R_{2+3} ; cell $1st M_2$ open by the atrophy of the outer deflection of M_3 ; basal deflection of Cu_1 immediately before the fork of M ; anal veins convergent.

Abdominal tergites brown, the caudal margin of the segments indistinctly paler; sternites brownish yellow. Male hypopygium with two pleural appendages; outer appendage small, dark-colored; inner appendage pale, the apex irregularly bilobed, the tip of the longest lobe with a few setae. Gonapophyses very powerful, appearing as flattened plates, the outer angles produced caudad and mesad into a long, gently curved spine, the extreme tips being contiguous or feebly decussate on the median line. The apparent ninth sternite (ninth tergite) a broad, pale lobe that is distinctly split medially.

Described from a single male, collected at Ketchikan, Alaska, August 7, 1919 (H. G. Dyar).

Type.—Male, Cat. No. 26078, U.S.N.M.

ORMOSIA CURVATA, new species.

General coloration dark brown; basal segment of antenna indistinctly pale; halteres with yellowish knobs; wings grayish yellow, stigma distinct; cell $1st M_2$ open by the atrophy of the outer deflection of M_3 ; anal veins divergent; male hypopygium with the outer pleural appendage produced into a long, slender curved point; inner pleural appendage with a powerful spine before the tip.

Male.—Length about 4 mm.; wing, 5.4 mm.

Rostrum and palpi dark. Antennae short, dark brown, the basal segment a little paler. Head discolored, dark, with yellow setae.

Mesonotum discolored, excepting the anterior part of the praescutum which is dark brown. Pleura dark. Halteres obscure yellow, the knobs brighter. Legs with the coxae brownish yellow; trochanters yellow; remainder of the legs dark brown, the femora paler basally. Wings with a strong grayish yellow tinge; stigma distinct, brownish; veins brown. Venation: Cell $1st M_2$ open by the atrophy of the outer deflection of M_3 ; anal veins divergent; vein $2dA$ straight.

Abdomen dark brown. Male hypopygium with the pleurites stout; outer pleural appendage relatively small, the mesal face produced into a long slender arm that gradually narrows to the cylindrical, chitinized, curved apex; inner pleural appendage appearing as a straight arm, immediately beyond midlength on the lateral or caudal face bearing a powerful, acute, black spine that is but little shorter than the apex beyond it; apex of the appendage pale, incrassated, with the lateral margins feebly chitinized, provided with a single stout seta. Gonapophyses appearing as slender, straight, chitinized rods, the extreme bases swollen, immediately beyond this enlargement on the lateral face with a small chitinized branch. Lobe of the

ninth tergite (the apparent sternite) narrow basally, gradually widened to the apex which is feebly bilobed.

Described from a single male, collected at Skagway, Alaska, June 3, 1919 (H. G. Dyar).

Type.—Male Cat. No. 26079, U.S.N.M.

ORMOSIA PROXIMA, new species.

General coloration dark brown; wings tinged with brown; stigma distinct; cell *1st M*₂ open by the atrophy of the outer deflection of *M*₃; anal veins feebly convergent but cell *1st A* widest at margin; inner pleural appendage of male hypopygium a flattened blade with the distal margin truncate, irregularly toothed.

Male.—Length about 4 mm.; wing, 5 mm.

Rostrum and palpi dark brown. Antennae short, dark brown throughout. Head dark gray.

Mesonotum and pleura dark brown, without distinct markings. Halteres brown, the knobs conspicuously yellowish. Legs with the coxae and trochanters yellowish brown; remainder of the legs dark brown, only the femoral bases a little paler. Wings tinged with brown, the stigma darker; veins dark brown. Venation: Cell *1st M*₂ open by the atrophy of the outer deflection of *M*₃; basal deflection of *Cu*₁ at or immediately beyond the fork of *M*; Anal veins slightly convergent, vein *2d A* being feebly sinuous on its distal third; cell *1st A* is much wider at the margin than at any point elsewhere.

Abdomen dark brown. Male hypopygium with two pleural appendages, the outer one larger, near the apex with two acute black horn-like spines and a brown lobe that is densely set with conspicuous setiferous punctures; inner appendage smaller, appearing as a blade with a short, curved base, the distal margin truncated and irregularly but conspicuously toothed. Gonapophyses conspicuous, appearing as powerful black horns that taper gradually to the acute tips which are inclined slightly mesad; at base of each apophyse a short, straight spine. Penis-guard a long, slender rod that juts beyond the level of the apophyses.

Described from three males, collected at Skagway, Alaska, June 3, 1919 (H. G. Dyar).

Type.—Male, Cat. No. 26080, U.S.N.M.

ORMOSIA FUSCOPYGA, new species.

Belongs to the *deviata* group; head brownish gray; mesonotum dark brown; thoracic pleura and sternum gray pruinose; halteres with the knobs dark brown; wings pale brownish subhyaline, with conspicuous veins; abdomen and hypopygium dark brown.

Male.—Length about 3.5 mm.; wing, 4.2–4.3 mm.

Rostrum and palpi dark brown; antennae short, pale brown throughout; flagellar segments with elongate verticils. Head dark brownish gray.

Pronotal scutellum conspicuously pale yellow. Mesonotum dark brown, the humeral region paler brown. Pleura and sternum conspicuously gray pruinose. Halteres yellow, the knobs dark brown. Legs with the coxae and trochanters obscure brownish yellow; remainder of the legs brown; legs relatively long and slender. Wings pale brownish subhyaline; stigma conspicuous, brown; veins dark brown, conspicuous. Venation as in *O. stylifer* Alexander but the cells distad of the cord are not quite so deep.

Abdomen dark brown, including the hypopygium. Male hypopygium very similar to that of *O. stylifer*; pleural appendages larger and more conspicuous, the apices of both more obtuse.

Described from three males, collected at Clío, Plumas County, California, July 9, 1916 (H. G. Dyar).

Type.—Male, Cat. No. 26081, U.S.N.M.

ERIOPTERA ALDRICHI, new species.

Allied to *E. katmai* Alexander; halteres pale, the knobs faintly darkened; head blue-gray; wings faintly tinged with brown; stigma elongate, dark brown; vein *2d A* subsinuous, ending beyond mid-length of *Rs*; male hypopygium concolorous with the remainder of the abdomen; outer pleural appendage slender, the apex acute; inner pleural appendage deeply bifid, the lateral arm strongly curved, the mesal arm slender, pale, terminating in a single powerful seta; gonapophyses appearing as small, blackened plates that are shorter than the penis-guard.

Male.—Length about 5 mm.; wing, 6.5 mm.

Rostrum and palpi black. Antennae black, the first scapal segment dusted with gray. Head clear blue-gray above, duller gray on the genae.

Pronotum clear gray; a setiferous area on either side of the scutum. Mesonotal praescutum gray with four brown stripes that tend to become confluent, only the lateral margins remaining of the ground-color; pseudosutural foveae elongate, black, conspicuous; scutum light gray medially, the centers of the lobes brown; scutellum light gray, the margins weakly infuscated; postnotum gray. Pleura clear gray, the mesosternum and mesepimeron with conspicuous, elongate, white setae. Halteres pale, the knobs weakly infuscated. Legs with the coxae light gray; trochanters brown; remainder of the legs black. Wings fully developed, faintly tinged with brown, the costal and subcostal cells a little more yellowish; stigma elongate, dark brown; veins dark brown, *Sc* yellowish. Venation: *Sc*₁ ending just before *r*; *Sc*₂ faint, opposite three-fifths the length of *Rs*; *R*₂₊₃

about equal to the first section of R_2 and a little longer than the deflection of R_{4+5} ; basal deflection of Cu_1 at the fork of M ; vein $2d$ A feebly sinuous, longer than usual in this group, ending beyond midlength of R_s .

Abdomen dark brown, sparsely pruinose; hypopygium concolorous. Male hypopygium with the ninth tergite appearing as a very large and flattened plate as in this group of species, the apex with a broad V-shaped notch, the lobes rounded. Pleurites comparatively stout, the ventral apical angle produced caudad into a fleshy lobe that is clothed with pale, erect setae; outer pleural appendage a slender, nearly chitinized arm that tapers to the acute apex, the outer or lateral margin microscopically squamulose; inner pleural appendage shorter, deeply bifid, the lateral arm a chitinized, strongly curved hook, the mesal arm pale yellow, straight and slender, terminating in a single powerful seta, the cephalic margin of the arm with a slight, wing-like expansion. Gonapophyses appearing as small, flattened plates, the mesal margin straight or nearly so, the apices obliquely subtruncate, the lateral margins rounded. Penis-guard a little longer than the apophyses, the apex strongly curved.

Described from a single male, collected at Valdez, Alaska, June 8, 1921 (J. M. Aldrich).

Type.—Male, Cat. No. 26082, U.S.N.M.

A female taken on the same day, at the type-locality, may belong here but the second anal vein is short and straight as usual in the group, ending before one-third the length of R_s .

This interesting crane-fly is dedicated to the collector, Dr. J. M. Aldrich. It is possible that this group of crane-flies may more correctly be referred to the genus *Psiloconopa* Zetterstedt.

ERIOPTERA ALASKENSIS, new species.

Allied to *E. angustipennis* Alexander; halteres pale yellow; wings long and narrow; male hypopygium reddish brown; outer pleural appendage of the hypopygium dilated apically into a broad, triangular blade; inner appendage a straight arm, the narrow blackened apex with one seta; gonapophyses slender, straight, the slightly enlarged tips with abundant short setae.

Male.—Length about 4.8 mm.; wing, 6 mm.

Rostrum and palpi dull gray. Antennae black, the basal segment gray pruinose. Head gray.

Mesonotal praescutum dull gray with four brown stripes, the lateral pair subobsolete; pseudosutural foveae very conspicuous, black; tuberculate pits likewise conspicuous, black; scutum dull gray, the centers of the lobes weakly infuscated; scutellum dull gray; postnotum brownish gray. Pleura dark, heavily yellowish gray pruinose. Halteres pale yellow. Legs with the coxae and

trochanters light gray pruinose; remainder of the legs black. Wings long and narrow, slightly less so than in *E. angustipennis* Alexander (Canadian North-west Territories), faintly tinged with brown; cells *C* and *Sc* a little more yellowish; stigma lacking; veins dark brown, *Sc* more yellowish. Venation: *Sc*₁ ending just before *r* which is very faint; *R*₂₊₃ from two to four times the deflection of *R*₄₊₅ and one-half longer than the first section of *R*₂; basal deflection of *Cu*₁ at or just before the fork of *M*; fusion of *M*₃ and *Cu*₁ variable, from one to nearly two times the basal deflection of *Cu*₁; vein *2d A* short and straight ending just beyond the origin of *Rs*.

Abdomen dark, conspicuously dull gray pruinose; hypopygium conspicuously reddish brown. Male hypopygium with the ninth tergite relatively small with a deep U-shaped median notch, the lobes with conspicuous setae. Pleurites slender, the ventral angle not so conspicuously produced as in related species; outer pleural appendage a powerful arm that rapidly narrows to the subacute black apex, the outer face microscopically squamulose, the mesal or inner face near midlength dilated into a conspicuous, elongate-triangular blade that is about as long as the apex itself; viewed laterally the entire distal end of the appendage appears triangularly dilated; inner pleural appendage a straight rod, the apex subtruncate and narrowly blackened, bearing a single seta. Penis-guard and gonapophyses slender, straight, subequal in length, the apophyses pale with the heads slightly enlarged, bearing on the mesal apical angle and along the mesal margin abundant short setae.

Described from two males collected by J. M. Aldrich in Alaska: one at Valdez, June 8, 1921, the other at Camp 327, Alaska Engineer Commission, (since named Windy, a siding on the Alaska Railroad), July 12, 1921.

Type.—Male, Cat. No. 26083, U.S.N.M.

ERIOPTERA (ERIOPTERA) DYARI, new species.

Allied to *E. villosa* Osten Sacken; eyes of male widely separated by the vertex; vertex yellow with a brown spot; general coloration pale brown, variegated with sulphur-yellow; male hypopygium with the inner pleural appendage curved before the tip, the apex suddenly narrowed into a powerful spine; outer gonapophyses cultriform.

Male.—Length about 5.2 mm.; wing 6.5 mm.

Rostrum and palpi dark brown. Antennae light brown; eyes of the male not conspicuously enlarged, widely separated by the vertex. Head yellow, the center of the vertex with a conspicuous brown spot.

Pronotum yellow, infuscated medially. Mesonotal praescutum very pale brownish, sparsely pollinose, the lateral margins and

humeral regions light sulphur-yellow; scutum with the median area light brown, the lobes yellow with the centers narrowly infuscated; scutellum pale brown, the caudal margin conspicuously light yellow; postnotum light brown, the anterior lateral angles yellowish. Pleura whitish yellow, the mesepisternum and the mesosternum faintly darkened. Halteres yellow. Legs relatively slender, obscure yellow, the tarsi infuscated. Wings with a yellowish suffusion, the stigmal region slightly darker; veins pale brown.

Abdomen brownish yellow. Male hypopygium generally similar to that in *E. villosa* Osten Sacken; outer pleural appendage blackened on the outer half, not blade-like; inner pleural appendage much shorter, at the curved tip suddenly narrowed into a powerful spine of which the apex only is darkened. Outer gonapophyses chitinized, cultriform, the tips acute; inner apophyses shaped like shepherd's crooks.

Described from a single male, collected at Gold Lake Camp, Plumas County, California, July 22, 1916 (H. G. Dyar).

Type.—Male, Cat. No. 26084, U.S.N.M.

Erioptera dyari is a very distinct species of the genus. It is dedicated to the collector, Dr. Harrison G. Dyar.

ERIOPTERA (ERIOPTERA) DILATATA, new species.

Allied to *E. villosa* Osten Sacken; eyes of the male very large, contiguous or nearly so; general coloration reddish brown, the pronotum and lateral margins of the mesonotal praescutum obscure yellow; male hypopygium with the inner pleural appendage dilated into a triangular blade at apex; gonapophyses small, covered with microscopic spinulae.

Male.—Length 5 mm.; wing 6 mm.

Female.—Length 5.4 mm.; wing 6.8 mm.

Rostrum and palpi brown. Antennae dark brown. Head light fawn-colored, more yellowish adjoining the inner margins of the eyes. Eyes of the male very large, contiguous.

Pronotum yellowish. Mesonotum reddish brown, the lateral margins of the praescutum, especially the humeral regions, yellowish. Pleura light purplish brown. Halteres yellowish. Legs with the femora brownish yellow, the tips narrowly darkened; remainder of the legs obscure brownish yellow, the terminal tarsal segments dark brown. Wings with a brownish yellow tinge, paler than in *E. villosa*, the stigma and apical region not conspicuously darkened.

Abdomen of male dark brown, of female obscure yellow, narrowly trilineate with brown above. Male hypopygium with the inner or shorter pleural appendage conspicuously dilated into a triangular blackened blade at tip, the apex slight produced, at the caudal angle

of the blade with a short, stout spine. Lateral gonapophyses small, flattened, the surface with microscopic spinulae.

Described from two males and one female, collected at Missoula, Montana, July 6, 1917 (H. G. Dyar).

Type.—Male, Cat. No. 26085, U.S.N.M.

GONEMPEDA, new subgenus.

Characters as in the subgenus *Empeda* but vein R_2 oblique in position, straight, cell R_2 being short-triangular as in *Gonomyia*; cell 1st M_2 closed.

Type of the subgenus.—*Erioptera flava* Schummel (Palearctic).

In the subgenus *Empeda* [type, *Erioptera (Empeda) stigmatica* (Osten Sacken)], veins R_2 and R_3 run generally parallel to one another and cell R_2 is not as in *Gonomyia* but more nearly, as in *Erioptera* although much shorter. Other species definitely referable to *Gonempeda* are *E. (G.) nyctops* Alexander (Eastern United States) and the species described herewith as *E. (G.) burra*.

ERIOPTERA (GONEMPEDA) BURRA, new species.

Head yellow, the vertex with a reddish brown area; mesonotum reddish brown; wings nearly hyaline; veins distinct, brown; *Sc* long; R_2 oblique; cell 1st M_2 closed; vein $2d A$ straight.

Female.—Length about 3.8 mm.; wing 4.2 mm.

Rostrum yellow; palpi pale brown. Antennae brown. Head yellow, the vertex with a conspicuous brown median area.

Pronotal scutum brown, the scutellum yellow. Mesonotum reddish brown, the praescutum of the type somewhat discolored. Pleura yellow. Halteres pale, the knobs dark brown. Legs with the coxae and trochanters yellow; remainder of the legs brown. Wings nearly hyaline; veins distinct, brown. Venation: *Sc* long, Sc_1 ending opposite r ; Sc_2 rather far from the tip of Sc_1 , Sc_1 alone a little longer than the basal deflection of Cu_1 ; Rs long, gently arcuated; r a little more than its own length beyond the fork of R_{2+3} ; R_2 oblique, about as long as the second section of R_{2+3} ; cell 1st M_2 closed; basal deflection of Cu_1 at about one-fourth the length of cell 1st M_2 ; vein $2d A$ straight.

Abdomen brown; ovipositor with the elongate valves reddish horn-color.

Described from one female collected at Tahoe City, California, June 20, 1920 (H. G. Dyar).

Type.—Female, Cat. No. 26086, U.S.N.M.

GONOMYIA (GONOMYIA) POLIOCEPHALA, new species.

General coloration yellow, variegated with brown; head brownish gray; thoracic pleura yellowish white striped with brownish gray; Sc_1 ending opposite the origin of Rs ; male hypopygium with the

penis-guard long, slender, straight, the extreme tip slightly decurved; gonapophyses slender, straight.

Male.—Length about 4.8 mm.; wing 5.5 mm.

Rostrum light yellow; palpi dark brown. Antennae dark brown throughout. Head brownish gray.

Pronotum yellow, brown medially. Mesonotal praescutum brown, the lateral margins and humeral regions broadly yellow; pseudosutural foveae elongate, shiny brown; remainder of the mesonotum brown, the median area of the scutum, posterior margins of each scutal lobe and the caudal margin of the scutellum obscure yellow; yellow postnotum grayish pruinose caudally. Pleura yellowish white with a conspicuous, dorsal, brownish gray stripe extending from above the fore coxa caudad to the lateral sclerites of the postnotum, passing above the base of the halteres; sides of the mesosternum brownish gray, the yellowish white stripe between the brownish gray areas broad; median area of the mesosternum broadly yellow. Halteres elongate, brown, the base of the stem yellow. Legs with the coxae obscure yellow, the bases more or less infuscated; trochanters testaceous; remainder of the legs brown, darker distally. Wings with a faint grayish tinge; stigma brown; veins dark brown. Venation: Sc_1 ending opposite the origin of R_s , Sc_2 at its extreme tip; R_s long, arcuated, about equal² to or a little longer than R_{2+3} ; R_2 straight; deflection of R_{4+5} very short; basal deflection of Cu_1 beyond the fork of M , the distance about equal to two-thirds the basal deflection of M_{1+2} .

Abdominal tergites brown; sternites obscure yellow. Male hypopygium with the pleurites relatively long and stout, the outer caudal angle produced into a blunt lobe; two pleural appendages, the outer appendage elongate, slender basally, near midlength dilated into an oblique blade; inner pleural appendage a flattened subcircular blade, the caudal margin produced into a powerful, straight, black spine, the proximal end produced into a short lobe that bears two powerful setae. Penis-guard long and slender, extending caudad beyond the level of the pleural appendages, straight, the small pale apex slightly decurved, hood-shaped; gonapophyses appearing as two small, slender, blackened rods at about midlength of the guard and appressed to it.

Described from two males, collected at Clio, Plumas County, California, July 9, 1916 (H. G. Dyar).

Type.—Cat. No. 26087, U.S.N.M.

RHABDOMASTIX (SACANDAGA) BOREALIS, new species.

Antennae black, the basal segment obscure yellow; pronotal scutellum yellow; mesonotal praescutum dark brown; pleura brownish yellow, variegated with dark brown; femora dark brown, the

bases narrowly paler; wings tinged with gray; stigma lacking; R_2 very short, the tip less than its own length from the tip of R_1 .

Female.—Length, 5.8 mm.; wing, 7 mm.

Rostrum yellowish testaceous; palpi dark brownish black. Antennae with the first scapal segment obscure yellow, the remainder of the organ black. Front yellow; vertex dark brown, dusted with yellowish gray.

Pronotum yellow, broadly dark brown medially; scutellum conspicuously yellow. Mesonotal praescutum dark brown, without conspicuous markings; tuberculate pits large, shiny, separated from one another by a distance a little greater than the diameter of one; scutellum obscure brownish yellow; postnotum similar, the posterior half dark brown. Dorso-pleural membrane conspicuously yellow. Pleura brownish yellow, variegated with dark brown, this latter appearing as an interrupted longitudinal stripe. Mesosternum dark brown. Halteres pale brown, the knobs conspicuously pale whitish yellow. Legs with the coxae brown; trochanters yellowish brown; femora dark brown, the bases narrowly paler; tibiae pale brown, tipped with darker brown; tarsi dark brown. Wings with a faint gray tinge; stigma lacking; veins dark brown. Venation: Sc_1 ending just before three-fourths the length of R_s , Sc_2 faint, some distance from the tip of Sc_1 , the latter alone nearly twice the basal deflection of Cu_1 ; r lacking; R_2 very short, nearly perpendicular to the end of R_{2+3} , at the margin not far from the tip of R_1 , the space on costa between R_1 and R_2 being a little less than R_2 ; R_2 a little less than one-fourth R_3 ; R_{2+3} a very little longer than R_3 alone, the latter gently arcuated; veins issuing from cell *1st* M_2 relatively long, gently arched as in the genus; basal deflection of Cu_1 about its own length beyond the fork of M .

Abdomen pale brown; base of the ovipositor yellow. Ovipositor with the tergal valves elongate, slender, horn-colored.

Described from one female, collected at Hurricane, Alaska, July 15, 1921 (J. M. Aldrich).

Type.—Female, Cat. No. 26088, U.S.N.M.

LIMNOPHILA (NEOLIMNOPHILA) ULTIMA ALASKANA, new subspecies.

Similar to typical *ultima* Osten Sacken, differing as follows:

Wings conspicuously broader in both sexes and more nearly hyaline; stigma pale but distinct. Male hypopygium with the pleurites much longer and more slender; outer pleural appendage with the straight basal portion very long in proportion to the curved apical hook. The smaller of the two spines at the base of the pleurites is much longer and more conspicuous than in typical *ultima*.

Described from one male and four females: the male collected at Healy, Alaska, July 24, 1921 (J. M. Aldrich); the females at Flat, Alaska, August 5, 1919 (U. S. Biol. Surv., A. H. Twitchell).

Type.—Male, Cat. No. 28089, U.S.N.M.

Paratypes are in the collection of the U. S. Biological Survey and of the writer.

It should be noted here that this group of flies will probably be found to be more closely related to *Cladura* and *Crypteria* than they are to *Limnophila*. European representatives of the group have recently been discovered.

LIMNOPHILA EUXESTA, new species.

General coloration polished black, the mesonotal praescutum with three narrow interspaces of yellowish gray pollen; remainder of the mesonotum and pleura with a gray pruinosity; halteres yellow; wings with a faint yellowish tinge; stigma small, brown; *r* near the tip of R_1 ; R_{2+3} long; basal deflection of Cu_1 a short distance beyond the fork of M ; male hypopygium with the pleurites stout, the single pleural appendage slender, chitinized.

Male.—Length 12 mm.; wing 11.6 mm.

Female.—Length 14 mm.; wing 11.5 mm.

Rostrum and palpi black. Antennae black, short in both sexes, the first scapal segment sparsely pollinose. Head shiny black, the front and a band across the vertex connecting the eyes yellowish gray pruinose. Head strongly narrowed behind.

Mesonotal praescutum shiny black with a triton-shaped yellowish gray pruinose area, the central arm occupying the median line of the body, the outer arms lying parallel and close to the median vitta, these areas occupying the interspaces between two linear intermediate and two broad lateral stripes that are polished black; median area of scutum, most of the scutellum and the postnotum heavily yellowish gray pruinose. Pleura black, sparsely pruinose. Halteres pale yellow throughout. Legs with the coxae black, gray pruinose; trochanters obscure yellow; femora black, the bases conspicuously yellow, narrowest on the fore legs, slightly broader on the posterior legs; remainder of the legs black. Wings with a faint yellowish tinge, cells *C* and *Sc* slightly brighter; stigma small, oval, brown; very narrow and indistinct brown seams along the cord and outer end of cell 1st M_2 ; veins dark brown. Venation; *Sc* long, Sc_1 extending to beyond the fork of *Rs*, Sc_2 at the extreme tip of Sc_1 , *Rs* long, angulated and spurred at origin; R_{2+3} long, about twice as long as the deflection of Cu_1 ; inner end of cell R_2 pointed; *r* near tip of R_1 , the latter beyond it about one and one-half *r*; cell M_1 present, its petiole about equal to or one-half longer than the basal deflection of Cu_1 , the latter rather close to the inner end of cell 1st M_2 , the distance about equal to or less than *r-m*.

Abdomen dark brown, sparsely pruinose; hypopygium shiny black. Male hypopygium with the pleurites very short and stout, contiguous

on the median line, the dorsal apical portion produced dorsad and proximad into very stout cylindrical lobes, the apices of which are contiguous at the median line, the bases widely separated; the slender, shiny pleural appendage is almost straight, broad-based, the extreme tip curved, these appendages decussate across the median line. Ninth tergite almost straight across or the margin even feebly concave. Ovipositor black basally, the long valves reddish horn color.

In the holotype, the left wing has cell *1st M*₂ open by the atrophy of the outer deflection of *M*₃.

Described from two males and two females: one specimen of each sex (type and allotype) from Longmire Springs, Mount Rainier, Washington, June, 1917 (H. G. Dyar); the other pair from Prospect, Oregon, May 23-29, 1921 (H. G. Dyar).

Type.—Male, Cat. No. 26090, U.S.N.M.

LIMNOPHILA RUBIDA, new species.

General coloration shiny reddish; legs yellow, the tips of the femora conspicuously blackened; bases and apices of the tibiae narrowly blackened; wings brownish fulvous, stigma pale; *Rs* long, angulated at origin; *r* at tip of *R*₁.

Male.—Length about 9 mm.; wing 9.3 mm.

Rostrum and palpi brown. Antennae with elongate basal segment of the scape brownish black; second segment black; flagellar segments dark brown. Head dark brown, paler behind.

Mesonotal praescutum shiny reddish orange with a narrow black median vitta that occupies the anterior half of the sclerite; remainder of the mesonotum reddish yellow, the postnotum indistinctly and narrowly darkened medially. Coloration of the pleura obscured by glue. Halteres broken. Legs with the coxae and trochanters reddish orange; femora obscure yellow, the tips rather broadly and conspicuously black, the amount equal on all the legs; tibiae brownish yellow, narrowly blackened both at base and apex; tarsi dark brown. Wings with a strong brownish fulvous tinge; stigma small, barely indicated; veins pale brown. Venation: *Sc* long, *Sc*₁ extending to just beyond the origin of *R*₂₊₃; *Sc*₂ at tip of *Sc*₁; *Rs* elongate, longer than *R*₂ alone, angulated at origin; *R*₂₊₃ equal to the basal deflection of *Cu*₁; *r* at tip of *R*₁; cell *M*₁ about as long as its petiole; basal deflection of *Cu*₁ before one-third the length of cell *1st M*₂.

Abdomen conspicuously reddish, unmarked. Male hypopygium with the mesal apical angle of the pleurite produced into short blunt lobes; pleural appendage very long and slender, broad-based, tapering rapidly to the slender apex, the margins smooth.

Described from a single male, collected at Prospect, Oregon, May 23, 1921 (H. G. Dyar).

Type.—Male, Cat. No. 26091, U.S.N.M.

The general appearance of this fly is very much like a *Phylidorea*, allied to *L. (P.) adusta* Osten Sacken, but the elongate sector would indicate that such a subgeneric reference would be incorrect.

LIMNOPHILA OCCIDENS, new species.

Male.—Length 6.8 mm.; wing 8.5 mm.

Female.—Length about 7 mm.; wing 9 mm.

Closely related to *L. brevifurca* Osten Sacken (Eastern North America), from which it differs as follows:

Size very notably larger. Thorax reddish brown, only sparsely pruinose, the reddish color showing through and giving the body a reddish cast. Wings with a strong yellow tinge.

Described from one male and one female; the former collected at Seattle, Washington, June 19, 1917 (H. G. Dyar); the latter at Gold Lake Camp, Plumas County, California, July 22, 1916 (H. G. Dyar).

Type.—Male, Cat. No. 26092, U.S.N.M.

The general appearance of this fly is very different from *L. brevifurca* but a critical comparison shows that they are unquestionably closely allied though distinct. The structure of the male hypopygium is the same in both species. Both species belong to the *nemorialis* group of the genus.

PILARIA MICROCERA, new species.

Closely related to *P. tenuipes* (Say); antennae of the male short; thoracic stripes confluent, dark brown; abdominal tergites and hypopygium brownish black.

Male.—Length 7.6–8 mm.; wing 10–10.5 mm.

Very similar to *P. tenuipes* (Say), with the following exceptions:

Antennae of the male short, if bent backward barely reaching the wing-root. Thoracic stripes very distinct, dark brown, confluent. Wings a little broader than in *P. tenuipes* but narrower than in *discicollis* (Meigen); *r* on R_2 immediately beyond the base; basal deflection of Cu_1 at about two-thirds the length of cell 1st M_2 . Abdominal tergites and the hypopygium almost black, the basal sternites paler brown with testaceous incisures.

The general resemblance of this species to *P. tenuipes* is very marked, in spite of the short antennae. The wings are conspicuously narrower than in the European *P. discicollis* (Meigen).

Described from two males (one teneral), collected at Prospect, Oregon, May 23, 1921 (H. G. Dyar).

Type.—Male, Cat. No. 26093, U.S.N.M.

TRICYPHONA RAINIERIA, new species.

General coloration dark brown, gray pruinose, the mesonotal praescutum with four conspicuous black stripes; wings yellowish, the

stigma dark brown; cord and outer end of cell $1st\ M_2$ seamed with paler brown; cell R_4 very short-petiolate; basal deflection of Cu_1 at about two-fifths the length of cell $1st\ M_2$.

Male.—Length, 10.5 mm.; wing, 11.6 mm.

Rostrum and palpi dark brown. Antennae short, dark brownish black. Head dark, brownish gray pruinose.

Mesonotal praescutum gray pruinose with four conspicuous black stripes, the intermediate pair separated from one another only by a capillary gray line, these stripes becoming obliterated before the suture; scutum dull gray, the lobes marked with darker; scutellum pale, light gray pruinose; postnotum dark, gray pruinose. Pleura dark, gray pruinose. Halteres obscure yellow, the knobs dark brown. Legs with the coxae gray pruinose; trochanters yellowish brown; femora obscure yellow, the tips broadly dark brown; remainder of the legs dark brown. Wings with a yellowish tinge; stigma dark brown; conspicuous paler brown clouds along the cord and on m ; very indistinct seams along the longitudinal veins; veins dark brown. Venation: R_s long, angulated and spurred at origin; R_{2+3} a little shorter than R_s , R_2 contiguous with the extreme tip of R_1 ; $r-m$ at midlength of the deflection of R_{4+5} ; petiole of cell R_4 very short; cell M_1 present, its petiole longer than the cell; cell $1st\ M_2$ closed, comparatively small, subrectangular, widened distally; m and outer deflection of M_3 subequal; basal deflection of Cu_1 at about two-fifths the length of the cell. In one wing of the type, R_2 is a short distance from the tip of R_1 ; in this same wing there is an adventitious crossvein in cell R_3 just before midlength of R_{2+3} .

Abdomen dark brown, sparsely gray pruinose; hypopygium rather large, dark colored.

Described from two males collected at Longmire Springs, Mt. Rainier, Washington, June, 1917 (H. G. Dyar).

Type.—Male, Cat. No. 26094, U.S.N.M.

The nearest ally of *Tricyphona rainieria* in America is apparently *T. auripennis* (Osten Sacken) of Northeastern North America.

RHAPHIDOLABIS (RHAPHIDOLABIS) STIGMA, new species.

General coloration brownish black, gray pruinose, the praescutum with three brownish black stripes; antennae with 12, 13, or 14 segments, the number remarkably variable, the flagellar segments short-cylindrical, crowded; wings faint brownish gray; stigma conspicuous, dark brown; R_s angulated at origin; cell R_3 sessile; cell M_1 present; cell $1st\ M_2$ open.

Male.—Length, 6.5 mm.; wing, 8.5–8.8 mm.

Female.—Length, 6.6 mm.; wing, 9.5 mm.

Rostrum and palpi dark brown. Antennae short in both sexes, the number of segments variable, ranging from 12 to 14; antennae

dark brown, the second scapal segment paler apically; flagellar segments short-cylindrical, crowded. Head dark with a yellowish gray pruinosity.

Mesonotal praescutum yellowish gray with three conspicuous dark brown stripes; remainder of mesonotum dark brownish black. Pleura gray. Halteres pale yellowish testaceous, the knobs darker. Legs with the coxae gray; trochanters obscure yellow; legs brownish black, the femoral bases obscure brownish yellow. Wings with a faint brownish gray tinge; stigma very conspicuous, dark brown; veins dark brown. Venation: Sc_1 ending opposite one-third the length of R_{2+3} ; R_s long, angulated and sometimes slightly spurred at origin; cell R_3 broadly sessile; R_2 about its own length from the tip of R_1 ; deflection of R_{4+5} a little shorter than $r-m$; deflection of R_5 angulated; cell M_1 present; cell 1st M_2 open; first section of M_3 about one-half the fusion of Cu_1 and M_3 .

Abdomen dark brown, gray pruinose. Male hypopygium with the pleurites stout, the outer angles produced caudad into a blunt, weakly spinous lobe; two pleural appendages, both small, the outer appendage flattened, pale; inner appendage oval in outline, the apex with large, conspicuous spines. There are no apparent developments from the base of pleurites as in other species of the genus. Anal tube broadly rounded at apex.

Habitat.—Washington, Colorado.

Described from 10 males and females collected at Longmire Springs, Mount Rainier, Washington, June, 1917 (H. G. Dyar); and one female from Boulder, Colorado (T. D. A. Cockerell).

Type.—Male, Cat. No. 26095, U.S.N.M.

TIPULA PEREXIGUA, new species.

Size very small (wing female, 8 mm.); antennal scape yellow; head gray; mesonotum yellow with pale brown stripes; wings brownish gray, the stigma darker brown; abdominal tergites obscure yellow, marked medially with darker brown; valves of ovipositor comparatively short and very compressed.

Female.—Length 8.8 mm.; wing 8 mm.

Frontal prolongation of the head obscure yellow; nasus distinct; palpi reddish brown basally, the terminal segments passing into dark brown. Antennae with the scape and first flagellar segment light yellow; remaining flagellar segments brown, the basal enlargements a little darker brown. Head light gray, the center of the vertex faintly infuscated.

Pronotum yellow, narrowly infuscated medially. Mesonotum gibbous; praescutum yellow with three pale brown stripes, the median stripe indistinctly split behind; scutum yellow, each lobe with a

large brown area; scutellum pale brown, sparsely pruinose, with a capillary brown median vitta; postnotum sparsely pruinose. Pleura pale, sparsely pruinose. Halteres brown, the base of the stem yellowish. Legs with the coxae yellow, sparsely pruinose; trochanters obscure yellow; femora yellow, the tips narrowly infuscated; tibiae brownish yellow, the tips narrowly darkened; tarsi brownish black, the bases of the metatarsi paler. Wings with a brownish gray tinge the stigma darker brown, oval; a faint brown spot at origin of R_s and an indistinct seam along the cord; whitish oblitative areas before and beyond the stigma, and across the base of cell $1st\ M_2$; veins dark brown. Venation: Sc_2 ending opposite two-thirds of the length of the R_s ; distal section of R_2 entirely preserved; petiole of cell M_1 about two-thirds the length of m ; cell $1st\ M_2$ elongate, the sides parallel; cell $2nd\ A$ narrow.

Abdominal tergites obscure yellow, each tergite with the base dark brown, sending caudad a median extension toward the posterior margin; basal sternites dark brown apparently discolored; terminal sternites yellow. Ovipositor with the tergal valves comparatively short and compressed, the apices obtuse, the two valves forming a V-shaped trough; sternal valves still shorter, very compressed.

Described from a single female collected at Missoula, Montana, July 6, 1917 (H. G. Dyar).

Type.—Female, Cat. No. 26096, U.S.N.M.

Tipula perexigua is the smallest Nearctic *Tipula* and one of the smallest Tipuline crane-flies so far made known.

REVISION OF THE TWO-WINGED FLIES OF THE FAMILY CLUSIIDAE.

By A. L. MELANDER and NAOMI GEORGE ARGO,

Of the State College of Washington, Pullman.

The family Clusiidae, sometimes called the Heteroneuridae or the Clusiodidae, is generally regarded as one of the rarer groups of the Diptera. Seldom are its members met with in more than solitary individuals. In our experience in collecting a hundred thousand specimens of Diptera but a few dozen representatives of Clusiidae have been encountered.

Previously there have been described from the entire world 13 valid genera and 55 species. Aldrich's Catalogue in 1905 listed but 2 genera and 12 species as known from North America. The subsequent publications of Johnson and Malloch have added 11 recognized new species to the American list. Fifteen species have been described from Europe and the same number from South America, while four species have been recorded from the islands south of Asia. The material secured for the present study, amounting to some 400 specimens, has produced 52 species, of which 25 are new. With the extension in distribution of species originally described from Europe or South America there are now known to occur in North America, including Central America, a total of 58 species belonging to 7 genera. Thus in its present status the family includes 80 recognized species distributed among 13 genera.

The Clusiidae are restricted in their distribution to Europe, North and South America, and the East Indies. No species have been described from Africa, Australia, or Asia, but there is mention by Lefroy of the occurrence of an undetermined species in India. Judging from the material at hand, the members of this family are more abundant both in individuals and in species in Neotropical than in either the Palaearctic or Nearctic regions.

In most of the literature dealing with this group of insects the family designation "Heteroneuridae" has been used. Coquillett

in 1904 pointed out that while Fallen used the name *Heteroneura* in 1823 to designate this group, he had previously, in 1810, used the same name for a genus of the Platypezidae. Accordingly Coquillett proposed to replace *Heteroneura* Fallen, 1823, by the genus name *Clusiodes* and to call the family the Clusiodidae. In this course he has been followed by Johnson and by Malloch in their revisions of the United States forms of the family. Kertész, Frey, and Collin, in publications subsequent to Coquillett's change, still retain *Heteroneura* as referring to the present group, while Hendel, Frey, 1921, and Aldrich (in litt.) prefer to base the family name on the oldest validly included genus, *Clusia*. As the last course appears to us the most logical, the family designation Clusiidae is used in the present paper.

The family Clusiidae includes small flies, varying in length from 2 to about 6 millimeters. Most of the species measure about 3 or 4 millimeters. They vary in color from pale yellow to black. The thorax especially is often variegated with black and yellow pattern, as sometimes also are the abdomen and legs. The wings range in color from a yellowish hyaline to a smoky brown, and from a uniform color to a variegation with as many as three or four large spots. Characteristic of many species distributed among several genera is an apical clouding, especially pronounced along the end of the second vein. Normally the wings are fully rounded and somewhat more than twice as long as wide. The distribution of the crossveins varies greatly. In some of the genera the crossveins are approximated more than in other Acalypterates, hence this character has been commonly used as a family distinction. However, in other genera the crossveins are no closer together than usual. The antennae are always yellowish, the third joint more or less orbicular, with nearly apical arista. The second joint usually bears a conspicuous dorsal bristle. The arista ranges from pubescent to densely plumose. Most of the species have the arista openly short-plumose, but here and there a species is found where the plumosity is heavily bushy.

Great variation is common among the specimens from Central America. These variations, especially in color pattern, are very suggestive of the mutants in *Drosophila* which have arisen and have been perpetuated in the genetics laboratories. From their similarity it seems quite possible that they have arisen in the same way—by mutation. In warm damp climates the mutant flies have abundant opportunity to survive, and races that might die out in a more inhospitable environment continue their existence in the Tropics. This renders the problem of deciding on species limits extremely difficult if not quite impossible. Just where to draw the line between species, just how much variation to ascribe to mutation or to Men-

delian recombination within a single species, require the services of some future experimental geneticist; but in view of the great rarity of specimens in this family the conclusions advanced in the following pages are given as a taxonomist's solution. A "splitter," disregarding the evidence produced by breeders of *Drosophila*, would find opportunity in many cases, especially with the tropical forms, to erect a new species for almost every individual, and still not exceed species characters accepted in other groups.

Chaetotaxy is important in identifying the different genera. At first it would appear that the genera are based too closely upon permutations of a few bristle characters, and hence are purely artificial concepts. However, the degree of development of such bristles as the fronto-orbitals, cruciate frontals, ocellars, postverticals, prothoracic, dorsocentrals, preapical tibials, and bristles on the first vein, leads to the primary separation of species into groups that may be regarded as natural genera. Williston has doubted the appropriateness of some of these chaetotactic genera, and in his North American Diptera has questioned the validity of characters like the preapical or cruciate bristles. The removal of Williston's species *Heteroneura lumbalis* and *H. valida* from *Heteromeriingia* to *Sobarocephala* straightens out the seeming discrepancy and stabilizes all three genera.

The substance of the present review was presented by Mrs. Argo to satisfy the thesis requirement for the degree of master of science in zoology at the State College of Washington. With the inclusion of subsequent material the senior author has rewritten the paper and shares equally in the responsibility of its presentation. We express herewith due appreciation and gratitude to Dr. J. M. Aldrich for forwarding the unworked Clusiidae of the United States National Museum, to Dr. O. A. Johannsen for the loan of the Cornell material, including cotypes of some of Williston's species, and to R. C. Shannon, who had anticipated monographing this family but who kindly relinquished his aggregated material. It was Mr. Shannon's request that we carry on his project that served as the first stimulus for undertaking this review. To Maj. E. E. Austen we also record gratefulness for information regarding types in the British Museum.

The photographs for the plates were made by the senior author, using a Zeiss 1C Tessar lens of 12 cm. focus, stopped to f/25. With a 4-foot camera the initial magnification was almost ten times. The specimens were lighted by a 400-watt stereopticon bulb, and were given a 5-minute exposure on Orthonon plate. To bring out the neurulation and chaetotaxy they were given a supplementary silhouetting exposure of 20 seconds, using a substage microscope lamp placed directly behind the specimen. Even with the ortho-

chromatic plate the customary yellows, browns, and black are not well differentiated and due allowance for color values must be made in interpreting the figures.

This paper is a contribution from the Zoological Laboratory of the State College of Washington in Pullman.

KEY TO THE GENERA OF CLUSIIDAE.

1. Costa broken beyond humeral crossvein, auxiliary vein curving forward to end considerably before termination of first vein; postverticals strong and distant; arista but little longer than antenna; eyes microscopically pubescent; crossveins widely distant; no cruciate bristles or preapicals. *Acartophthalmus* Czerny.
Costa not broken near humeral crossvein, but weakened or broken near end of auxiliary vein which extends parallel with first vein even at tip; postverticals approximate, sometimes absent; arista two or more times the length of the antenna, short only in *Hendelia*; eyes bare.....2
2. All fronto-orbitals reclinate; prothoracic bristle vestigial or absent; cruciate bristles present on middle of front.....3
Foremost pair of fronto-orbital bristles convergent or proclinate.....6
3. Cruciate bristles arising from the orbits; three or four fronto-orbitals of equal length; preapicals present.....*Czernyola* Bezzi.
Cruciate bristles arising from middle frontal stripe.....4
4. Crossveins approximate, sections of fourth vein 1:4; preapicals present; presutural dorsocentrals present or absent.....5
Crossveins distant, sections of fourth vein 1:3; no preapicals, postverticals, or presutural dorsocentrals.....*Allometopon* Kertész.
5. Antennae distant, arista thick; postverticals absent; lunule covered; two fronto-orbitals.....*Hendelia* Czerny.
Antennae close together, arista thin; postverticals usually present; lunule exposed; two or three fronto-orbitals.....*Clusiodes* Coquillett.
6. Cruciate bristles present on middle frontal stripe; crossveins distant, the sections of fourth vein 1:3; ocellars long.....7
Cruciate bristles absent.....8
7. Postverticals absent; no prescutellar setae; prothoracic bristle strong.
Postverticals small; prescutellars present; prothoracic bristle short.
Clusia Haliday.
Paraclusia Czerny.
8. Postverticals absent; first vein bristly; ocellars small; crossveins approximate.
Postverticals present; first vein not bristly.....9
Chaetoclusia Coquillett.
9. Preapical bristles present on middle tibiae; crossveins usually distant, the anterior crossvein nearer middle of discal cell, the last two sections of fourth vein usually about 1:3.....10
Preapical and prescutellar bristles absent; crossveins approximate, the sections of the fourth vein about 2:1:4; ocellars small.....*Heteromeria* Czerny.
10. Ocellar bristles long; presutural dorsocentrals present.....11
Ocellars short; no presutural dorsocentrals.....*Sobarocephala* Czerny.
11. Prothoracic bristle strong.....12
Prothoracic bristle short; three fronto-orbitals.....*Apiochaeta* Czerny.
12. Arista lanceolate, densely pubescent; three fronto-orbitals; four scutellar bristles.
Arista slender; four fronto-orbitals; six scutellars.....*Phylloclusia* Hendel.
Alloclusia Hendel.

1. Genus *ACARTOPHTHALMUS* Czerny.

Acartophthalmus CZERNY, Wien. ent. Ztg., vol. 21, p. 256 (1902); vol. 22, p. 71 (1903).

Eyes provided with very fine scattered hairs; arista but little longer than antenna; postverticals strong and widely spaced; no cruciate frontal bristles, ocellars long, three fronto-orbitals, the foremost small and reclinate; prothoracic seta wanting, three post-sutural dorsocentrals, no prescutellars, four scutellars, the basal pair strong; no preapicals; crossveins widely distant.

Genotype.—*A. nigrinus* Zetterstedt. This is the only genus having pubescent eyes, but this character requires high magnification to be detected. It is unique further in having a short arista, distant postverticals and a humeral break in the costa. Two species are known.

KEY TO THE SPECIES OF *ACARTOPHTHALMUS*.

Body black, legs brown or black, the front coxae somewhat paler; wings hyaline. (Europe, N. Amer.).....*nigrinus* Zetterstedt.
Face, cheeks, anterior part of front, antennae, and mouthparts yellow; legs yellowish; wings infuscated anteriorly. (Europe.)*bicolor* Oldenberg.

1. *ACARTOPHTHALMUS NIGRINUS* Zetterstedt.

(Fig. 10.)

Anthophilina nigrina ZETTERSTEDT, Dipt. Scand., vol. 7, p. 2697 (1848).

Acartophthalmus nigrinus CZERNY, Wien. ent. Ztg., vol. 22, p. 71 (1903).—MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 3 (1918).

Entirely blackish, the front coxae and halteres alone yellowish. No distinct vibrissae, about six uniform buccal bristles present; arista weakly pubescent, scarcely exceeding the length of the antenna, the basal joint thickened. Basal scutellar bristles about half the length of the convergent apical pair. Hypopygium very small. Wings grayish hyaline, auxiliary vein distinctly separated from the first vein, costal ratio, 3.8:1.4:1, sections of fourth vein 1:1.5, of fifth vein 3:1. Length 2 mm.

Distribution.—Twenty-two specimens, collected by Melander, from Petersham, Massachusetts; Moscow Mountain and Waha, Idaho; Wawawai, Olga, Mount Constitution, Quilcene, Blewett, Vashon, and Tacoma, Washington. Compared with a specimen from Admont, Austria, received from Prof. G. Strobl. Recorded from Sweden, Germany, and Austria.

2. *ACARTOPHTHALMUS BICOLOR* Oldenberg.

Acartophthalmus bicolor OLDENBERG, Deut. ent. Zts., 1910, p. 284 (1910).

Lower part of head, antennae, anterior margin of front and legs yellowish; costal margin of wings infuscated; length 2 mm.

Habitat.—Germany. Type in collection of L. Oldenberg, Berlin.

2. Genus ALLOMETOPON Kertész.

Allometopon KERTÉSZ, Ann. Mus. Nat. Hung., vol. 4, p. 320 (1906).

Three reclinate orbitals, no postverticals, cruciate bristles very small, ocellars long; prothoracic bristle minute, three postsutural dorsocentrals, three supra-alars, four scutellars, no preapicals; arista thin; sections of fourth vein 1:3.

Genotype.—*A. fumipenne* Kertész.

3. ALLOMETOPON FUMIPENNE Kertész.

Allometopon fumipenne KERTÉSZ, Ann. Mus. Nat. Hung., vol. 4, p. 320 (1906).

Head and thorax mostly yellow, abdomen mostly blackish, third antennal joint brown above, notum with brown anterior margin and abbreviated vitta; legs yellow; wings smoky, the costal margin darker; 3 mm.

Habitat.—New Guinea. Type in Hungarian National Museum.

4. ALLOMETOPON FLAVUM Lamb.

Allometopon flavum LAMB, Trans. Linn. Soc., vol. 16, p. 311 (1914).

Described from Seychelles. The description is not available to us.

3. Genus APIOCHAETA Czerny.

Apiochaeta CZERNY, Wien. ent. Ztg., vol. 22, p. 98 (1903).

Three fronto-orbitals, the first converging, postverticals present, no cruciates, ocellars long; prothoracic short, a presutural dorsocentral present, basal scutellars smaller than the distal pair; arista apical; crossveins distant, sections of fourth vein 1:3, posterior crossvein oblique, forming an acute angle with fifth vein.

Genotype.—*A. bicolor* Schiner, the species figured by Hendel in Czerny's paper.

KEY TO THE SPECIES OF APIOCHAETA.

Abdomen with exception of base shining black; wings subhyaline; thorax bivittate. (Chile.) *bicolor* Schiner.
Abdomen black only at tip; costal margin and discal spots blackish; thorax quadrivittate. (Chile.) *limbipennis* Rondani.

5. APIOCHAETA BICOLOR Schiner.

Heterochroa bicolor SCHINER, Novara Dipt., p. 237 (1868).

Apiochaeta bicolor CZERNY, Wien. ent. Ztg., vol. 22, p. 98, pl. 2, figs 6, 7 (1903).

Front yellow, face and cheeks whitish; arista pubescent; thorax reddish, with two posterior black vittae; pleurae with black stripe below notopleural suture; abdomen black except at base; legs yellow; halteres white; wings with pale brownish tinge; 4.5 mm.

Habitat.—Chile.

6. APIOCHAETA LIMBIPENNIS Rondani.

Peratochaetus limbipennis RONDANI, Arch. di Canestrini, p. 43 (1863).

Apiochaeta limbipennis CZERNY, Wien. ent. Ztg., vol. 22, p. 99 (1903).

Yellowish, an ocellar spot black; arista nearly bare; notum with four vittae, the inside pair extending into sides of scutellum, the outside pair extending into pleurae to the metathorax; abdomen tipped with black; legs brownish; halteres luteous; wings yellowish hyaline, the front margin, apex broadly, posterior crossvein, base posteriorly and sixth vein bordered with blackish; 4 mm.

Habitat.—Chile.

4. Genus CHAETOCLUSIA Coquillett.

Chaetoclusia COQUILLET, Proc. Ent. Soc. Wash., vol. 6, p. 93 (1904).—MALLOCH

Proc. Ent. Soc. Wash., vol. 20, p. 5 (1918).

Three fronto-orbitals, the front pair convergent, no cruciate or postvertical bristles, ocellars small; no prothoracic, two dorsocentrals, no prescutellars; preapicals present; lunule covered; first vein setose.

Genotype.—*C. bakeri* Coquillett, the original species. The bristly first vein is the striking character of this genus.

KEY TO THE SPECIES OF CHAETOCLUSIA.

1. Arista densely plumose.....2
Arista finely pubescent or plumose; wings dark except at base.....3
2. Thorax wholly yellow; wings yellowish hyaline; front tibiae and tarsi brown; antennae yellow. (New Jersey).....*affinis* Johnson.
A horseshoe-shaped black mark around root of wing, notum bivittate; wings with central and apical vague clouds; posterior tibiae brownish basally; antennae with brown apex. (C. Amer.).....*bakeri* Coquillett.
3. Pleurae yellow; legs yellow; notum marked with black or brown stripes.....4
Sternopleura with jet black circular spot; legs apically brownish; antennae luteous; notum yellow, a small spot between wings and scutellum. (Hayti)
nigromaculata, new species.
4. Notum black on the sides from and including humeri to the posterior margin; antennae yellow. (W. Ind.).....*xanthops* Williston.
Notum quadrivittate; third antennal joint black or brown above.....5
5. Femora not setose beneath; markings of body black; first vein with about 12 setulae. (Costa Rica).....*quadrivittata*, new species.
Front and middle femora with comb of setae beneath; markings brown; first vein with about 6 setulae. (Costa Rica).....*longefilata*, new species.

7. CHAETOCLUSIA AFFINIS Johnson.

Chaetoclusia affinis JOHNSON, Psyche, vol. 20, p. 101 (1913).—MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 5 (1918).

Chusia flava JOHNSON, in part, New Jersey List (1899).

Male.—Head light yellow, palpi and antennae yellow, arista black, densely plumose, ocelli black. Thorax yellow, abdomen brownish, tip yellow. Legs yellow, anterior tibiae and tarsi brown. Halteres yellow. Wings yellowish hyaline. Length 2.5 mm.

Female.—Similar to male except that anterior tibiae and tarsi are black and the abdomen shining with an obscure dorsal line and black tip. Length 3 mm.

Habitat.—New Jersey. Types in collection of C. W. Johnson Boston. The two types are the only specimens recorded of this species. We have not seen it, and quote the original description.

8. *CHAETOCLUSIA BAKERI* Coquillett.

(Fig. 16.)

Chaetoclusia bakeri COQUILLET, Proc. Ent. Soc. Wash., vol. 6, p. 93 (1904).—MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 5 (1918).

Head and its members yellow, polished, the bushy plumose apical arista and ocellar dot black, a brownish spot on outer side of third antennal joint; thorax yellow, sides of mesonotum black, prolonged downward in front of and behind each wing, and inward at each end of the mesonotum, the two ends connected by a second black vitta extending along the dorsocentral rows; scutellum yellow, with brownish sides or wholly black; abdomen black, the extreme base and sometimes a pair of spots at bases of segments four to six, the genitalia and venter, yellow; legs yellow, basal half of middle or hind tibiae usually brownish, femora devoid of bristles, middle tibiae bearing a stout apical spur on the inner side and the preapical bristle on the outer side; wings largely hyaline, apex brownish, this color extending to the middle of last section of third vein, an indistinct brownish cloud covering the crossveins, last section of fourth vein about seven times as long as preceding section; halteres yellow, all hairs and bristles yellowish; length 4 mm.

Habitat.—Originally described from Nicaragua, type in National Museum. Five specimens before us, collected by Pablo Schild in Costa Rica.

CHAETOCLUSIA LONGEFILATA, new species.

(Fig. 12.)

General color testaceous, antennae and palpi flavous, ocellar spot brown, arista brownish, three times the antennal length, openly pubescent, bristles concolorous with body at their place of origin, buccal hairs all small. Thorax with light brown sides between dorsocentral rows and root of wing, each stripe paler along its middle, humeri, central stripe, and scutellum testaceous, metanotum brownish, pleurae, halteres and base and more or less of fifth segment of abdomen flavous, middle of abdomen and apex castaneous, hypopygium large, inflexed, the valves testaceous and remarkably long, acuminate, reaching to base of abdomen; no prescutellars. Wings and veins yellowish, the anterior half of the apical half infumated,

its veins brown, costal sections 6:1.3:1, third vein ending at wing-tip, sections of fourth vein 2:1:4. Legs entirely yellowish, front and middle femora with close-fitting double flexor combs of short setae, middle tibiae with preapical bristle. Length 3 mm.

Holotype.—Alhajuelo, Panama, 12 March, 1912, August Busck, Cat. No. 26260, U.S.N.M.

10. CHAETOCLUSIA QUADRIVITTATA, new species.

(Fig. 15.)

Female.—Front yellow, ocellar spot black, face and cheeks pale yellow; antennae and mouthparts yellow, the former dorsally piceous, arista slender, three and a half times the antennal length and delicately pubescent; head bristles long and brownish. Mesonotum testaceous with two blackish stripes on either side, extending from the neck, where they are joined, to the tip of the scutellum, where they are joined again; pleurae pale yellow except metapleurae which are brownish. Abdomen blackish except first and basal sides of fifth segments. Legs entirely yellow, apical spur of middle tibiae strong and black, no femoral comb of setae. Wings cloudy except on basal third, bristles of first vein distinct, costal ratio about 5:1:1, segments of fourth vein 1.5:1:3.5, of fifth vein 2.3:1. Length 3.5 mm.

Types.—Three females, La Suiza de Turrialba, Costa Rica, April-July (Pablo Schild). Type and one paratype in Melander collection, paratype in National Museum, Cat. No. 26261, U.S.N.M.

11. CHAETOCLUSIA NIGROMACULATA, new species.

Female.—Testaceous, the abdomen black except apex, a black spot between root of wing and scutellum, a large round black spot filling upper portion of sternopleura, metapleurae black anteriorly; antennae and mouthparts yellow, arista delicately plumose; bristles dark brown. Legs yellow, front and hind tibiae and tarsi brownish. Knobs of halteres whitish; wings brownish, paler at basal half, costal sections 5:1:1, sections of fourth vein 3:2:8, of fifth vein 1.4:1. Length 3.5 mm.

Holotype.—Hayti, in Melander collection.

12. CHAETOCLUSIA XANTHOPS Williston.

(Fig. 14.)

Heteroneura xanthops WILLISTON, in part, Trans. Ent. Soc. Lond., (1896), p. 386.—CZERNY, Wien. ent. Ztg., vol. 22, p. 100 (1903).

Head including antennae and mouthparts wholly yellow, arista loosely plumose, brown. Mesonotum black lateral to dorsocentral rows, centrally luteous, scutellum and metathorax yellow, pleurae

flavous. Abdomen black except at base, hypopygium black, the long lamellae yellow. Legs yellow; hind tibiae slightly brownish, apical and preapical spurs of middle tibiae strong, underside of fore femora fimbriate with setae. Wings lightly brownish, stronger on apical third, first vein strongly setose, sections of fourth vein 5:3:15, of fifth vein 5:3, fifth and anal veins not reaching margin. Length 3.5 mm.

Habitat.—St. Vincent, West Indies. Described from a cotype specimen in the possession of Cornell University. Doctor Williston suggested that this species was a composite of several forms. In addition to the present form which seems most typical, the species is here segregated into *Sobarocephala bistrigata* Kertész and *S. xanthomelana*, new species, which see.

5. Genus CLUSIA Haliday.

Clusia HALIDAY, Ann. Nat. Hist., vol. 2, p. 188 (1838).—SCHINER, Fauna Austr., vol. 2, p. 36 (1864).—CZERNY, Wien. ent. Ztg., vol. 22, p. 87 (1903).—MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 3 (1918).

Heteromyza in part, MEIGEN, Syst. Bes., vol. 6, p. 45 (1830).—WALKER, Ins. Brit., vol. 2, p. 163 (1853).

Macrochira ZETTERSTEDT, Ins. Lapp., p. 784 (1838); Dipt. Sc., vol. 7, p. 2681 (1848).

Peratochaetus in part, RONDANI, Dipt. Ital. Prodr., vol. 1, p. 119 (1856); Arch. di Canestrini, vol. 3, pt. 1, p. 42 (1863); Bull. Soc. ent. Ital., vol. 6, p. 250 (1874).

Stomphastica in part, LOEW, Berl. ent. Zts., vol. 8, p. 336 (1864).

Relatively large species, three fronto-orbitals, the foremost pair converging, cruciate bristles present, postverticals absent, ocellars long, prothoracic bristles strong, two posterior dorsocentrals, four or six scutellars all long, no prescutellars, a row of mesopleural setae present, preapical bristle of middle tibiae very small, crossveins distant, lunule covered.

Genotype.—*Clusia flava* Meigen (*Heteromyza*.)

KEY TO THE SPECIES OF CLUSIA.

1. Abdomen without conspicuous black lateral spots; face yellow; pleurae usually yellow.....2
- Abdomen with more or less conspicuous shining black lateral spots or stripes; face of male black, of female bimaculate; upper pleurae with black vitta.....3
2. Arista very finely short-pubescent; antennae yellow; palpi yellow; pleurae not vittate with brown. (Western N. Amer.).....occidentalis Malloch.
- Arista evidently pubescent; upper side of antennal third joint and apex of female palpi blackish; pleurae usually brown above. (Eur.).....flava Meigen.
3. Wings with two brown or blackish bands, one slightly beyond middle and the other at apex, connected along costa; male with bristles of anterior and posterior flexor surfaces of front femora subequal in length; sides of abdomen usually spotted instead of striped. (Eastern N. Amer.).....czernyi Johnson.
- Wings with only one brown band, the apical one; males with posterior flexor bristles of front femora much stronger than the anterior ones; sides of abdomen usually striped. (Eastern N. Amer.).....lateralis Walker.

13. *CLUSIA CZERNYI* Johnson.

(Fig. 3.)

Clusia czernyi JOHNSON, Psyche, vol. 20, p. 100 (1913).—MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 4 (1918).

Mostly yellow, face of male black, of female with curving subantennal stripes, antennae, palpi and lower orbits pale yellow, arista very finely pubescent; an entire horizontal black vitta beneath notopleural suture; bristles of head and thorax strong and black; abdomen black and centrally yellowish, or yellow and laterally blackish, hypopygium globular and black, valves small and luteous, ovipositor yellow; legs yellowish, flexor bristles of front and middle femora of male moderate, those of posterior row longer than those of anterior; basal half of wings subhyaline, apical half marked with a blackish cloud paler in middle part of first and most of second posterior cells, sections of fourth vein nearly 1:1:2, of fifth vein 3.5:1. Length 5 mm.

Distribution.—Types from Maine, in collection of Boston Society of Natural History. Recorded from New Hampshire, Vermont, Massachusetts, New York, and Pennsylvania. Specimens, all taken during May or June, are before us from Waubanic, Ont.; Ithaca, Labrador Lake and McLean, N. Y.; Plummer Island, Md.; Dead Run, Va.

14. *CLUSIA FLAVA* Meigen.

Heteromyza flava MEIGEN, Syst. Bes., vol. 6, p. 46 (1830).—WALKER, Ins. Brit. Dipt., vol. 2, p. 163 (1853).

Heteroneura spurca HALIDAY, Ent. Mag., vol. 1, p. 171 (1838).—LOEW, Wien. ent. Monatsch., vol. 1, p. 51 (1857).

Stomphastica flava LOEW, Zts. Entom. Bresl., p. 11 (1859); Berl. ent. Zts., vol. 7, p. 337 (1864).

Macrochira flava ZETTERSTEDT, Ins. Lapp., p. 784 (1838); Dipt. Sc., vol. 7, p. 2683, (1848).

Peratochaetus lutescens RONDANI, Bull. Soc. ent. Ital., vol. 6, p. 250 (1874).

Clusia flava HALIDAY, Ent. Mag., vol. 1, p. 171 (1838); Ann. Nat. Hist., vol. 2, p. 188 (1839).—BOIE, Stett. ent. Zts., vol. 8, p. 331 (1847).—SCHNER, Faun. Austr., vol. 2, p. 36 (1864).—BRAUER, Zweifl. Mus. Wien., p. 92 (1883).—MRK, Wien. ent. Ztg., vol. 5, p. 101 (1886).—CZERNY, Wien. ent. Ztg., vol. 22, p. 88 (1903).

Yellow, face, cheeks and mouthparts whitish, palpi of female apically dark, upper edge of third antennal joint blackish, arista evidently pubescent. Thorax testaceous, sometimes with brownish dorsocentral stripes, pleurae sometimes brown above. Abdomen usually yellow, sometimes a pair of spots on middle of segments two to five. Legs yellow, the somewhat broadened front tarsi of the female black. Wings light brownish, darker along costa, especially about end of second vein and apex, posterior crossvein clouded, sections of fourth vein 1:2.5, third and fourth veins parallel, be-

coming somewhat convergent and at apex somewhat divergent. Length 5-6.5 mm.

Distribution.—The species is distributed over entire Europe.

15. *CLUSIA LATERALIS* Walker.

(Fig. 1.)

Helomyza (?) *lateralis* WALKER, List Dipt., vol. 4, p. 1095 (1849).

Heteroneura spectabilis LOEW, Wien. ent. Monatsch., vol. 4, p. 82 (1860); Berl. ent. Zts., vol. 7, p. 207; Cent. 4, 92 (1863).

Clusia lateralis CZERNY, Wien. ent. Ztg., vol. 22, p. 89 (1903).—JOHNSON, Psyche, vol. 20, p. 101 (1913).—MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 4 (1918).

Front brownish yellow, ocellar spot black, face of male black, of female with subantennal black stripes, cheeks and mouthparts pale yellow, antennae reddish yellow, arista sparsely pubescent. Notum testaceous with a brownish lateral stripe beginning one-fourth the way back from the neck and reaching the scutellum, pleurae pale yellow, the upper part with a complete broad black stripe. Abdomen mostly yellow, the posterior sides of segments two to four with triangular blackish marks, hypopygium black. Legs yellowish, the basal half of the hind tibiae brownish, postero-flexor bristles of the fore femora much stronger than those of the anterior row. Wings yellowish hyaline with a brownish spot on apical third, a slight clouding over basal two-thirds of fifth vein, costal ratio 4.5:1.3:1, sections of fourth vein 1:1.2, of fifth vein 5.3:1; halteres yellowish. Length 5 to 7 mm.

Puparium.—Rufous, stigmal area less rugose than body and somewhat lighter in color, a central pair of divergent triangular stigmal processes, anus below stigmal area and surrounded by a black plate. Length 5 mm.

Distribution.—The species has been recorded previously from Maine, Vermont, Massachusetts, New Jersey, Pennsylvania, Ottawa, Canada, District of Columbia, and Illinois. The female type is in the British Museum of Natural History. Specimens before us have come from the following localities: White Mountains, N. H.; Greenfield, Mass.; Ithaca and Gloversville, N. Y.; Brookside, N. J.; Pittsburgh, and Allegheny, Pa.; Plummer Island and Camp Meade, Md.; Dead Run, Va.; and Black Mountain, N. C. Most of the specimens were collected in late June and July.

16. *CLUSIA OCCIDENTALIS* Malloch.

(Fig. 2.)

Clusia occidentalis MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 4 (1918).

Entirely yellowish, front, upper occiput and antennae luteous, face, cheeks and palpi whitish, arista very minutely pubescent, bristles strong. Thorax testaceous, coxae paler; abdomen in the

dried specimens usually dark testaceous, the globular hypopygium and small valves luteous. Legs yellowish, of the flexor setae of front and middle femora those of the posterior row are much longer than those of the anterior set. Wings grayish hyaline, basal half of costal margin yellow, apical half blackish, connecting with the blackish tip of the wing, posterior crossvein surrounded by a blackish cloud, sections of fourth vein proportioned 1:1:2, of fifth vein, 3:1. Length 5 to 7.5 mm.

Distribution.—Type from Washington, in collection of Natural History Survey, Illinois University; allotype from California, in Aldrich collection. Specimens have been reviewed by us from Vancouver Island, B. C.; Olympia, Ilwaco, Vashon, Monroe, Dewatto, Mount Rainier, Olga, Everett, and Lake Cushman, Washington; and Viento, Oreg.

6. Genus CLUSIODES Coquillett.

Clusiodes COQUILLET, Proc. Ent. Soc. Wash., vol. 6, p. 93 (1904).—HENDEL Wien. ent. Ztg., vol. 29, p. 309 (1910).—JOHNSON, Psyche, vol. 20, p. 97 (1913).—MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 5 (1918); Occ. Papers Bost. Soc. N. Hist., vol. 5, p. 47 (1922).

Heteroneura FALLEN (not 1810), Dipt. Suec. Agromyz., p. 2 (1823).—MEIGEN, Syst. Bes., vol. 6, p. 126 (1830).—MACQUART, Hist. Nat. Dipt., vol. 2, p. 587 (1835).—ZETTERSTEDT, Dipt. Sc., vol. 7, p. 2786 (1848).—SCHNER, Faun. Austr., vol. 2, p. 37 (1864).—CZERNY, Wien. ent. Ztg., vol. 22, p. 73 (1903).—WILLISTON, Trans. Ent. Soc. Lond., 1896, p. 386 (1896).

Agromyza in part, ZETTERSTEDT, Ins. Lapp., p. 790 (1838).

Clusiaria MALLOCH, Occ. Papers Boston Soc. N. Hist., vol. 5, p. 49 (1922).

Columbiella MALLOCH, Occ. Papers Boston Soc. N. Hist., vol. 5, p. 49 (1922).

Lunule exposed, two or three reclinate fronto-orbitals, cruciate bristles present, postverticals present in almost all the species, ocellars distinct; prothoracic bristle vestigial, dorsocentral formula 1-2 or 0-3, four or six scutellars; preapical present; crossveins approximate.

Genotype.—*Heteroneura albimana* Meigen.

KEY TO THE SPECIES OF CLUSIODES.

1. Three strong dorsocentral bristles present, the front pair presutural; at least front tarsi more or less black; wings with apical clouding. 2
Two strong dorsocentrals present, if a third pair is present it is small and post-sutural; usually the front tarsi and generally the entire legs yellow; hypopygium relatively robust. (Subgenus *Clusiaria* Malloch). 10
2. Postvertical bristles entirely wanting, or if present very small; normally but two fronto-orbitals. (Subgenus *Columbiella* Malloch). 3
Postvertical bristles present. (Subgenus *Clusiodes* Coquillett). 5
3. Thorax mainly rufous, subshining, bivittate with blackish; lamellae rounded, hairy but devoid of bunches of spines; basal two joints of male front tarsi black. (Eastern U. S.) (*johnsoni* Malloch). 4
Mesonotum and upper pleurae black; lamellae three times as long as greatest breadth, the apical portion less than one-fourth as wide as the basal part, hairs of lamellae long; front metatarsus of male black; palpi yellow. (Atlantic States) *apiculata* Malloch.

- Thorax of female not so extensively darkened as of male; lamellae much flattened, broad at base, then rapidly narrowing and again gradually broadening out to the rounded tip, where on the lower inner side they bear a cluster of black spines, their hind margin ciliate with long hairs. (England).....*verticalis* Collin.
4. Palpi usually entirely yellow; third joint of antennae usually yellow.
johnsoni Malloch, s. str.
Palpi and third joint of antennae largely or wholly black.
johnsoni, form *nigripalpis* Malloch.
5. Legs, including coxae, entirely piceous black; thorax and abdomen black, the humeri yellow; face, cheeks, antennae, and mouthparts yellowish. (N. Mex.)
nigra, new species.
- Legs, at least in part, pale, usually only the first or second joints of front tarsi black.....6
6. Normally three fronto-orbitals; hypopygium small, the valves short and rounded; vibrissae long and nearly straight, buccal hairs strong; thorax of female usually paler than of male. (Eur.; U. S.) (*albimana* Meigen).....7
Normally two fronto-orbitals; hypopygium larger; vibrissae shorter and incurved, buccal hairs fine; thorax of both sexes colored alike; antennae pale.....8
7. Face, cheeks, mouthparts, and antennae yellow; notum and pleurae reddish; legs largely yellow; average length 3.5 mm.....*albimana*, form *pallidior* Loew.
Face, mouthparts, third joint of antennae, notum largely, pleurae, and most of legs blackish; average length 4 mm.....*albimana*, form *obscurior* Loew.
8. Hypopygial lamellae about twice as long as greatest breadth, the recurved apical portion half as wide as the basal part, hairs of lamellae short; face and palpi yellow; notum blackish. (Scotland).....*caledonica* Collin.
Lamellae shorter, broader and more flattened at end and not recurved at tip....9
9. Palpi black, face yellowish, notum rufous, upper pleurae brown, posterior legs pale. (Eastern U. S.).....*americana* Malloch.
Palpi yellow, face somewhat darkened, thorax piceous, posterior legs extensively darkened. (England).....*gentilis* Collin.
10. Postverticals absent; cloud of wing commencing at end of first vein; thorax brownish yellow, with front margin, two vittae, scutellum and upper pleurae blackish; front tarsi and apices of front and hind tibiae infuscated. (Me.)
orbitalis Malloch.
Postverticals present.....11
11. Mesonotum reddish, sometimes vittate posteriorly; pleurae mostly or entirely yellow; legs entirely yellowish.....12
Mesonotum and pleurae mostly black, the sides of mesonotum narrowly yellow; legs partly dusky or dark.....15
12. Face of male black; one, two, or more pairs of strong porrect vibrissae; female with face pale and single normal vibrissa; mesonotum usually without dark stripes, uppermost pleurae vittate; hypopygium large, globose, the valves large, flat, trapezoidal, uncinately apically and glabrous. (N. Amer.) (*melanostoma* Loew).....13
Face of both sexes not black; only one vibrissa.....14
13. Vibrissa single; usually three fronto-orbitals.....*melanostoma* Loew, s. str.
Vibrissae of male plural; usually two fronto-orbitals.
melanostoma, form *duplicata* Malloch.
14. Face reddish; notum with four blackish stripes; pleurae not vittate; antennae brownish. (Eur.).....*nubila* Meigen.
Face pale yellow; notum with two dark stripes; upper pleurae vittate; antennae yellow, in female brownish at base of arista. (Eur.; Can.)...*ruficollis* Meigen.

15. Costal margin of wings more or less smoky from end of first vein; cheek bristles small; antennae reddish. (Eur.; U. S.).....*geomyzina* Fallen.
 Wings smoky on apical third and not along middle of costa.....16
16. Front tarsi entirely yellow, remainder of legs dusky.....17
 Front tarsi more or less black, tibiae and femora in part piceous or black.....18
17. Face of male black; bristles of male cheeks strong; antennae yellow; hypopygium large. (Eur.; U. S.).....*apicalis* Zetterstedt.
 Face of male white; buccal bristles and vibrissae moderate; antennae apically brown; hypopygium rather small. (N. H.).....*terminalis*, new species.
18. Mesonotum shining; head reddish.....19
 Mesonotum opaque-dusted; head almost wholly black (male); femora and tibiae black except extremities; antennae blackish. (Mass.; N. Y.)
atra, new species.
19. Femora mainly black; antennae tipped with brown; wings with only the apical third clouded. (Eur.; N. Mex.).....*pictipes* Zetterstedt.
 Femora yellowish; third antennal joint mostly or wholly blackish; a distinct cloud surrounding middle part of fifth vein (*nitida*, n. sp.).....20
20. Scutellum and mesonotum black, except for the usual pale lateral margin (N. Mex.).....*nitida*, new species, s. str.
 Scutellum and a large prescutellar spot yellowish. (Colo.)
nitida, var. *scutellata*, new variety.

17. CLUSIODES ALBIMANA Meigen.

(Fig. 7.)

Heteroneura albimana MEIGEN, Syst. Bes., vol. 6, p. 128 (1830).—MACQUART, Hist. Nat. Dipt., vol. 2, p. 588 (1835).—ZETTERSTEDT, Dipt. Sc., vol. 7, p. 2790 (1840); vol. 12, p. 4817, var. b. (1855).—LOEW, Wien. ent. Monats., vol. 1, p. 51 (1857); Berl. ent. Zts., vol. 8, p. 339 (1864).—SCHINER, Faun. Austr., vol. 2, p. 38 (1864).—PERRIS, Ann. Soc. ent. France, vol. 10, p. 344 (1870).—BRAUER, Zweifl. Mus. Wien, p. 92 (1883).—GIRSCHNER, Ent. Nachr., vol. 14, p. 98, figs. 5, 6 (1888).—BECKER, Zts. Hym. Dipt., vol. 2, p. 313 (1902).—CZERNY, Wien. ent. Ztg., vol. 22, p. 81, pl. 1, fig. 5 (1903).

Clusiodes albimana JOHNSON, Psyche, vol. 20, p. 98 (1913).—MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 6 (1918); Occ. Papers Bost. Soc. N. Hist., vol. 5, p. 47 (1922).

Agromyza geomyzina FALLÉN, Dipt. Suec. Agrom., p. 3, var. b. (1823).—ZETTERSTEDT, Ins. Lapp., p. 790, var. c. (1838).

Heteroneura pictipes SCHINER, Faun. Austr., vol. 2, p. 37 (1864).—HANDLIRSCH, Verh. Ges. Wien., vol. 34, pl. 5, fig. 12 (1884).

Form *pallidior* Loew. Front luteous, face, cheeks, mouthparts, and antennae yellow, upper occiput piceous, vibrissae relatively smaller. Notum testaceous, sometimes piceous between humeri, two narrow dark vittae just outside dorsocentral rows; abdomen black. Legs yellowish, front tibiae and front metatarsi brownish. Wings and other details as in darker form. Length 3.5–4 mm.

Form *obscurior* Loew. Front blackish brown, orbits yellow, face and palpi blackish; antennae yellow, last joint blackish, arista black and very minutely pubescent; one pair of very strong porrect oral vibrissae; usually three fronto-orbitals, the uppermost weak, bristles black. Notum blackish brown, shining between humeri, lateral margins yellow, pleurae shining piceous. Abdomen black, hypopy-

gium small, valves rounded, wider than long. Front coxae whitish, posterior ones yellow, extremities of femora yellow, tibiae brown, front ones darkest, front metatarsi blackish. Wings yellowish, apical third brownish, a slight clouding about posterior crossvein, second and third veins nearly parallel, third and fourth veins centrally divergent and apically slightly convergent; costal ratio 6:1.3:1, sections of fourth vein 2.5:1:6, of fifth vein 1:1; halteres whitish. Length 4 mm.

Distribution.—Europe and North America. Specimens of both extremes examined from Germany. There are no North American specimens before us like the form *obscurior*, but the paler form is represented from Potlatch and Everett, Wash., and Priest Lake, Idaho (Melander). The paler form is typical, and in Europe intergrades with the darker according to Czerny. The type of *albimana* is supposed to be destroyed.

18. *CLUSIODES AMERICANA* Malloch.

Clusiodes americana MALLOCH, Occ. Papers Bost. Soc. N. Hist., vol. 5, p. 48 (1922).

Male.—In the *albimana* group with three strong dorsocentrals. Head yellow, the upper occiput brown, antennae yellow, palpi brown, arista short, twice the antennal length, evidently pubescent, two fronto-orbitals, the cruciate bristles inserted in advance of the posterior pair, vibrissa small and curved, three fine buccal hairs, bristles of head and thorax brown. Thorax reddish yellow, darker along sides of notum and along upper half of pleurae. Abdomen black, hypopygium fairly large, the black valves as in Collin's figure of *gentilis*, about twice as long as wide, finely hairy, the blunt apical portion half the width of the base. Legs yellow, the front metatarsi alone black. Wings largely smoky, a central hyaline crossband, first posterior cell widest at middle, sections of costa about 3:1:0.5, of fourth vein 2:1:6, apical section of fifth vein a little shorter than the basal; halteres white. Length 3 mm.

Female.—Apex of antennae dusky; front tarsi brown.

Recorded from Maine, New Hampshire, Vermont, and Maryland. Specimens before us from Mount Washington, N. H. (Mrs. Slosson), labeled by Coquillett as *Heteroneura*, new species, Jeannette, Pa. (Henry Klages), and several from Dead Run, Va. (Shannon), collected with *C. johnsoni*. A large female taken by Shannon in May at Ithaca, N. Y., is darker, the sides of the thorax almost blackish above the lower pleurae, the dark part of the wings fuliginous and the posterior legs luteous beyond the base. It is quite possible that this species is only a mutation of *C. johnsoni*, as it differs merely in the presence of small postverticals. If this should prove to be the case the subgenus *Columbiella* becomes untenable, a conclusion reached by the writers before the appearance of Malloch's last paper.

19. CLUSIODES CALEDONICA Collin.

Heteroneura caledonica COLLIN, Ent. Mag., vol. 48, p. 106, fig. 1 (1912).

Resembling *albimana*, face, palpi and antennae yellow, a spot at base of arista, two fronto-orbitals, the anterior one-half the length of the posterior, cruciate bristles midway between the fronto-orbitals, vibrissa not spike-like. Thorax of both sexes dark, hypopygium large, lamellae twice as long as wide and recurved apically. Posterior legs yellowish.

Habitat.—Scotland.

20. CLUSIODES GENTILIS Collin.

Heteroneura gentilis COLLIN, Ent. Mag., vol. 48, p. 107, fig. 2 (1912).

Resembling *albimana*, face darkened, palpi and antennae yellow, a spot at base of arista, two fronto-orbitals, the cruciate bristles nearer the posterior fronto-orbitals, vibrissae not spike-like. Thorax of both sexes dark, hypopygium large, lamellae more than half as wide at tip as at base and not recurved. Posterior legs darkened. Wing cloud relatively restricted.

Habitat.—England.

21. CLUSIODES NIGRA, new species.

Male.—Front brownish, orbits paler, cheeks, mouthparts and antennae yellowish, the last brownish at the insertion of the black, microscopically pubescent arista; four rather long buccal setae, vibrissae broken, but judging from the socket not excessive, three fronto-orbitals, postverticals present, head bristles strong and black. Notum black, humeri and lateral margin whitish, pleurae entirely black, one strong presutural and two postsutural dorsocentrals. Abdomen black, hypopygium small, globose, lamellae rounded triangular. Legs piceous, front coxae whitish, posterior coxae fuscous, hind tarsi brown. Wings subhyaline, the apical third and the area about the two crossveins brownish, sections of the evanescent fifth vein 1.1:1; halteres yellow. Length 4 mm.

Holotype.—In National Museum collection, from Rio Ruidoso, White Mountains, New Mexico, altitude 6,500 feet, August, collected by C. H. T. Townsend, Cat. No. 26262, U.S.N.M.

22. CLUSIODES (CLUSIARIA) APICALIS Zetterstedt.

Heteroneura geomyzina, var. *apicalis* ZETTERSTEDT, Dipt. Sc., vol. 7, p. 2189 (1848).

Heteroneura geomyzina MEIGEN, Syst. Bes., vol. 6, p. 129, in part (1830).—LOEW, Wien. ent. Monats., vol. 1, p. 54 (1857); Berl. ent. Zts., vol. 8, p. 345 (1864).

Heteroneura apicalis CZERNY, Wien. ent. Ztg., vol. 22, p. 79, pl. 1, figs. 3, 6 (1903).

Front brownish, antennae yellow, brownish at insertion of the microscopically pubescent arista, orbits and posterior portions of the cheeks yellowish, face and anterior portions of cheeks forming a black triangle, mouthparts whitish, buccal hairs almost as stout as the

vibrissae, head bristles strong and black, three fronto-orbitals, post-verticals long. Notum blackish, with a whitish lateral stripe extending full length, pleurae piceous, two strong dorsocentrals, and a small adjacent anterior one. Abdomen blackish, hypopygium robust, valves large, quadrate, nearly glabrous, the middle of the apical edge with a strong finger-like process. Coxae white, legs uniformly yellowish. Wings grayish with apical third between costa and third veins infuscated, third and fourth veins centrally divergent and apically convergent, sections of costa 6 : 1.7 : 1, of fourth vein 1.4 : 1 : 4, of the evanescent fifth vein 1.2 : 1; halteres whitish. Length 3 mm.

Distribution.—A robust species, reported from Sweden to Germany. The specimens described above are from Moscow Mountain, Idaho, collected by Shannon and Melander. Malloch's record of the occurrence of this species in Illinois probably concerns *C. terminalis*.

23. *CLUSIODES (CLUSIARIA) ATRA*, new species.

(Fig. 9).

Male.—Front piceous except the yellowish orbits and anterior fourth, face, cheeks, and occiput blackish, facial orbits white; antennae blackish, arista one and one-half times the antennal length and microscopically pubescent; mouthparts yellow, vibrissa single, short and curved, buccal setae strong; three fronto-orbitals. Notum dull black, humeri and lateral margin white, pleurae shining black. Abdomen black, hypopygium semiglobose, valves very large, incised subapically and with round end. Legs blackish except at knees, posterior tarsi brownish. Wings grayish hyaline, with an infuscation on the apical third between the costa and the third vein, costal ratio 4.5 : 1.3 : 1, sections of fourth vein 1.2 : 1 : 4.3, of fifth vein 1.1 : 1, fifth vein scarcely attaining margin, second and third veins diverging; halteres whitish. Length 3.6 mm.

Type.—Greenfield, Mass., 1 June, 1914 (Melander). Paratype, Ithaca, N. Y., 3 May, 1903 (Cornell University).

24. *CLUSIODES (CLUSIARIA) GEOMYZINA* Fallén.

Heteroneura geomyzina FALLÉN, Dipt. Suec. Agromyz, p. 2, excl. var. *b* (1823).—MEIGEN, Syst. Bes., vol. 6, p. 129, male (1830).—ZETTERSTEDT, Dipt. Sc., vol. 7, p. 2788 (1848).—SCHNER, Faun. Austr., vol. 2, p. 38 (1864).—LOEW, Berl. ent. Zts., vol. 8, p. 345 (1864).—CZERNY, Wien. ent. Ztg., vol. 22, p. 77 (1903).

Agomyza geomyzina ZETTERSTEDT, Ins. Lapp., p. 790, var. *b* (1838).

Clusiodes geomyzina JOHNSON, Psyche, vol. 20, p. 97 (1913).—MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 6 (1918).

Clusiaria geomyzina MALLOCH, Occ. Papers Bost. Soc. Nat. Hist., vol. 5, p. 48 (1922).

Heteroneura alpina LOEW, Wien. ent. Monats., vol. 1, p. 53 (1857); Berl. ent. Zts., vol. 8, p. 344 (1864).—GIRSCHNER, Ent. Nachr., vol. 14, p. 98, figs. 7, 8 (1888).

Robust. Head blackish, the orbits, antennal region and posterior cheeks yellowish, mouthparts yellow, antennae blackish on apical

half, arista one and a half times the antennal length, microscopically pubescent, three fronto-orbitals, the cruciate bristles near the middle fronto-orbitals, postverticals present. Thorax black, the humeri and side margins of mesonotum yellow, two strong and one weak dorsocentrals, pleurae piceous. Abdomen black, hypopygium robust, valves large, flat, rhomboidal. Legs dull yellow. Halteres including stem whitish. Wings dusky along costa, about crossveins and in apical region excepting the hind margin, third and fourth veins slightly converging in the apical cloud, anterior crossvein a little beyond middle of discal cell, fifth vein reaching margin, its sections proportioned 6 : 5. Length 3.25 mm.

Distribution.—Sweden and Norway to Austria and Italy. Recorded by Johnson from Maine. The present specimens were collected by R. C. Shannon at Mount Lemon, South Catalina Mountains, Arizona at an altitude of 8,000 feet.

25. CLUSIODES (CLUSIARIA) MELANOSTOMA Loew.

(Fig. 4).

Heteroneura melanostoma LOEW, Berl. ent. Zts., vol. 8, p. 260; Cent. 5. 97 (1864).—CZERNY, Wien. ent. Ztg., vol. 22, p. 77 (1903).

Clusiodes melanostoma JOHNSON, Psyche, vol. 20, p. 98 (1913).—MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 5 (1918).

Clusiaria melanostoma MALLOCH, Occ. Papers Bost. Soc. Nat. Hist., vol. 5, p. 48 (1922).

Clusiaria duplicata MALLOCH, Occ. Papers Bost. Soc. Nat. Hist., vol. 5, p. 49 (1922).

Male.—Front testaceous, the ocellar spot black, antennae yellowish, dusky at apex, arista very lightly pubescent, one and one-half times the antennal length, face black, anterior half of cheeks black, posterior half, orbits and mouthparts whitish; one, two or more pairs of very strong vibrissae equal in length and projecting as far as length of head, three buccal bristles, three or two fronto-orbitals. Mesonotum rufous, the sides reddish brown. humeri, notopleural suture and upper pleurae deeper brown, lower pleurae yellow, metanotum more or less blackish. Abdomen blackish, hypopygium large, globose, valves prominent, distorted rhomboidal, the outer apical angle prolonged in a spoon-shaped process, the inner apical angle projecting in a strong thumb-like piece. Wings grayish, apical third between costa and fourth vein infuscated, a slight infuscation about posterior crossvein, sections of costa 5 : 1.5 : 1, of fourth vein 1.3 : 1 : 4.5, of fifth vein 1.3 : 1; halteres white.

Female.—Face yellowish, a single normal vibrissa.

Distribution.—Recorded localities include Maine, New Hampshire, Vermont, Massachusetts, New Jersey, Maryland and Canada. The type, from New York, is in Agassiz Museum of Harvard University. The specimens before us have come from Mount Washington, N. H.;

Ithaca and Labrador Lake, N. Y.; Plummer Island and Camp Meade, Md.; Dead Run, Va.; Algonquin, Ill.; and Pullman, Wash.

A male from Lake Waha, Idaho, differs in having a single normal vibrissa and three fronto-orbitals. The thumb-like process at the apex of the genital valves is stronger than in the Eastern specimens. It is left with this species pending the securing of additional material. Possibly the Pullman record above given belongs to this race, as it is based on a single female specimen.

The name *Heteroneura flavifacies* Coquillett, given in Smith's list of New Jersey insects, refers to the female of this species.

Recently Malloch has attempted to segregate from this as a distinct species under the name of *duplicata* those forms which lack the uppermost fronto-orbital and whose males possess two vibrissae. The extensive series of specimens before us show that these and the other characters mentioned by Malloch are variable and are not correlated. In a pair from Dead Run, Va., mounted together by Shannon, the male shows two fronto-orbitals, with three vibrissae on one side and two on the other, while the female has three fronto-orbitals. Another male has four stout vibrissae, others show two on one side and one on the other. Several specimens have three fronto-orbitals on one side and two on the other. An individual may have three fronto-orbitals and two vibrissae. The name *duplicata* therefore does not have even varietal rank.

26. *CLUSIODES* (*CLUSIARIA*) *NITIDA*, new species.

(Fig. 6.)

Female.—Front yellow, antennae yellowish, last joint black, arista almost bare, nearly twice as long as antenna, face and cheeks whitish, one vibrissa, three buccal setae, three fronto-orbitals, cruciate bristles midway between the middle and front orbitals, head bristles including postverticals strong and black. Thorax largely piceous and shining, a conspicuous white vitta covering humeri and extending to base of wing, one weak and two strong postsutural dorsocentrals. Abdomen entirely black. Legs fuscous, front tarsi black. Wings hyaline with two brownish spots, one on apical third between fourth vein and costa, and one about posterior crossvein, extending basally along fifth vein, third and fourth veins centrally divergent and apically convergent, sections of costa 4.5 : 1.3 : 1, of fourth vein 1.5 : 1 : 4.5, of the evanescent fifth vein 1.2 : 1; Halteres white. Length 4 mm.

Holotype.—Hill above Beulah, N. Mex., August 9, T. D. A. Cockerell collector, in National Museum, Cat. No. 26263, U.S.N.M.

Var. *scutellata*, new variety. A female from Boulder, Colo., also collected by Dr. T. D. A. Cockerell, is similar to the preceding, but the mesonotum has a large quadrate yellow spot at the base of the

yellow scutellum, sending three thin yellow stripes forward, one of which is median, the two others in the dorsocentral rows; pleurae reddish yellow, wings lacking the infuscation about the posterior crossvein.

Holotype.—In National Museum, Cat. No. 26264, U.S.N.M.

27. *CLUSIODES (CLUSIARIA) NUBILA* Meigen.

Heteroneura nubila MEIGEN, Syst. Bes., vol. 6, p. 127 (1830).—CZERNY, Wien. ent. Ztg., vol. 22, p. 76 (1903).

Differs from *ruficollis* Meigen (p. 22), in having the face ferruginous, antennae more or less brown, pleurae without the superior dark vitta, and notum quadrivittate. 3.5 to 4 mm.

Habitat.—Germany and Austria.

28. *CLUSIODES (CLUSIARIA) ORBITALIS* Malloch.

Columbiella orbitalis MALLOCH, Occ. Papers Bost. Soc. Nat. Hist., vol. 5, p. 50 (1922).

Head yellow, darker above, antennae and palpi yellow; three fronto-orbitals, no postverticals. Thorax brownish yellow, the front margin, two vittae, scutellum and upper pleurae blackish; two dorsocentrals. Abdomen black. Legs yellow, the front and hind tibiae at apex and the front tarsi infuscated. Cloud of wing extending from end of first vein to apex. 4 mm.

A single female is known, from Maine, now located in the Boston Society of Natural History.

29. *CLUSIODES (CLUSIARIA) PICTIPES* Zetterstedt.

Heteroneura pictipes ZETTERSTEDT, Dipt. Sc., vol. 12, p. 4816 (1855).—CZERNY, Wien ent. Ztg., vol. 22, p. 80 (1903).

Clusiodes pictipes JOHNSON, Psyche, vol. 20, p. 98 (1913).—MALLOCH, Proc. Ent. Soc. Wash., vol. 22, p. 7 (1918).

Clusiaria pictipes MALLOCH, Occ. Papers Bost. Soc. N. Hist., vol. 5, p. 48 (1922).

Front brownish, antennae luteous, the third joint brown, face and cheeks whitish, mouthparts brownish; one pair of moderate vibrissae and three buccal setae, three fronto-orbitals, postverticals present. Notum black, a conspicuous white vitta covering humeri and extending to base of wing, pleurae entirely black, one weak postsutural and two strong dorsocentrals. Abdomen entirely black. Legs piceous, the coxae, base of femora, knees, and posterior tarsi yellowish brown. Wings nearly hyaline, a brownish apical spot between costa and fourth vein, sections of costa 4.6 : 1.2 : 1, sections of fourth vein 1.4 : 1 : 3.5, of fifth vein 1.4 : 1; halteres white. Length 4 mm.

Distribution.—Sweden and United States. *C. pictipes* has not been recovered in Europe since Zetterstedt's time. Johnson's record of it in the New Jersey list refers to *Heteromeriugia nitida*. Mrs. Slosson has reported it on Coquillett's determination from New Hampshire.

A specimen from Clouderoft, N. Mex., was identified as *pictipes* on superficial comparison with specimens in the United States National Museum so determined by Coquillett. Johnson and Malloch are doubtful if Zetterstedt's species actually occurs in America, and the question can not be settled in the absence of typical European material. However, since Zetterstedt's description applies well to our form, there is nothing to be gained by bestowing a new specific name on the specimens from the United States. Malloch tabulates the species as having a light colored thorax.

30. CLUSIODES (CLUSIARIA) RUFICOLLIS Meigen.

Heteroneura ruficollis MEIGEN, Syst. Bes., vol. 6, p. 128 (1830).—ZETTERSTEDT, Dipt. Sc., vol. 7, p. 2789 (1848).—LOEW, Wien. ent. Monats., vol. 1, p. 52 (1857); Berl. ent. Zts., vol. 8, p. 343 (1864).—SCHINER, Faun. Austr., vol. 2, p. 38 (1864).—CZERNY, Wien. ent. Ztg., vol. 22, p. 75 (1903).
Clusiaria ruficollis MALLOCH, Occ. Papers Bost. Soc. N. Hist., vol. 5, p. 48 (1922).
Heteroneura laterella ZETTERSTEDT, Dipt. Sc., vol. 7, p. 2791 (1848).

Front yellow, ocellar spot black, face, cheeks, mouthparts and antennae pale yellowish, arista pale and finely pubescent, one vibrissa, three fronto-orbitals, postverticals strong. Notum testaceous, pale laterally, pleurae rufous above, one small and two large postsutural dorsocentrals. Abdomen black, hypopygium greatly swollen, the valves as in *melanostoma*. Legs yellowish except the brownish front tarsi. Wings nearly hyaline, a slight infumation on apical third between costa and third vein, sections of costa proportioned 5:1.2:1, of fourth vein 1.2:1:4.5, of fifth vein 1.3:1, third and fourth veins slightly convergent at tip; halteres whitish. Length 3 mm.

Distribution.—Northern and Central Europe. We have specimens from Waubamic, Ontario, collected by H. S. Parish, which agree with the diagnoses of the European species except that they lack the variable brown vittae just outside the dorsocentral rows. These have furnished the preceding description, but in the absence of European material for comparison may not be identically the same form. They may represent a pale faced mutation of our common *C. melanostoma*.

31. CLUSIODES (CLUSIARIA) TERMINALIS, new species.

(Fig. 8.)

Clusiodes apicalis MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 6 (1918).
Clusiaria apicalis MALLOCH, Occ. Papers Bost. Soc. N. Hist., vol. 5, p. 48 (1922).

Male.—Front dusky yellow, posterior half darker, antennae yellow, the third joint infuscated, arista yellow, microscopically pubescent, face, the broad cheeks and mouthparts whitish, vibrissa moderate, two strong buccal bristles three-fourths as long as the vibrissa, head bristles strong and black, three fronto-orbitals, postverticals present. Notum dull castaneous, humeri and lateral vitta

white, pleurae entirely shining castaneous; three postsutural dorso-centrals. Abdomen piceous, hypopygium moderately large, the lamellae elongate triangular with bluntly rounded tip and devoid of long hairs. Legs yellow. Wings nearly hyaline, a brownish spot on apical fourth between costa and fourth vein, third vein bent, sections of costa proportioned 4.5:1.5:1, of fourth vein 1.3:1:4, of fifth vein 1.1:1; halteres white. Length 3 mm.

Holotype.—White Mountains, New Hampshire, Morrison, in National Museum, Cat. No. 26265, U. S. N. M. Malloch's record of the occurrence of *C. apicalis* Zetterstedt in Illinois probably has reference to this species.

32. CLUSIODES (COLUMBIELLA) APICULATA Malloch.

Columbiella apiculata MALLOCH, Occ. Papers Bost. Soc. N. Hist., vol. 5, p. 49 (1922).

Male.—Front brown, orbits scarcely lighter, occiput piceous, face and cheeks yellowish, mouthparts pale yellow, antennae blackish except at base, the arista minutely pubescent; two fronto-orbitals, the cruciate bristles inserted at the level of the upper fronto-orbital, buccal hairs fine. Notum black, subshining, upper half of pleurae shining black, lower half pale yellow, pectus brown, three dorso-centrals. Abdomen black, hypopygium large, its valves unusually long and hairy, crossing beneath the abdomen. Legs yellow, front metatarsus black, hind femora and tibiae centrally brownish. Wings variegated hyaline and smoky, dark on apical two-fifths and along third and fifth veins near their respective crossveins, the hyaline middle area encroaches on the apical cloud along the middle of the submarginal and first posterior cells, sections of costa 6:2:1, of fourth vein 1:0.6:4, of fifth vein 1:1; halteres white. Length 3 mm.

This description is drawn from a specimen from the North Fork of the Swannanoa, Black Mountains, N. C., May (Banks) from the United States National Museum. Malloch records the species from New Hampshire and Vermont.

33. CLUSIODES (COLUMBIELLA) JOHNSONI Malloch.

(Fig. 5.)

Columbiella johnsoni MALLOCH, Occ. Papers Bost. Soc. N. Hist., vol. 5, 49 (1922).

Columbiella nigripalpis MALLOCH, Occ. Papers Bost. Soc. N. Hist., vol. 5, p. 49 (1922).

Male.—In the *albimana* group, with three dorsocentrals. Front piceous, the orbits yellow, face black, pollinose, facial orbits and gena pruinose, upper occiput blackish; base of antennae yellow, third joint almost wholly black, arista brown, twice the antennal length, minutely but closely pubescent; palpi black, proboscis yellow; two fronto-orbitals, the cruciate bristles between the posterior pair, no postverticals, vibrissa single, porrect and very strong, buccal hairs

strong. Mesonotum blackish, the sides yellow, pleurae and pectus piceous, a little paler about the posterior coxae; four scutellars, sides of metanotum yellowish. Abdomen entirely black except the claspers, hypopygium globose, valves rounded trapezoidal, hairy. Legs mostly yellow, a spot above front knees, the front tibiae and first two joints of front tarsi black, postero-flexor bristles of anterior femora strong. Halteres white; wings grayish hyaline, smoky on apical two-fifths except along hind margin, third and fifth veins clouded near their respective crossveins, sections of costa proportioned 7 : 2 : 1, of fourth vein 5 : 4 : 17, of fifth vein 6 : 5, first posterior cell widest just beyond middle. Length 3-4 mm.

Female.—Front, face, cheeks, mouthparts and antennae yellow, upper occiput and ocellar region piceous, antennae tipped with a dark spot; vibrissae less firm and more curved. Notum mostly rufous, a black stripe just external to dorsocentral rows, the two connected in front, extreme sides yellow, lower pleurae yellow, middle pleurae rufous, a subsutural black stripe. Abdomen black, the ovipositor yellow. Legs yellow, front tibiae and front metatarsus black.

Distribution.—Numerous specimens, all collected by R. C. Shannon, on Plummer Island, Md., Dead Run, Va., and Labrador Lake, N. Y., bearing dates from May 14 to September 19; also from Wau-bamic, Ont. (H. S. Parish), and Ottawa. Described by Malloch from Maine, New Hampshire, Vermont, Massachusetts, and Maryland.

The many specimens show much intergrading variation in color. The description of the male is based on the form described by Malloch as *nigripalpis*; that of the female is based on the form *johnsoni*. In one male a second pair of oral vibrissae is developed as is commonly the case in *melanostoma*.

34. CLUSIODES (COLUMBIELLA) VERTICALIS Collin.

Heteroneura verticalis COLLIN, Ent. Mag., vol. 48, p. 107 (1912).

Resembling *albimana*, normally two fronto-orbitals, post-verticals lacking. Thorax of female less extensively darkened than a male, hypopygial lamellae flattened, broad at base, then rapidly narrowing and again gradually broadening out to the rounded tip, where on the lower inner side they bear a cluster of black spines, the lower margin ciliate with long hairs.

Habitat.—England.

7. Genus CZERNYOLA Bezzi.

Czernyola BEZZI, Wien. ent. Ztg., vol. 26, p. 52 (1907).

Craspedochaeta CZERNY, Wien. ent. Ztg., vol. 22, p. 103 (1903).—KERTESZ, Ann. Mus. Nat. Hung., vol. 1, p. 569 (1903).

Lunule covered; three or four reclinate fronto-orbitals, cruciate bristles present and located on the orbits between the second and

third fronto-orbital bristles counting from in back, postverticals present, ocellars short, prothoracic vestigial, one or two postsutural dorsocentrals, apical scutellars divergent, preapicals present on all tibiae; crossveins approximate.

Genotype.—*C. transversa* Czerny. This genus is unique in the location of the cruciate bristles on the frontal orbits. Czerny originally described the genus under the name *Craspedochaeta*, but Bezzi called attention that this name had already been used by Macquart in 1851 for a genus of the Anthomyiidae.

KEY TO THE SPECIES OF CZERNYOLA.

1. Third and fourth veins convergent; four fronto-orbitals; wings infumated on apical half, weaker behind and stronger about crossveins; legs yellow; mesonotum and pleurae marked with black and yellow. (Peru).....*transversa* Czerny.
Third and fourth veins parallel.....2
2. Four fronto-orbitals; wings hyaline; notum black, pleurae yellow. (Costa Rica).....*claripennis*, new species.
Three fronto-orbitals; infumation of wings extending into basal half; pleurae black.....3
3. Darker portion of wings divided by a transverse paler band.....4
Wings not marked with central paler fascia.....5
4. Legs yellow, tarsi and middle of hind tibiae brown; head largely pale, male. (Peru).....*basalis* Czerny.
Front coxae, all of anterior femora, apical two-thirds of hind femora and the hind tibiae black, femora not fimbriate; head black, palpi piceous, antennae blackish at apex, female. (Costa Rica).....*fascipennis*, new species.
5. Wings brown, more intensive between costa and posterior crossvein; legs yellow, hind femora with brown preapical ring; face, mouthparts and antennae, yellow, occiput, thorax and abdomen black, male. (Formosa)....*biseta* Hendel.
Wings uniformly infumated except at paler base; legs yellow in male, or mostly black in female, underside of femora setose; face, antennae and palpi yellow, male, or largely dark, female. (Bolivia; Costa Rica).....*atra* Kertesz.

35. CZERNYOLA ATRA Kertesz.

(Fig. 11.)

Craspedochaeta atra KERTESZ, Ann. Mus. Hung., vol. 1, p. 570 (1903).

Male.—Front blackish, anterior portion reddish to yellow, face cheeks, mouthparts, and antennae pale yellow, arista evidently pubescent, three times antennal length; bristles yellow to brown, three fronto-orbitals, vibrissa long and slender, about five uniform buccal hairs. Thorax uniformly black and shining, bristles yellow to brown, two small dorsocentrals placed well back. Abdomen black, lamellae long. Legs, including coxae, pale yellow, the hind femora and tibiae somewhat infuscated at apices, under side of femora with long regular yellow bristles. Wings uniformly infumated except at paler base, sections of costa 4:1.4:1, of fourth vein 1:1.4, of fifth vein 1.2:1; halteres whitish. Length 2.5 mm.

Female.—Head, including mouthparts, black, antennae tipped with black, bristles black. Legs with front coxae, anterior femora,

apical two-thirds of hind femora and posterior tibiae black, femoral bristles shorter and black.

Distribution.—Originally described from Bolivia. Eleven males and fourteen females received from Pablo Schild, La Suiza de Turrialba, Costa Rica. Were it not that the dimorphism is constant according to sex it would be surmised that two species are here.

36. *CZERNYOLA BASALIS* Czerny.

Craspedochaeta basalis CZERNY, Wien. ent. Ztg., vol. 22, p. 104 (1903).—KERTESZ, Ann. Mus. Hung., vol. 1, p. 569 (1903).

Front black, yellow anteriorly, face and cheeks whitish, antennae and palpi yellow. Thorax and abdomen shining black. Legs yellow, tarsi and middle of hind tibiae brown. Wings dark on apical half and between end of first vein, anal cell and posterior crossvein, only the base and a median crossband hyaline, third and fourth veins parallel, sections of fourth vein 1:7. Length 2.5–3 mm.

Habitat.—Peru.

37. *CZERNYOLA BISETA* Hendel.

Czernyola biseta HENDEL, Suppl. Ent. Berlin, vol. 2, p. 80 (1913).

Male.—Front and occiput black, face, mouthparts, and antennae yellow, arista evidently pubescent. Thorax and abdomen black, bristles reddish. Coxae and legs pale yellow, hind tibiae with pre-apical brown ring. Wings brownish, more intensive on middle of costal half, third and fourth veins parallel. Length 25 mm.

Habitat.—Formosa.

38. *CZERNYOLA CLARIPENNIS*, new species.

Male.—Front rufous, piceous posteriorly, cheeks, mouthparts, and antennae whitish yellow, arista finely pubescent, three times the antennal length, vibrissa long and curved, two buccal setae half the length of the vibrissa, head bristles yellowish and strong, four fronto-orbitals. Notum blackish, pleurae pale yellow the metapleurae black, two dorsocentrals, the anterior one weak. Abdomen blackish except base and venter yellow, hypopygium elongate. Legs uniformly whitish yellow. Wings nearly hyaline, sections of costa 5.5:1.3:1, of fourth vein 1.6:1.4.5, of evanescent fifth vein 1.5:1, third and fourth veins nearly parallel; halteres whitish. Length 3 mm.

Holotype.—La Suiza de Turrialba, Costa Rica, Pablo Schild, collector, in Melander collection.

39. *CZERNYOLA FASCIPENNIS*, new species.

(Fig. 13.)

Female.—Front black, face and narrow cheeks cinereous black, antennae yellow, brownish at apex, arista finely but evidently pubescent, three times the antenna, one vibrissa, five uniform short buccal

hairs, three fronto-orbitals. Thorax shining black, two dorsocentrals. Abdomen blackish brown, except at base and ovipositor. Front coxae, anterior femora except knees, apical two-thirds of hind femora and hind tibiae black, femora not fimbriate. Wings infumated, base and a transverse band extending over the posterior crossvein hyaline, sections of costa 5 : 1.5 : 1, of fourth vein 2 : 1 : 4.5, of fifth vein 1.5 : 1; halteres white. Length 3 mm.

Holotype.—La Suiza de Turrialba, Costa Rica (Pablo Schild), Melander collection. This may prove to be the unknown female of *C. basalis*.

40. CZERNYOLA TRANSVERSA Czerny.

Craspedochaeta transversa CZERNÝ, Wien. ent. Ztg., vol. 22, p. 103 (1903).

Front reddish, darker above, face and cheeks whitish; antennae yellow, somewhat brownish apically, palpi yellow. Thorax reddish, with a median black stripe and a transverse stripe before the wings extending on pleurae to sternopleura, scutellum and metanotum black; bristles reddish, two dorsocentrals. Abdomen black. Legs reddish, coxae and base of femora paler. Wings brown on apical half and about crossveins, sections of fourth vein 1 : 7, third and fourth veins convergent. 3—3.5 mm.

Habitat.—Peru.

8. Genus HENDELIA Czerny.

Henelia CZERNÝ, Wien. ent. Ztg., vol. 22, p. 83 (1903).

Front broad, the antennae distant, cheeks deep, arista thickened and thickly plumose; lunule covered; two reclinate fronto-orbitals, cruciate bristles present but small, no postverticals, ocellars distinct, prothoracic vestigial, one presutural and two postsutural dorsocentrals, no prescutellars, six scutellars, preapicals absent; crossveins approximate.

Genotype.—*H. beckeri* Czerny.

41. HENDELIA BECKERI Czerny.

Henelia beckeri CZERNÝ, Wien. ent. Ztg., vol. 22, p. 84, pl. 2, figs. 1-3 (1903).

Male.—Front yellowish, face, cheeks and palpi whitish, vibrissa long and strong, vibrissal angle of face rectangular; antennae lengthened, third joint brownish above, the black arista but little longer than antenna. Thorax reddish with three piceous vittae, upper pleurae piceous. Abdomen blackish. Legs yellowish, front tarsi flattened and black. Wings with apical spot, crossveins clouded, third and fourth veins convergent.

Female.—Face marked with black, vibrissa smaller, palpi large, blackened.

Habitat.—Austria.

9. Genus **HETEROMERINGIA** Czerny.

Heteromeriugia CZERNY, Wien. ent. Ztg., vol. 22, p. 72 (1903).—KERTESZ, Ann. Mus. Nat. Hung., vol. 1, p. 567 (1903).—JOHNSON, Psyche, vol. 20, p. 98 (1913).—MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 7 (1918).

Lunule covered; three fronto-orbitals, the front pair convergent, no cruciates, postverticals present, ocellars distinct, no prothoracic, two posterior dorsocentrals, no prescutellars, apical scutellars convergent, no preapicals; crossveins approximate.

Genotype.—*H. nigrimana* Loew, the single original species.

The inclusion of Williston's West Indian species, *H. valida* and *lumbalis*, which have a preapical bristle on the middle tibiae, made this genus poorly defined. Moreover, these species have the neuration different from *Heteromeriugia*, the crossveins being more widely spaced. The removal of the disturbing species to *Sobarocephala* leaves the genus *Heteromeriugia* as clearly cut as the others of this family.

KEY TO THE SPECIES OF HETEROMERINGIA.

1. Wings with subbasal and apical clouding and central paler fascia; foremost buccal hair vibrissa-like; arista loosely pubescent or short-plumose.....2
Wings uniformly darkened or with apical cloud; one vibrissa; arista closely pubescent.....4
2. Legs wholly yellow, the middle tibiae sometimes with extremities brownish and front tarsi sometimes dusky. (West Indies, Fla.).....*flavipes* Williston.
Legs otherwise pictured.....3
3. Hind femora and tibiae tipped with dark ring; apical cloud entirely beyond end of fifth vein; lower pleurae yellow. (N. Car.).....*annulipes* Johnson.
Front tarsi and hind tibiae, and in female front tibiae also, black; apical cloud occupying nearly distal half of wing; pleurae wholly black; anterior half of male front opaque, pruinose when viewed from before. (Peru; C. Amer.)
czernyi K
4. Front legs except coxa and sometimes base of femur black.....5
Anterior femora and middle tibiae black, rest of legs yellow; wings dark except at base; head black. (Peru).....*nigrifrons* Kertesz.
5. Halteres blackish; posterior legs yellow, only their coxae dark at base; cheeks mostly yellow. (Eur.).....*nigrimana* Loew.
Halteres white; posterior legs variable, usually yellow in Eastern United States specimens, sometimes femora and sometimes tibiae more or less darkened; cheeks mostly black.....6
6. Wings with an apical cloud especially pronounced along costa; opaque anterior part of male front leaving a cordate smooth spot surrounding ocelli. (*nitida* Johnson).....7
Wings dark except costal portion of base; opacity of male front restricted to anterior portion; distal third (male) or less (female) of hind femora and the hind tibiae black. (Costa Rica).....*fumipennis*, new species.
7. Posterior legs nearly or wholly yellow; front black; male palpi yellow, female palpi black with yellow tip. (Eastern U. S.).....*nitida* Johnson, s. str.
Posterior femora and tibiae more or less blackened; male front reddish above antennae; palpi black except whitish tip. (U. S.)
nitida, form *nigripes*, new variety.

42. *HETEROMERINGIA ANNULIPES* Johnson.

Heteromeriugia annulipes JOHNSON, Psyche, vol. 20, p. 99 (1913).—MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 8 (1918).

"Face and cheeks white, lower part of the front and orbits yellow; upper part of the front, the vertex and occiput black, palpi and antennae yellow, apical half of the third joint and arista dark brown. Thorax, upper half of the pleura, scutellum, metanotum, and abdomen, shining black; lower half of the pleura, legs and halteres yellowish white; tip of the posterior femora and tibiae annulated with dark brown. Wings hyaline, apical third, and a small area at the anterior crossvein, and end of the discal cell, slightly clouded with smoky black. Length 3 mm."

Habitat.—The only record is the holotype specimen from Murfreesboro, N. Car. Type in collection of C. W. Johnson.

43. *HETEROMERINGIA CZERNYI* Kertész.

(Fig. 20.)

Heteromeriugia czernyi KERTESZ, Ann. Mus. Hung., vol. 1, p. 568 (1903).

Front and occiput, thorax and abdomen black, face, cheeks, antennae, and mouthparts yellowish, arista finely short-plumose, front buccal hair nearly as large as vibrissa; anterior half of male front opaque, appearing white pruinose when viewed from before, front of female shining black. Legs mostly yellowish, front tibiae and tarsi and hind tibiae black, middle tibiae brownish, anterior femora of male with rows of strong flexor setae, scarcely developed in female, front tibiae of male less saturate black than of female. Wings infumated, base and central fascia pale, third and fourth veins parallel, sections of fourth vein 2.5 : 1 : 6. Length 3–4.2 mm.

Distribution.—The species was originally described from Peru. We have fifteen males and twelve females from San Mateo, Costa Rica (P. Schild) and Cabima, Panama (A. Busek). The species is doubtfully distinct from *H. flavipes*, differing only in the darker legs and front.

44. *HETEROMERINGIA FLAVIPES* Williston.

(Fig. 18.)

Heteroneura flavipes WILLISTON, Trans. Ent. Soc. Lond., 1896, p. 387, pl. 13, fig. 135 (1896).—CZERNY, Wien. ent. Ztg., vol. 22, p. 101 (1903).—WILLISTON, Manual Dipt., p. 319 (1908).

Chusiodes flavipes MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 6 (1918).

Front brown, red below, the orbits more yellowish, face, cheeks, mouthparts, and antennae yellow, the third joint brownish, arista finely pubescent. Thorax and abdomen black. Legs light yellow, flexor setae of anterior femora of male strong. Wings brownish, the base and central fascia clear, third and fourth veins parallel, sections of fourth vein 2.3 : 1 : 5. Length 3 mm.

From a cotype specimen from St. Vincent in the collection of Cornell University. Johnson has recorded the occurrence of the species in Florida (Florida List). The National Museum has a specimen from Chinandega, Nicaragua, collected by C. F. Baker. After an examination of a cotype specimen Malloch located the species in *Clusiodes*, but Williston stated in his Manual that the cruciate bristles are lacking, as they are also in the present specimen.

45. *HETEROMERINGIA FUMIPENNIS*, new species.

(Fig. 19.)

Head black, face brown, proboscis and distal half of palpi, and antennae except apex yellow, arista closely pubescent, three times as long as antenna, the third antennal joint orbicular; cheeks one-sixth eye-height, buccal hairs uniform; bristles black. Thorax and abdomen black, notum sericeous, notal hairs brown, pleurae and humeri polished, abdominal hairs black. Legs yellow except the distal two-fifths of front and hind femora, all of front and hind tibiae and the front tarsi which parts are black, posterior coxae mostly piceous. Wings infumated except costal portion of base, veins blackish, the second vein proximally yellow, costal sections proportioned 5 : 1.6 : 1, fourth vein 2 : 1 : 6, fifth vein 1.3 : 1, third and fourth veins nearly parallel; halteres entirely white. Length 3.5 mm.

Habitat.—Costa Rica. Type male and six paratypes, Turrialba, collected by Pablo Schild, Melander collection. A paratype in possession of National Museum from same collector, Cat. No. 26266 U. S. N. M. A male in collection of American Entomological Society collected by P. P. Calvert at Juan Vinas.

46. *HETEROMERINGIA NIGRIFRONS* Kertész.

Heteromeriugia nigrifrons KERTESZ, Ann. Mus. Hung., vol. 1, p. 568 (1903).

Black, the orbits narrowly, antennae except apex, and tip of palpi yellowish; arista pubescent, buccal hairs short; legs reddish, femora and anterior tibiae largely black, the knees paler; wings infumated, the base yellowish, third and fourth veins parallel, sections of fourth vein 1 : 5; length 4.3 mm.

Habitat.—Peru.

47. *HETEROMERINGIA NIGRIMANA* Loew.

Heteroneura nigrimana LOEW, Berl. ent. Zts., vol. 8, p. 338 (1864).

Heteromeriugia nigrimana CZERNY, Wien. ent. Ztg., vol. 22, p. 73, pl. 3 figs. 1, 2; pl. 1, figs. 7, 8 (1903)

Black, face, cheeks, mouthparts, antennae except tip, and most of legs yellow; arista short-pubescent; front legs with distal half of femur, most of tibia and all of tarsus black; wings with apical cloud,

third and fourth veins somewhat convergent, sections of fourth vein 1 : 5; halteres blackish; length 3.5 mm.

Habitat.—Germany.

48. HETEROMERINGIA NITIDA Johnson.

Heteromeringia nitida JOHNSON, Psyche, vol. 20, p. 99 (1913).—MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 8 (1918).

Male.—Black, the face, sometimes front part of cheeks, antennae except tip, palpi, coxae, basal half of front femora, and posterior legs yellow, sometimes extremities of hind tibiae brownish, knob of halteres white. Front largely opaque: arista short-pubescent. Wings infumated, strongly so along distal half of costal area, tip and about crossveins. 3 mm.

Female.—Front not opaque; palpi black except yellow tip.

Distribution.—Originally described from New Jersey, where in the New Jersey List it had previously been enumerated as *Heteroneura pictipes*. Malloch records its occurrence in Illinois. The types are in the collection of C. W. Johnson. We have reviewed specimens from the National Museum from Dead Run, Va. (Shannon), Falls Church, Va. (Banks); Chesapeake Beach, Md. (Knab), Bladensburg, Md. (Shannon), Rock Run, Md. (Shannon), and Plummer Island, Md. (Barber).

Form *nigripes*, new variety (fig. 17). Middle and hind femora black except extremities; palpi of both sexes black except whitish tip; front of male reddish toward antennae.

William's, Ariz. (Barber), Mount Lemon, Ariz. (Shannon); Las Vegas, N. Mex. (Barber), Mathias Point, Va. (Shannon) and Westville, N. J., the last bearing Coquillett's identification label as *Heteroneura pictipes* Zetterstedt. The type, from Las Vegas, is Cat. No. 26296 U.S.N.M.

10. Genus PARACLUSIA Czerny.

Paracclusia CZERNY, Wien. ent. Ztg., vol. 22, p. 90 (1903).

Foremost fronto-orbitals convergent, cruciates present, postverticals small, ocellars developed, prothoracic present, two post-sutural dorsocentrals, prescutellars present, apical scutellars diverging, preapical very small, front coxae with one interior and three exterior bristles; crossveins distant.

Genotype.—The following and only species.

49. PARACLUSIA TIGRINA Fallén.

Helomyza tigrina FALLÉN, Heteromyz., p. 4 (1820).

Heteromyza trigrina ZETTERSTEDT, Dipt. Sc., vol. 6, p. 2466 (1847).

Clusia tigrina MIK, Ent. Nachr., vol. 23, p. 133 (1897).

Paracclusia tigrina CZERNY, Wien. ent. Ztg., vol. 22, p. 90 (1903).

Heteroneura decora LOEW, Wien. ent. Monats., vol. 7, p. 39 (1863); Berl. ent. Ztg., vol. 8, p. 337 (1864).

Stomphastica decora VERRAL, Ent. Monthly Mag., vol. 30, p. 144 (1894).

Clusia decora MIK, Ent. Nachr., vol. 23, p. 133 (1897) Wien. ent. Ztg., vol. 7, p. 167 (1898)

Clusia miki HANDLIRSCH, Verh. z. b. Ges. Wien, vol. 34, p. 137, pl. 5, fig. 9 (1884).

Pholeogeton setiger SCHINER, in litt., see CZERNY, Wien. ent. Ztg., vol. 22 p. 91 (1903).

Front yellowish, opaque, face, cheeks and palpi pale yellow, antennae testaceous, brown at base of the pubescent arista, vibrissa strong, anterior two or three buccal hairs stronger than the others. Body testaceous, sometimes brownish marks on notum, pleurae and abdomen. Legs yellow. Wings with brownish clouds below end of first vein, about posterior crossvein and at apex, third and fourth veins diverging, sections of fourth vein 1 : 1.3. 6-7.5 mm.

Distribution.—Europe, Sweden to Southern Austria.

11. Genus ALLOCLUSIA Hendel.

Alloclusia HENDEL, Deut. ent. Zts., 1917, p. 36 (1917).

Heterochroa SCHINER, preoc., Novara Dipt., p. 236 (1868).

Peratochaetus RONDANI, not 1856, which is *Clusia* Haliday; Arch. di Canestrini, p. 43 (1863); Bull. Ent. Soc. Ital., vol. 6, p. 8 (1874).—CZERNY, Wien. ent. Ztg., vol. 22, p. 92 (1903).

Four fronto-orbitals, the foremost convergent, no cruciates, ocellars and postverticals long, prothoracic well developed, one presutural and two postsutural dorsocentrals, four supra-alars, prescutellars long, a row of mesopleural bristles, the upper two longest, preapicals present; hypopygium robust; crossveins distant.

Genotype.—*Peratochaetus philippii* Rondani.

KEY TO THE SPECIES OF ALLOCLUSIA.

Posterior crossvein surrounded by a brown spot, three rounded hyaline spots in apical half and another large clear spot around anterior crossvein. (Chile)

philippii Rondani.

Whitish spots around both crossveins and several invading the cells. (Chile)

pictipennis Wulp.

50. ALLOCLUSIA PHILIPPII Rondani.

Peratochaetus philippii RONDANI, Arch. di Canestrini, p. 43 (1863).—CZERNY, Wien. ent. Ztg., vol. 22, p. 94, pl. 2, figs. 3, 5 (1903).

Heterochroa picta SCHINER, Novara Dipt., p. 236 (1868).—WULP, Notes Leyden Mus., vol. 4, p. 91, pl. 2, figs. 14, 15 (1882).—HANDLIRSCH, Verh. z. b. Ges. Wien, vol. 34, p. 141, pl. 5, fig. 11 (1885).

Testaceous, front with median brown line, face, cheeks, mouth-parts and antennae yellow, arista apical pubescent, buccal hairs small. Notum with two or three brown vittae, the lateral ones reaching sides of scutellum, metathorax brown, pleurae brown vittate above and on upper sternopleura. Abdominal segments marked with brown fasciae, hypopygium yellow with brown tip. Legs yellow. Wings infumated more intensely along costa, at end of third vein and along fourth vein, and with two hyaline fasciae and apical

spot, the proximal fascia between end of first vein and anterior crossvein, the distal one consisting of three spots. 6 mm.

Habitat.—Chile.

51. *ALLOCLUSIA PICTIPENNIS* Wulp.

Heterochroa pictipennis WULP, Notes Leyden Mus., vol. 4, p. 91, pl. 2, fig. 16 (1882).

Peratochaetus pictipennis CZERNY, Wien. ent. Ztg., vol. 22, p. 96 (1903).

Ochraceous, front with median brown line, mesonotum bivittate, the stripes continuing on sides of scutellum, pleurae with upper and sternopleural vittae, abdominal segments in part brown, femora with preapical brown ring. Wings with brown and hyaline markings the clear spots located about both crossveins, in center of submarginal and first posterior cells, in second posterior cell, and a double spot at tip. 5 mm.

Habitat.—Chile.

12. Genus *PHYLLOCLUSIA* Hendel.

Phylloclusia HENDEL, Suppl. Ent. Berl., vol. 2, p. 78 (1913).

Three fronto-orbitals, the foremost proclinate, no cruciates, postverticals and ocellars long, prothoracic strong, three postsutural dorsocentrals, the front one small, prescutellars absent, one presutural, four scutellars, preapical absent; arista compressed; crossveins distant.

Genotype.—The original single species, *P. steleocera* Hendel.

52. *PHYLLOCLUSIA STELEOCERA* Hendel.

Phylloclusia steleocera HENDEL, Suppl. Ent. Berl., vol. 2, p. 78 (1913).

Reddish species with red bristles, thorax with several blackish lines, abdomen with several spots, legs reddish, wings brownish especially along costa; cheeks very narrow, one vibrissa. 6 mm.

Habitat.—Formosa. Types in the German Entomological Museum.

13. Genus *SOBAROCEPHALA* Czerny.

Sobarocephala CZERNY, Wien. ent. Ztg., vol. 22, p. 85 (1903).

Meriza KERTESZ, Ann. Mus. Hung., vol. 1, p. 571 (1903).

Monorrhax KERTESZ, Ann. Mus. Hung., vol. 1, p. 572 (1903).

Lunule covered; three fronto-orbitals, the foremost pair convergent, cruciates absent, postverticals present, ocellars short, prothoracic vestigial, two posterior dorsocentrals, a pair of small prescutellar setae usually developed, apical scutellars convergent, usually two small lateral scutellars, preapical well developed on middle tibiae; crossveins relatively distant, the sections of the fourth vein usually ranging between 1:3.5 and 1:2.

Genotype.—*S. rübsaameni* Czerny. Erroneously this species was described as lacking preapical bristles on the middle tibiae. Thus

mislead, Kertész erected the genera *Meriza* and *Monorrhhexa* for those species possessing preapicals. *Monorrhhexa* was proposed for a species lacking prescutellars and having but four scutellars, and *Meriza* for the species having prescutellar setae and six scutellars. These characters are too inconstant to have generic value. *Sobarocephala* is apparently the dominant neotropical genus.

KEY TO THE SPECIES OF SOBAROCEPHALA.¹

1. Wings with a large dark isolated spot around anterior crossvein. 2
Wings with apical spot or extended clouding or uniformly subhyaline, but with no special mark around anterior crossvein. 3
2. Front less than one-third width of head; thorax with large posthumeral and supraalar spots, scutellum black; wings with broad apical cloud, the cloud over the anterior crossvein connected with the cloud over the posterior crossvein. (Brazil). *finnilaei* Frey.
Front one-third the width of the head; thorax with black supraalar and usually without posthumeral spots, scutellum largely or wholly yellow; wings with apical cloudings at ends of veins, the clouds over the crossveins disconnected. (Peru; C. Amer.) *rübsaameni* Czerny.
3. Arista densely bushy plumose; apex of wing and posterior crossvein blackish . . . 4
Arista loosely plumose or pubescent, at most bushy on basal half; apical infumation of wing extended or absent; posterior crossvein not markedly clouded; male lamellae usually rounded; thorax scarcely spotted or the spots large . . . 5
4. Notum and pleurae marked with several black streaks; hind femora centrally and middle femora at extremities black, tarsi pale; a distinct cloud over posterior crossvein; lamellae long and ham-shaped. (Costa Rica).
variegata, new species.
Mesonotum marked with six spots, pleurae luteous; femora yellow, front tarsi black; cloud over posterior crossvein weak; lamellae minute. (Panama.)
plumata, new species.
Mesonotum marked with broad black stripe tapering in front and extending laterally as curved brown band, abdomen with central vitta; femora yellow, tibiae and tarsi brownish. (Surinam). *pictipennis* Kertész.
5. Front decidedly narrowed above due to the bulging in of the eyes 6
Sides of front nearly parallel; humeri not contrastingly white; arista plumose . . . 7
6. Entirely yellowish, including bristles and legs; arista openly plumose. (Eastern U. S.). *convergens* Malloch.
Thorax mottled, humeri contrastingly white; tibiae darker than remainder of legs; arista pubescent. (Costa Rica). *humeralis*, new species.
7. Mesonotum entirely black 8
Mesonotum more or less yellowish 10
8. Pleurae concolorous with notum; sections of fourth vein 1:6. (W. Ind.)
concinna Williston.
Pleurae light yellow. 9
9. A brownish spot reaching down on pleura before wings; front yellow; sections of fourth vein 1:6. (W. Ind.) *pleuralis* Williston.
Pleurae entirely yellow; front largely black; sections of fourth vein 1:3. (Costa Rica). *nigronotum*, new species.
10. Mesonotum with blackish marks 11
Mesonotum yellow, at most blackish in the scutellar region². 21
11. All femora centrally more or less blackish; meso- and metapleurae largely black. 12
Femora not annulate; pleurae entirely yellow, at most the metapleurae black. . 13

¹ *S. flavisetata* is not included, see couplet 10.² *Cf. flavisetata* Johnson if head bristles yellowish.

12. Tibiae, tarsi, scutellum and face yellow; wings bifasciate. (Panama)
fascipennis, new species.
 Tibiae, front tarsi, scutellum and face black; outer two-thirds of wings dark.
 (Costa Rica)..... *annulata*, new species.
13. Lateral black marks of mesonotum extending over the humeri.....14
 Humeri yellow like the central anterior portion of the notum; hypopygium yellow.
 low.....17
14. Posterior half of mesonotum and the scutellum black, abdomen black; tibiae dark;
 prescutellars absent; wings infumated except at base.....15
 Middle vitta of notum, metapleurae, scutellum and abdomen including hypopygium black;
 legs wholly yellow; prescutellars absent; wings uniformly yellowish; base of arista
 densely plumose (Costa Rica)..... *plumatella*, new species.
 Mesonotum and scutellum yellow except for lateral stripes, abdomen mostly yellowish;
 tibiae yellow; prescutellar setae present; wings darkened along costa and tip.
 (Eastern U. S.) (if lateral stripe is bisected and marginal cell not dark see *bivittata*.).....
latifrons Loew.
15. Notum with black center stripe; second vein distinctly diverging from third
 near tip.....16
 Notum uniformly black except for a central round yellow spot toward the front;
 second vein slightly diverging from third. (Costa Rica)
xanthomelana, new species.
16. Wings broad, twice as long as wide, costa strongly arched opposite posterior cross-
 vein and spinulose, the second vein abbreviated, costal sections 2.5:2:1, sections
 of fourth vein 1:2. (Costa Rica)..... *latipennis*, new species.
 Wings normal, more than twice as long as wide, second vein not shortened, the
 costal sections 4.5:1.5:1, sections of fourth vein 1:2.5. (Costa Rica)
liturata, new species.
17. Posterior portion of mesonotum black, apparently marked with three fused vittae
 which disappear in front, scutellum and metathorax black; only front tarsi
 brown. (Peru; Costa Rica) (if notum has broad black stripe tapering anteriorly
 and extending laterally as bowed brown band, see *pictipennis* Kertész.)
dorsata Czerny.
 Mesonotum bivittate.....18
18. Wings with apical clouding; front tibiae and tarsi more or less brown; prescutellars
 present.....19
 Wings uniformly hyaline; legs yellow; no prescutellars; scutellum brown.....20
19. Lateral mark of thorax obliquely interrupted by the suture, the anterior spot
 adjacent to the margin (sometimes absent), the posterior located between the
 supra-alar and dorsocentral bristles; scutellum laterally or wholly black. (Costa
 Rica)..... *bivittata*, new species.
 Lateral mark of thorax not extending in front of suture; scutellum black or yellow
bistrigata Kertész.
20. Yellow of sides of mesonotum extending behind suture. (West Ind.; C.
 Amer.)..... *lumbalis* Williston.
 Lateral black marks of mesonotum extending in front of suture. (West Ind.)
valida Williston.
21. Femora devoid of flexor combs of setae; a faint cloud at end of second vein; front
 tarsi alone somewhat dusky; body entirely yellow. (U. S.)..... *flava*, new species.
 Underside of anterior femora furnished with a row of black or sometimes pale
 setae.....22
22. Mesosternum with long hairs; abdomen bristly with hairs; hypopygium longer
 than depth of abdomen; cheeks silvery pruinose when viewed from above.....23
 Mesosternum short-hairy but not setose; abdomen not markedly bristly; hypopygium
 small.....24

23. Valves of hypopygium very large, scoop-shaped, extending forward under abdomen. (Costa Rica).....hypopygialis, new species.
Hypopygial valves hidden, circular. (Va.).....lachnosternum, new species.
24. Middle femora with two rows of outstanding flexor bristles. (Md.)
setipes, new species.
Anterior row of flexor setae undeveloped. 25
25. Mesonotum paler in middle than on the brownish sides; wings nearly hyaline. (West Ind. ; Panama).....lumbalis Williston.
Mesonotum ferruginous, at most the scutellar region darker; wings with vague apical clouding. (S. and C. Amer.).....ferruginea Czerny.

53. SOBAROCEPHALA ANNULATA, new species.

(Fig. 34.)

Male.—Front pale yellowish, ocellar dot shining black, face and cheeks whitish, the bucca rimmed with black; mouthparts and antennae yellowish white, the finely plumose subapical arista black; all bristles on head blackish and longer than usual, buccal hairs all small. Thorax shining, variegated yellow and black, mesonotum with a broad shining central spot extending back to meet the black scutellum, metanotum brownish with a large black spot on either metapleura, mesopleurae largely black; posterior dorsocentral strong, two pairs of basal scutellar setae, notal hairs black. Abdomen black except at extreme base, hypopygium small. Legs yellowish with black bristles, the femora with central black annulus, posterior flexor bristles of front femora strong. Wings twice as long as wide, smoky on outer half, costa vanishing at third vein, costal ratio 3.5 : 1.6 : 1, sections of fourth vein 1 : 1 : 2, of fifth vein 3 : 1, second vein strongly diverging from third; calypteres pale with black edge and fringe; halteres whitish. Length 3.5 mm.

Female.—Head luteous, a medial vitta sometimes extending along front and face, antennae deep yellow. Abdomen with last segment and ovipositor whitish. All tibiae and front tarsi blackish. Length 4.5 mm.

Types.—Seven males and five females, Turrialba, Costa Rica (Schild) in Melander collection. A female from the National Museum, Cat. No. 26267, U.S.N.M., collected by August Busck at Porto Bello, Panama, is considerably darker; the front and face are smudgy, the black spot of notum connects with the prealar pleural spot, and the femora are largely blackened.

54. SOBAROCEPHALA BISTRIGATA Kertész.

(Fig. 33.)

Sobarocephala bistrigata KERTÉSZ, Ann. Mus. Hung., vol. 1, p. 572 (1903).

Heteroneura xanthops WILLISTON, in part, Trans. Ent. Soc. Lond., 1896, p. 386 (1896).—CZERNY, in part, Wien. ent. Ztg., vol. 22, p. 100 (1903)

Ochraceous, posterior sides of notum black, scutellum, metapleurae and abdomen except base and apex black; legs yellow, the front

tibiae and tarsi and hind tibiae brown; arista closely plumose; wings infumated on apical third and above fifth vein, sections of fourth vein 1 : 3.5; length 3.2–4.3 mm.

Distribution.—Originally described from Peru. Specimens from Costa Rica, Jamaica, and St. Vincent, the last a cotype of *Heteroneura xanthops* Williston, have the scutellum and metathorax yellow, the antennae not brown at tip, the arista rather openly plumose, and the hind tibiae less evidently brown. There is some variation in size of hypopygium, the St. Vincent specimen having the hypopygium very robust.

55. SOBAROCEPHALA BIVITTATA, new species.

(Fig. 36.)

Front, face, antennae and mouthparts yellow, ocellar dot black, cheeks whitish, arista black and distinctly feathery, bristles of front brown, buccal hairs all small. The shining yellow mesonotum bivittate with black, each vitta obliquely interrupted behind the suture, the anterior spot reaching along notopleural suture from humeri to base of wing, the posterior stripe beginning near middle of notum and extending exteriorly to dorsocentral rows to include sides of the yellow scutellum; pleurae pale yellow, metanotum brownish, metapleurae brown; notal hairs and bristles black, two lateral scutellar setulae. Dorsum of abdomen with a large central oval black spot widest on fourth segment; hypopygium yellow, of medium size. Legs yellow, with blackish hairs; front tarsi dusky, flexor setae of posterior row of front femora nearly as long as femur-width and black. Wings slightly cloudy on apical third, sections of costa 4.3 : 1.2 : 1, of fourth vein 1.2 : 1 : 3.8, of fifth vein 1.6 : 1; halteres whitish. Length 3.5–4 mm.

Types.—Seven specimens, Turrialba, Costa Rica, July (Pablo Schild) in Melander collection, and four in National Museum, Cat. No. 26268, U. S. N. M. The species is variable in extent of color, the scutellum may be black or entirely yellow, the anterior thoracic spot may encroach on the humeri or be almost obliterated, the metathorax may be wholly yellow. *S. bistrigata* and this species may ultimately prove to be geographic races of one widely distributed variable neotropical species.

56. SOBAROCEPHALA CONCINNA Williston.

Heteroneura concinna WILLISTON, Trans. Ent. Soc. Lond., 1896, p. 387 (1896).—
CZERNY, Wien. ent. Ztg., vol. 22, p. 101 (1903).

“Very much like *H. flavipes*, from which it differs in the antennae being wholly light yellow, in the wings being nearly uniformly blackish, except the immediate base, and especially in the presence of distinct preapical bristles on the middle and hind tibiae. It is also a little smaller.” (Williston.)

Habitat.—St. Vincent. Major E. E. Austen has furnished the following information regarding the male type in the British Museum: Cruciate bristles absent, postverticals present, middle tibiae with preapical, first vein bare, sections of fourth vein about 1.6 : 1 : 5.5. The species thus finds its best location in *Sobarocephala*.

57. SOBAROCEPHALA CONVERGENS Malloch.

(Fig. 31.)

Heteromeriugia convergens MALLOCH, Occ. Papers Bost. Soc. N. Hist., vol. 5, p. 50 (1922).

Heteromeriugia flaviseta MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 7 (1918).

Entirely yellowish, the bristles yellow, lower part of head and body and the humeri whitish; head robust, front narrowed above by the bulging in of the eyes, cheeks more than one-fourth the eye-height; abdomen sometimes darkened toward tip; wings hyaline, apically with faint cloud about end of second vein; lamellae of hypopygium bluntly triangular, a little longer than wide; 4 mm.

Recorded from Illinois, Indiana, Virginia, and Missouri. We have specimens from White Mountains, N. H., Plummer Island and Washington, D. C., Algonquin, Ill., southern Georgia. The species is readily distinct among those from the States in the peculiar shape of the eyes, whose anterior margins diverge strikingly from the level of the uppermost orbital bristle to their lowest point. Malloch described the larva and puparium in his earlier paper, and suggested the possible identity of the species with *latifrons*. In view of the different head structure the two species are undoubtedly distinct, a conclusion also evidently reached by Malloch when he bestowed a new specific name on this form.

58. SOBAROCEPHALA DORSATA Czerny.

(Fig. 38.)

Sobarocephala dorsata CZERNY, Wien. ent. Ztg., vol. 22, p. 105 (1903).

Meriza dorsata KERTESZ, Ann. Mus. Hung., vol. 1, p. 571 (1903).

Ochraceous, posterior part of mesonotum with a quadrate black spot which extends over scutellum and metathorax, sometimes also a supra-alar spot; abdomen largely black; front tarsi brownish; wings nearly hyaline, with a vague apical cloud; arista evidently plumose, face ochraceous, buccal hairs small, cephalic bristles typically yellowish, notal bristles brown, prescutellar setae present. Length, 3.5–3.9 mm.

Distribution.—Originally described from Peru. Specimens agreeing well with the description are before us from Costa Rica, collected by Pablo Schild.

59. SOBAROCEPHALA FASCIPENNIS, new species.

(Fig. 29.)

Male.—Beautifully variegated in color, black, brown, yellow, and white, as follows: Upper occiput and front ochraceous, paler toward antennae; face, vibrissal angle of cheeks, lower occiput, mouth parts, and antennae flavous, cheeks blackish; mesonotum ochraceous before suture, the sides between the brown humeri and root of wing white, posterior two-thirds of notum dark castaneous, scutellum whitish, metathorax black, pleurae entirely blackish brown; base of abdomen yellowish, remainder black; coxae and posterior femora except knees blackish, remainder of legs pale yellow; halteres yellow; wings with two infumated cross-bands, one including apical fourth, the other extending between the crossveins, base and preapical portions subhyaline, costal veins yellow up to the apical cloud; arista black, bristles and hairs nearly concolorous with the integument, the reclinate front-orbitals and setae of front femora black. Arista long-pubescent, buccal hairs small; front occupying less than one-third the head, longer than wide, its orbits nearly parallel; prescutellars relatively strong, only one lateral scutellar seta; front femora with double row of flexor setae; the black hypopygial valves shaped like an orange spoon; third vein ending at tip of wing, parallel with fourth; sections of costa 5.5 : 1.4 : 1, of fourth vein 1 : 1 : 3. Length 3 mm.

Holotype.—Alhaluelo, Panama, 12 March, 1912, August Busck, collector, U. S. National Museum, Cat. No. 26269, U.S.N.M.

60. SOBAROCEPHALA FERRUGINEA Czerny.

Sobarocephala ferruginea CZERNY, Wien. ent. Ztg., vol. 22, p. 105 (1903).

Ochraceous, bristles concolorous, sometimes scutellum and posterior middle part of mesonotum brownish; arista evidently plumose; front tarsi brownish, front femora with flexor bristles; wings nearly hyaline, with a faint apical clouding; 3.5 mm.

Habitat.—Peru. A few specimens from Costa Rica secured from Pablo Schild probably belong to this species. The hypopygium is small and yellow, the middle portion of the abdomen brownish. Possibly *S. dorsata* is the same species, since the relative intensity of dark color in the scutellar region is of doubtful specific value.

61. SOBAROCEPHALA FINNILÄI Frey.

Sobarocephala finniläi FREY, Ofvers. Vet. Soc., vol. 60, p. 32 (1919).

Head, including antennae and mouthparts ochraceous, arista plumose. Thorax ochraceous, with two broad black vittae which are triangularly excised along outer side at suture, scutellum and metathorax black. Abdomen black except at base. Legs entirely yellow. Wings cinereous, costal cell and base yellow, with three

broad infumations, located between first vein and anterior crossvein surrounding posterior crossvein, and at apex, the last rectangularly excised within; sections of fourth vein 1 : 3. Length 5 mm.

Habitat.—Brazil.

62. SOBAROCEPHALA FLAVA, new species

(Fig. 22.)

Female.—Head ochraceous, ocellar dot black, cheeks and mouthparts flavous, third antennal joint reniform, blackish, with finely plumose arista; head bristles black and strong, four or five long delicate buccal hairs. Thorax ochraceous, notal hairs close fine and dusky; prescutellar setae present, two lateral setae on scutellum, sternal hairs not conspicuous. Abdomen reddish yellow, darker posteriorly. Legs yellow, the front tarsi brown, tibial spurs black, flexor setae of front femora vestigial. Wings hyaline, lightly infumated about apical end of second vein, costal ratio 4.5 : 1.2 : 1, fourth vein 1.2 : 1 : 3, fifth vein 1.5 : 1; halteres yellowish; calypteres yellowish with blackish border and fringe. Length 3 mm.

Puparium.—Reddish brown, trilobed at cephalic end, transversely striated, posterior end irregularly rugose, tipped with two simple hooks, anal opening surrounded by a black nearly semi-circular plate, venter of last segment sharply margined behind. Length 3.5 mm.

Types.—Reared by Shannon from puparia found at Dead Run, Fairfax County, Virginia, in what was thought to be a maple log, the adults issuing April 15. Type in National Museum, Cat. No. 26270, U. S. N. M. Paratypes from Plummer Island, Md., Falls Church, Va., and Opelousas, La. All the specimens are females.

63. SOBAROCEPHALA FLAVISETA Johnson.

Heteromeringia flaviseta JOHNSON, Psyche, vol. 20, p. 99 (1913).

Yellow, the face, cheeks, lower occiput, humeri, pleurae, coxae and legs whitish; head bristles yellowish; antennae fulvous yellow, arista blackish; posterior abdominal segments with brownish marks; wings yellowish hyaline, apical third slightly clouded, especially near veins; 4 mm.

Habitat.—New Jersey. One of the two known specimens was recorded in the New Jersey list under the name of *Clusia flava*. The species discussed by Malloch as *flaviseta* is *convergens*.

64. SOBAROCEPHALA HUMERALIS, new species.

(Fig. 25.)

Female.—Front and center of face brownish yellow, the ocellar, dot blackish, occiput luteous, cheeks and facial orbits pale yellow with a conspicuous dark spot below the eye; antennae flavous,

arista nearly three times the antennal length and pubescent; front decidedly narrowed above due to the bulging in of the eyes; bristles small, brown, buccal hairs short. Mesonotum mostly black, a central vitta and sutural spot yellowish, humeri and sides of mesonotum in front of suture contrastingly white, scutellum whitish, metanotum brown; pleurae shining yellow with two black spots, one directly under humeri, the other behind the front coxae, metapleurae black; presuturals present, one lateral scutellar seta located well up on the disk, thoracic bristles brown. Abdomen black except at yellowish base. Legs yellow except front tarsi and all tibiae which are blackish; flexor femoral bristles undeveloped, only three in posterior row of front femora near knee. Wings nearly hyaline, a vague clouding at apex and in distal half of discal cell, first and second veins yellow, others black except at root; costal ratio 5 : 1.5 : 1, fourth vein 1 : 1 : 2.5, fifth vein 2.5 : 1; halteres pale yellow. Length 4 mm.

Type.—La Suiza de Turrialba, Costa Rica, collected during August, 1921, by Pablo Schild; in Melander collection.

Variations.—A female in the National Museum, Cat. No. 26271, U.S.N.M., from the same collector represents an extreme pale variation. The genal spot is luteous, the black of the mesonotum is reduced to a prescutellar spot medially excised in front and another in front of the wings, the pleurae and metathorax are immaculate yellow, the abdomen black only on the middle tergites, and the tibiae have a faint brown ring below the knee. Another female, collected by Dr. P. P. Calvert at Juan Vinas, Costa Rica, in the collection of the American Entomological Society, represents the other color extreme. The upper sides of the occiput are black, the notum and pleurae are wholly black except for the humeral-lateral white mark and the white scutellum, and the clouding of the wings is more evident. Structurally the three specimens agree.

65. SOBAROCEPHALA HYPOPYGIALIS, new species.

(Fig. 41.)

Male.—Front shining yellow, more opaque and luteous above antennae, ocellar spot black, face and cheeks white, the genae silky; mouthparts and antennae yellowish, the latter brown above the black plumose arista; bristles of head long and brown, four long buccal hairs. Notum shining ochraceous with two narrow parallel very faint brownish dorsocentral stripes reaching from center of mesonotum to tip of scutellum, notal hairs and bristles black, prescutellars lacking, two lateral scutellar setae; pleurae pale yellow, mesosternal hairs long. Abdomen black-bristly, yellowish brown, hypopygium yellowish and unusually large, the valves very large and scoop-shaped extending forward under the abdomen and almost reaching the base., Legs yellowish, hairs black, front tarsi brownish, front femora with

nine long setae in posterior flexor row, middle femora with twelve moderate setae in posterior row and about four oblique setae in anterior row toward knee. Wings almost uniformly hyaline, costal ratio 4.5 : 1.2 : 1, fourth vein 1 : 1 : 2.6, fifth vein 2 : 1. Length 3 mm.

Types.—Two males, La Suiza de Turrialba, Costa Rica, Pablo Schild collector, in Melander collection. Several females from Mr. Schild may be the same species. They all have weaker femoral setae, some have darkened scutellum, none has the brown spot at end of antennae nor the faint dorsal vittae, and one has shorter plumosity of the arista.

66. *SOBAROCEPHALA LACHNOSTERNUM*, new species.

(Fig. 21.)

Front shining ochraceous, opaque luteous above the antennae, ocellar dot black, face and mouthparts yellow, genae silvery pruinose, a brownish line below each antenna, extending on bucca; antennae luteous, arista short-plumose; head bristles brown, five delicate long buccal hairs. Thorax shining ochraceous, pleurae and coxae flavous, sometimes, especially in female, with lateral brownish marks behind the humeri, prescutellar setae sometimes absent, hairs of mesosternum and coxae long and conspicuous. Abdomen strongly setose, brownish in male, yellow with brown middle portion in female; hypopygium large and yellow, valves circular. Legs uniformly yellow except the brownish front tarsi, flexor setae of anterior femora strong and black. Wings nearly hyaline, costal ratio 5 : 1.3 : 1, sections of fourth vein 1 : 1 : 3.3, of fifth vein 1 : 2.6; halteres pale yellow. Length 3 mm.

Puparium.—Reddish brown, closely and transversely striate, last segment irregularly rugose, posterior extremity with two hooks, each with basal prong on inner side, anal opening elliptical and surrounded by a black trapezoidal plate, no sharp margin at rear of last sternite. Length 5 mm.

Types.—Ten specimens, Rosslyn and Dead Run, Va., bred by Shannon from larvae found in rotting wood. Type, Cat. No. 26272, U.S.N.M.

67. *SOBAROCEPHALA LATIFRONS* Loew.

(Fig. 32.)

Heteroneura latifrons LOEW, Wien. ent. Monats., vol. 4, p. 83 (1860); Berl. ent. Zts., vol. 7, p. 207; Cent. 4, 93 (1863).—CZERNY, Wien. ent. Ztg., vol. 22, p. 99 (1903).
Heteromeriugia latifrons JOHNSON, Psyche, vol. 20, p. 99 (1913).—MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 8 (1918).

Testaceous, lower part of head and thorax flavous; arista black, two and one-half times length of antenna, relatively long-plumose, buccal hairs vestigial, bristles strong and black; cheeks one-sixth eye-height, front square. Sides of mesonotum including the humeri brown, metapleurae brown, two pairs of lateral setae on scutellum,

prescutellar setae present. Abdomen yellowish, base and apex somewhat brown, ovipositor yellow. Legs yellow, middle tibiae with preapical bristle. Wings infumated along costa and tip, elsewhere cinereous, third vein curving back to end almost at wing-tip, costal sections 5 : 1.2 : 1, fourth vein 1.2 : 1 : 4; halteres yellow. Length 3.5 mm.

Distribution.—Massachusetts, New Jersey, Pennsylvania, District of Columbia, Indiana, Illinois. Shannon has taken the species on Plummer Island, Md., and at Dead Run, Va.

The species is similar to *flava*, differing in the greater approximation of the crossveins, the more extended infumation of the wings, darker thoracic markings, and in the presence of setae along the antero-flexor edge of the front femora.

68. SOBAROCEPHALA LATIPENNIS, new species.

(Fig. 24.)

Male.—Front and center of face brown, cheeks yellow, antennae and mouthparts luteous, arista three and three-fourth times the length of the antenna, short-plumose, almost openly pubescent, cephalic bristles strong and black, four buccal hairs; head remarkably wide, front broader than eye. Mesonotum mostly black, a broad C-shaped yellow spot on each side enclosing the suture, scutellum black, metanotum brownish, pleurae whitish, metapleura black. Abdomen black except at yellowish base, hypopygium small, with yellowish valves. Legs yellow with exception of all tibiae and front tarsi which are blackish, about twelve pale setae in posterior row of front femora, only two prominent setae in posterior row of middle femora. Wings broad, only twice as long as wide, costa strongly arched and aciculate, second vein abbreviated and bent forward to end midway between tip and posterior crossvein, costal ratio 2.5 : 2 : 1, fourth vein 1 : 2.5, fifth vein 3.5 : 1; outer half of wing strongly infumated, contrasting with hyaline basal half; halteres whitish. Length 3 mm.

Type and two paratypes.—Turrialba, Costa Rica, Pablo Schild collector, in Melander collection. Paratype: Porto Bello, Panama, August Busck, in National Museum, Cat. No. 26273, U.S.N.M. A beautiful species allied to *S. liturata* but differing from all the species in its curious wing formation.

69. SOBAROCEPHALA LITURATA, new species.

(Fig. 42.)

Male.—Front and face brownish, facial orbits and cheeks white, the bucca rimmed with brown, mouthparts and antennae yellow, the black short-plumose arista three and a half times the antennal length, four short buccal hairs, cephalic bristles strong and black,

ocellar bristles reaching half-way to antennae and equal to postverticals; front narrower than eye. Mesonotum brownish, on each side in front with an inverted H-shaped yellow spot, scutellum black, metanotum brown, pleurae pale yellow, metapleura blackish; notal hairs and bristle black, prescutellars absent, one lateral scutellar seta located well up on disk, sternal hairs short and yellow. Abdomen blackish except at extreme base, hypopygium small, valves nearly square. Legs yellowish, posterior knees capped with brownish, front tibiae and front tarsi black, hind tibiae brownish before apex, hairs dark, though pale at base of femora, nine black setae in posterior flexor row of front femora, middle femora with four setae in front row near knee and eighteen setae in posterior row arranged the full length of the femur. Wings with apical three-fourths cloudy, gradually merging into the subhyaline base, costal ratio 4.5 : 1.5 : 1, fourth vein 0.9 : 1 : 2.5, fifth vein 2.25 : 1, second vein distinctly diverging from third at tip, but ending much nearer to tip of wing than to posterior crossvein; halteres white. Length 3 mm.

Female.—Abdomen with last segment and ovipositor whitish; hind tibiae black.

Types.—Ten specimens, Turrialba, Costa Rica, secured from Pablo Schild, Melander collection. Paratype deposited in National Museum, Cat. No. 26274, U.S.N.M. Remarkably constant in structure and color.

70. SOBAROCEPHALA LUMBALIS Williston.

(Fig. 37.)

Heteroneura lumbalis WILLISTON, Trans. Ent. Soc. Lond., 1896, 388 (1896).—
CZERNY, Wien. ent. Ztg., vol. 22, p. 103 (1903).—WILLISTON, Manual N. Am.
Dipt., 3 ed., p. 319 (1908).

Heteromeriingia lumbalis MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 8 (1918).

Head, thorax, antennae, palpi, hypopygium, ovipositor, legs and halteres yellow, the posterior part of mesonotum and the scutellum brown, abdomen blackish, extreme base yellowish in female. Arista plumose, buccal hairs small, bristles strong and brown, no prescutellars, a single minute lateral scutellar hair. Hypopygial lamellae rounded elongate triangular. Preapical bristles of middle tibiae strong. Wings and veins yellowish, not clouded, sections of costa 4 : 1.1 : 1, of fourth vein 1.1 : 1 : 3.5, third vein ending almost at wing-tip. Length 2.5–3 mm.

Distribution.—Described from cotype specimens from collection of Cornell University. Original locality, St. Vincent, West Indies. Recorded by Malloch from Grenada. The National Museum contains the species from Alhajuelo and Paraiso, Panama, collected by August Busck.

71. SOBAROCEPHALA NIGRONOTUM, new species.

(Fig. 28.)

Male.—Front blackish brown, mouthparts, cheeks, and face whitish, the latter centrally grayish with the facial ridges brownish; antennae reddish yellow, arista black and finely short-plumose; head bristles reddish yellow. Notum entirely black, pleurae pale yellow, metapleura brownish; prescutellars scarcely larger than the black notal hairs, two small lateral scutellar setae. Abdomen blackish, hypopygium yellow, valves oblong twice as long as wide and crossing each other. Legs uniformly pale yellow, only the hind femora with slight duskiness before knee, no flexor femoral bristles. Wings uniformly and strongly infumated, veins blackish, costal ratio 4: 1.3; 1, fourth vein 1: 1: 2.7, fifth vein 1.5: 1; halteres pale yellow. Length 3 mm.

Female.—Front reddish with a black central stripe, face yellowish marked with a W-shaped brown design, clypeus brownish, facial orbits and cheeks whitish, six long delicate buccal setae, mouthparts yellow. Last abdominal segment and ovipositor pale yellow. Front tarsi and all of the tibiae dark, the five setae on the postero-upper edge of front femora dark and stronger than in male. Length 3.75 mm.

Types.—Two males and two females. La Suiza de Turrialba, Costa Rica (Pablo Schild), Melander collection. One of the paratypes deposited in National Museum, Cat. No. 26275, U.S.N.M.

72. SOBAROCEPHALA PICTIPENNIS Kertész.

Monórhexa pictipennis KERTÉSZ, Ann. Mus. Hung., vol. 1, p. 573 (1903).

Reddish yellow, a little shining. Upper part of head yellowish gray, lower part concolorous but somewhat lighter, ocellar spot black. Mesonotum with a broad black clear-cut vitta tapering in front and anteriorly sending a blackish brown bowed band to each side margin; base of scutellum with a brown line which continues toward the apex in a curved angle. Abdomen reddish but marked with a broad black vitta which ends on the fifth segment. Tibiae and tarsi infuscated. Wings with yellowish tinge, apical third more or less brown, a paler brown mark over the posterior crossvein which in front forms a semi-circular spot in the first posterior cell; hind margin clear brown; halteres yellow. Length 5.5 mm.

Habitat.—Surinam, South America.

73. SOBAROCEPHALA PLEURALIS Williston.

Heteroneura pleuralis WILLISTON, Trans. Ent. Soc. Lond., 1896, p. 387 (1896).—CZERNY, Wien. ent. Ztg., vol. 22, p. 102 (1903).

Head, pleurae and legs light yellow, notum and a prealar pleural spot dark brown, abdomen black except immediate base. Wings

smoky hyaline, the apical third and a spot over crossveins brown, penultimate section of fourth vein about one-third the last section of fifth vein and only a little longer than posterior crossvein. Arista yellow at the base, very finely pubescent. Length 2.5 mm.

Habitat.—St. Vincent. Major E. E. Austen has courteously furnished the following additional information regarding the holotype in the British Museum: cruciates absent, postverticals present, one dorsocentral, middle tibiae with preapical, first vein bare, sections of fourth vein about 3.5: 1: 6.5. Notwithstanding the approximation of the crossveins the chaetotaxy places the species best in the genus *Sobarocephala*.

74. SOBAROCEPHALA PLUMATA, new species.

(Fig. 35)

Female.—Front and occiput luteous, face and cheeks pale, mouthparts and antennae reddish yellow, the third antennal joint with a dusky stripe on outer side at base of arista, the arista black and densely short-plumose, twice the length of antennae, ocellar bristles microscopic, cephalic bristles yellowish, four very delicate buccal hairs. Thorax reddish yellow, with six blackish spots arranged in pairs, one at lateral margin anterior to wing, one much smaller on the same transverse line just outside the dorsocentral row, and a third pair across the suture in front of the second pair; scutellum and metanotum black, pleurae luteous; bristles yellowish, prescutellars scarcely differentiated. Legs yellowish, the front tarsi and adjoining half of tibiae dusky. Wings hyaline, cloudy on apical third and with a slight clouding over posterior crossvein, costal ratio 4: 1.2, fourth vein 1.4: 1: 3.2, fifth vein 2: 1; halteres whitish; calypteres yellowish with brownish border. Length 3.5 mm.

Holotype.—Alhajuelo, Canal Zone, Panama, collected by August Busek, in National Museum, Cat. No. 26276, U.S.N.M.

75. SOBAROCEPHALA PLUMATELLA, new species.

(Fig. 39.)

Male.—Occiput and front ochraceous, face, cheeks, antennae and mouthparts yellow, arista black, closely plumose on basal two-fifths, remainder openly plumose, cephalic bristles ferruginous. Mesonotum marked with a black vitta between the dorsocentral bristles, tapering point behind the neck, laterally blackish, between these stripes ivittate with chraceous; scutellum black, metanotum and pleurae pale yellow, the metapleura black; thoracic bristles blackish. Abdomen black except the first segment, the sternites and the small quadrate lamellae, a l of which parts are yellowish. Legs entirely yellowish, flexor fringe of front femora with uniform short setae. Wings subhyaline, gradually darker to tip, costal sections 3.6:1, of

fourth vein 1.2:1:3.6, of fifth vein 1.5:1; halteres pale yellow. Length 3.4 mm.

Holotype.—La Suiza de Turrialba, Costa Rica, November, 1922 (Pablo Schild), in Melander collection.

76. *SOBAROCEPHALA RÜBSAAMENI* Czerny.

(Fig. 23).

Sobarocephala rübsaameni CZERNY, Wien. ent. Ztg., vol. 23, p. 86, pl. 3, figs. 3-5 (1903).

Entire head reddish yellow, ocellar spot black, front shining, arista black and short-plumose, twice antennal length; head bristles reddish and strong, five long buccal hairs. Thorax shining reddish yellow, posterior part of mesonotum maculate with black, sometimes a smaller posthumeral blackish spot present, scutellum yellow, the tip sometimes black, pleurae yellowish, metathorax varying from black to yellow; prescutellar setae present, two pairs of lateral scutellar setae. Abdomen yellowish, with lateral blackish spots on second, fourth, fifth, and sixth segments. Legs yellowish, front tarsi somewhat dusky, flexor setae not developed on femora. Wings yellowish, pictured with brown markings, one forming a transversely oblique stripe between the ends of the first and anal veins, a second forming an oval spot at the end of the second vein, the third including the apex and following the last section of the fourth vein and the posterior crossvein, sometimes filling the second posterior cell; costal ratio 2.5:1.3:1, fourth vein 1:1:1.5, fifth vein 4:1; halteres and calypteres yellow. Length 5 mm.

Distribution.—Five specimens collected by Pablo Schild in Costa Rica and by August Busck at the Trinidad River, Panama. The type specimen, on which Czerny erected the genus *Sobarocephala*, came from Peru. As preapical bristles are well developed on the specimens before us they were probably broken from the type.

77. *SOBAROCEPHALA SETIPES*, new species.

(Fig. 26.)

Male.—Front shining yellow, ocellar spot black, mouthparts and antennae yellow, arista black, plumose, cheeks not silvery, head bristles yellowish brown, three fine buccal hairs. Dorsum shining ochraceous, pleurae paler, sternal hairs not conspicuously abundant, prescutellars undeveloped, only one lateral seta on scutellum. Abdomen brown except at the yellowish base, sides and venter; hypopygium yellowish, small, the end valves round and minute. Legs yellowish, front tarsi dusky, anterior flexor bristles of front femora vestigial, about fourteen in posterior row, middle femora with two flexor rows of strong, close, outstanding bristles, about twenty in the posterior row and ten in the anterior. Wings yellowish hyaline,

costal ratio 4:1.2:1, fourth vein 1.1:1:3.2, fifth vein 2:1; Halteres whitish. Length 3.5 mm.

Holotype.—Marlboro, Md., collected by R. C. Shannon, 19 June, 1916; in National Museum, Cat. No. 26277, U.S.N.M.

78. SOBAROCEPHALA VALIDA, Williston.

(Fig. 30.)

Heteroneura valida, WILLISTON, Trans. Ent. Soc. Lond., 1896, p. 388, fig. 136 (1896).—CZERNY, Wien. ent. Ztg., vol. 22, p. 102 (1903).—WILLISTON, Manual N. Amer. Dipt., 3 ed, p. 319 (1908).

Heteromerinia valida MALLOCH, Proc. Ent. Soc. Wash., vol. 20, p. 8 (1918).

Head including antennae, proboscis and occiput light yellow, arista black, pubescent, two and a half times length of antennae, bristles yellowish. Thorax light yellow, mesonotum broadly on the sides and behind and the scutellum brown or black, shining, metanotum yellow; the yellow of the front of the mesonotum extends as a broad central stripe to or beyond the suture. Abdomen black or dark brown, its base, the ovipositor and the small hypopygium yellow. Legs yellow, double rows of short setae on underside of anterior femora. Wings uniformly cinereous hyaline, narrow, the sections of costa 7:1.5:1, of fourth vein 1:1:3.5, of fifth vein 1.5:1. Length 2.5 mm.

From cotype specimens from St. Vincent, from the collection of Cornell University.

79. SOBAROCEPHALA VARIEGATA, new species.

(Fig. 40.)

Male.—Head ochraceous, paler beneath, a small brownish spot under each eye; third antennal joint circular, luteous, a blackish spot at base of the black and bushy-plumose apical arista; head bristles reddish yellow, six fine hairs in buccal fringe, upper occipital orbits with a row of ten black stiff setae, postverticals very small, no ocellars. Thorax variegated black and yellow; mesonotum with three distinct pairs of black markings, including one pair of parallel vittae half the length of the mesonotum and extending to base of the black scutellum, one pair of oblique spots directly above the wings and fusing anteriorly with the first pair of stripes, and a third pair of narrow posthumeral fasciae, the last crossing the pleurae to the middle coxae; pleurae with two additional subalar spots and the hypopleurae black; presuturals undeveloped, two small lateral scutellar setae, mesonotal hairs black. Abdomen centrally black, first two segments yellow; hypopygium large and yellow, valves long, narrow, nearly parallel-sided. Legs yellow, the middle femora with brownish spot above knee, hind femora with central brownish

ring, all tibiae slightly dusky due to the covering of stouter hairs; all femora with double row of short flexor setae, becoming stronger on apical half, tibial spurs black and not long. Wings hyaline, with an abrupt blackish clouding confined to the apical fourth, a variable pale spot in the cloud in middle of submarginal cell, a distinct clouding over posterior crossvein; sections of costa 4 : 1.5 : 1, of fourth vein 1.5 : 1 : 2.5, of fifth vein 2.3 : 1; halteres white. Length 5 mm.

Types.—Six specimens, La Suiza de Turrialba, Costa Rica (Pablo Schild), Melander collection, one deposited in National Museum, Cat. No. 26278, U. S. N. M. The National Museum has a specimen from Corazal, Canal Zone, Panama, secured by August Busck.

80. SOBAROCEPHALA XANTHOMELANA, new species.

(Fig. 27.)

Front and occiput dark ochraceous, ocellar dot black, face and mouthparts yellow, cheeks silvery, facial margin shining yellow, antennae luteous, the third joint orbicular and with an apical blackish spot, arista short-plumose, black, three times antennal length; lateral bristles of head long, strong and black, five delicate buccal hairs. Mesonotum and scutellum black, a large yellow cordate central spot in front part of notum, metanotum blackish, the metapleurae black, pleurae otherwise pale yellow, no prescutellars. Abdomen black except whitish ovipositor or sometimes ferruginous hypopygium, valves oval and yellowish. Legs with all femora and coxae pale yellow, all tibiae and front tarsi blackish, apical and preapical bristles of middle tibiae strong, four strong setae on underside of front femora in posterior row toward knee. Wings narrow, uniformly infumated, costal ratio 5 : 1 : 1, fourth vein 1 : 1 : 2.8, fifth vein 2 : 1; halteres whitish. Length 3 mm.

Types.—Four males and two females, Turrialba, Costa Rica, April to August, Pablo Schild, in Melander collection, and one male from same collector, in National Museum, Cat. No. 26279, U.S.N.M. The aberrant female with yellow dorsal triangle mentioned by Williston in his description of *Heteroneura xanthops* is very suggestive of the present species.

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Indispensible to the student of this family because of its wealth of detailed information is the Revision der Heteroneuriden by P. Leander Czerny, published in Wiener entomologische Zeitung, volume 22, Heft 3, pages 61-107 (1903). The papers that have appeared subsequent to this and to Aldrich's Catalogue of North American Diptera are as follows:

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EXPLANATION OF PLATES.

PLATE 1.

(All figures enlarged eight diameters; photographed by A. L. Melander.)

- FIG. 1. *Clusia lateralis* Loew. .
 2. *Clusia occidentalis* Malloch.
 3. *Clusia czernyi* Johnson.
 4. *Clusiodes (Clusiaria) melanostoma* Loew, form *duplicata* Malloch.
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 9. *Clusiodes (Clusiaria) atra*, new species.

PLATE 2.

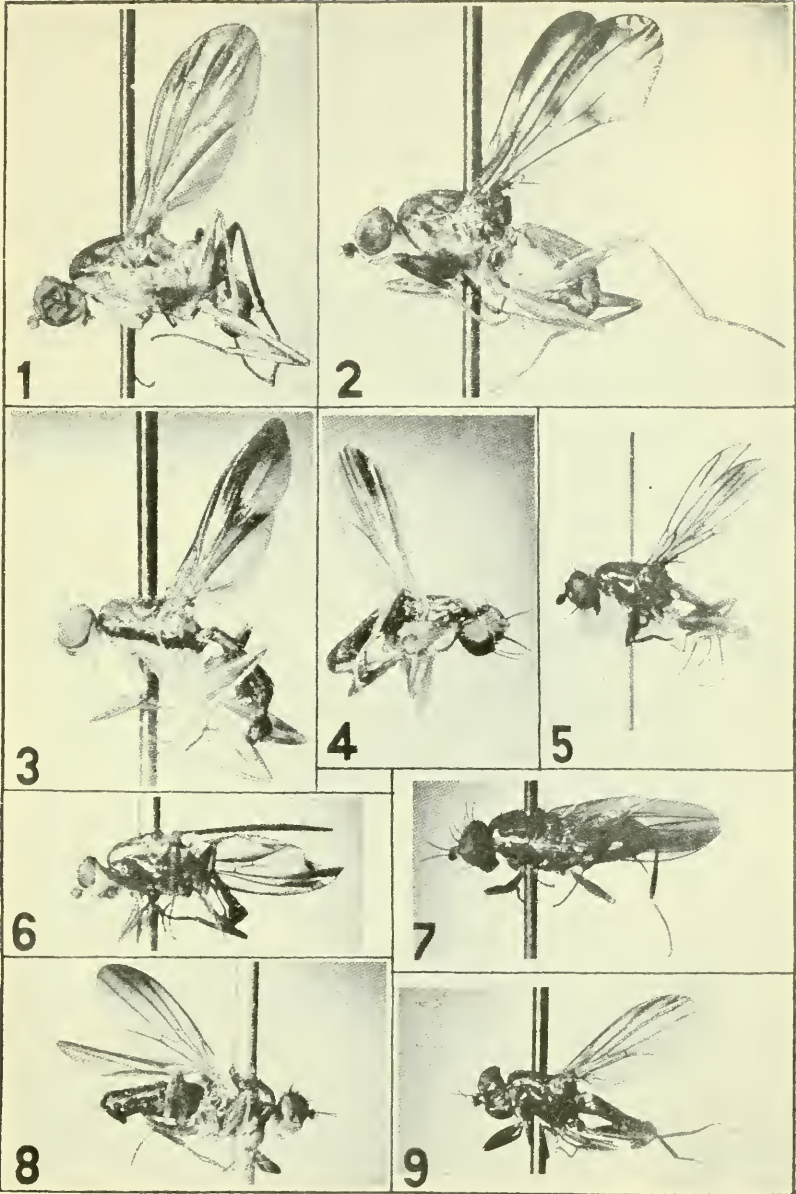
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 13. *Czernyola fascipennis*, new species.
 14. *Chaetoclusia xanthops* Williston, cotype.
 15. *Chaetoclusia quadrivittata*, new species.
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 29. *Sobarocephala fascipennis*, new species.
 30. *Sobarocephala valida* Williston, cotype.
 31. *Sobarocephala convergens* Malloch.

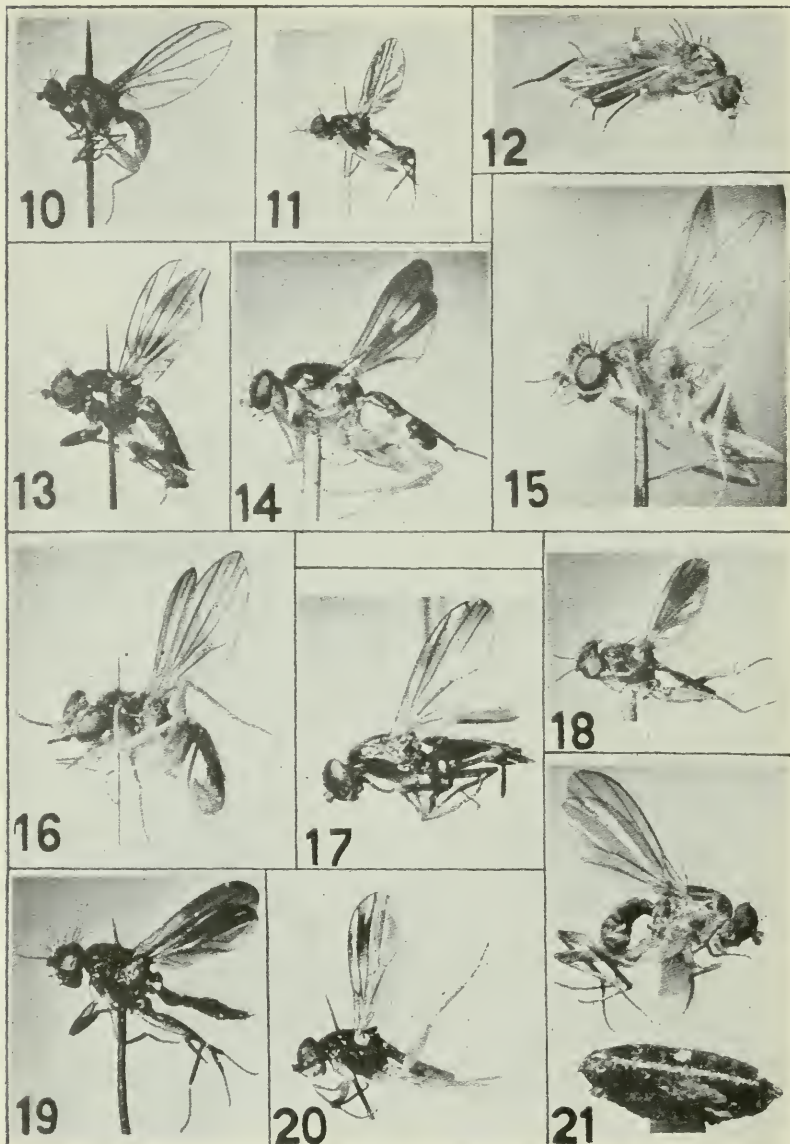
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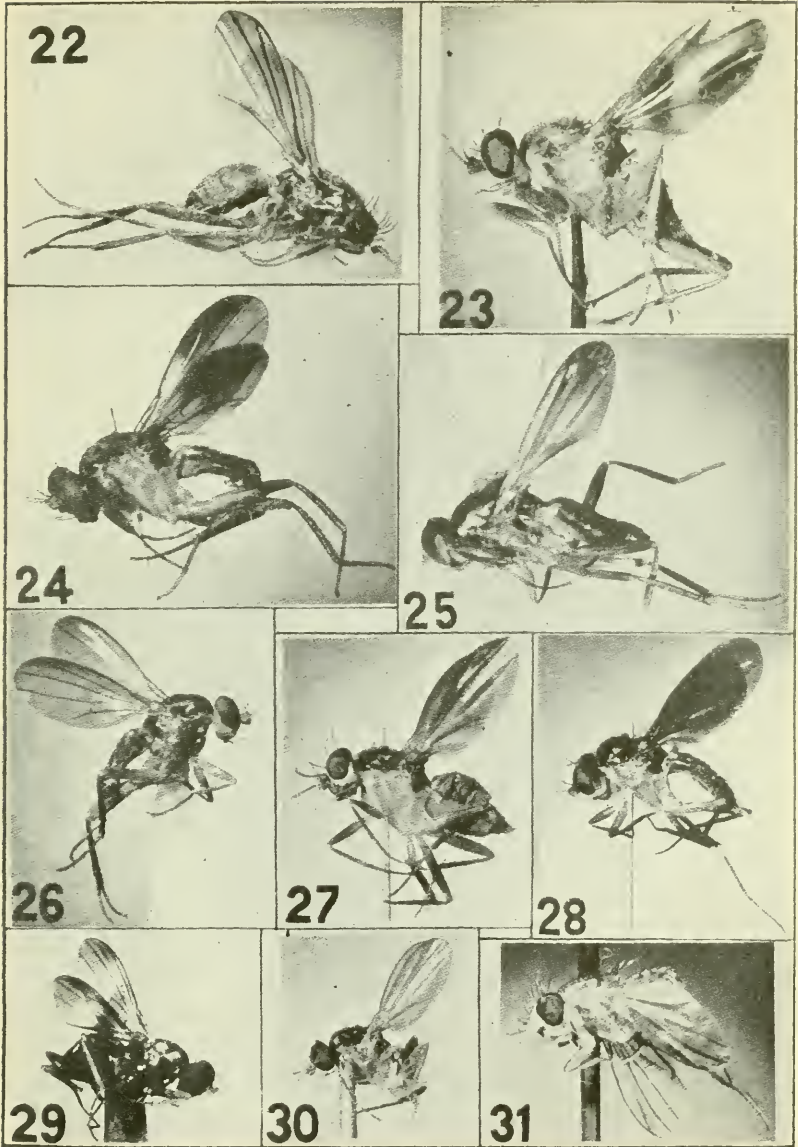
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FOR EXPLANATION OF PLATE SEE PAGE 51.



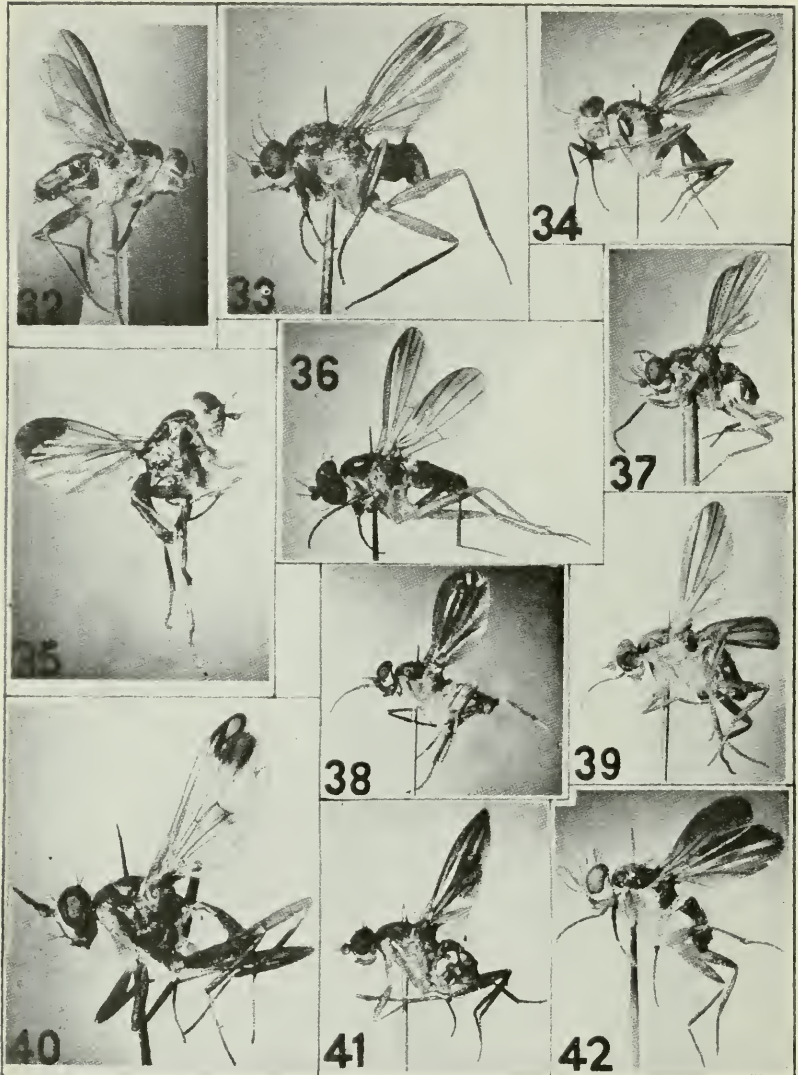
FLIES OF THE FAMILY CLUSIIDAE.

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NOTES AND DESCRIPTIONS OF NAIADS BELONGING TO
THE DRAGONFLY GENUS HELOCORDULIA.

By CLARENCE HAMILTON KENNEDY,
Ohio State University, Columbus, Ohio.

The writer saw his first and only living *Helocordulia selysii* (Hagen) one bright March day, when Prof. Simon Marion and he were taking an early spring tramp through the woods of the Raleigh (N. C.) Country Club. Vegetation was beginning to develop a little green here and there, but the shrubs and trees were still bare. Early flies and beetles were out enjoying the spring sunshine, but the writer was not expecting to find Odonata. Suddenly a dragonfly arose from the forest path and flew leisurely down into a neighboring hollow—apparently an extra early *Tetragoneuria*. On capturing it the writer felt a glow of satisfaction as it had the speckled wings of the rare *Tetragoneuria petechialis*, a little-known southern species, though its black and yellow coloration struck the writer as being odd for that genus. Later in the laboratory the true worth of the catch was disclosed when the specimen was identified as the very rare *Helocordulia selysii*.

Professor Marion and the writer continued their steps 50 yards farther, down a gentle slope to the shore of the artificial pond of the Country Club grounds, and on the side of a small boathouse found a single Odonate exuvium. It was identified later as a *Helocordulia*, but not the species *uhleri* found in the Northeastern States. No other Odonate was seen, so it was concluded that the teneral specimen caught in the woods was probably the individual that had emerged from this exuvium.

Helocordulia selysii is one of our rarest American Odonata. Probably few more than a dozen specimens exist in collections. C. S. Brimley, who has collected Odonata continuously for 20 years in various parts of North Carolina, has recorded¹ less than 12 captures. Because of this extreme rarity our knowledge of its

¹ Brimley, North Carolina Records of Odonata in 1903, Ent. News, March, 1904, pp. 100-102.

Brimley, North Carolina Records of Odonata in 1904 and 1905, Ent. News, March, 1906, pp. 91-92.

Brimley, Records of North Carolina Odonata from 1908-1917.

habits is practically nothing. Mr. Brimley has said to the writer that his captures were usually made in open sunny glades of the woods, sometimes long distances from water. Two individuals appear, from the records, to be the largest number seen at one time. Mr. Brimley's captures range in season from March 18 to April 17. My finding of this single exuvium at the Country Club lake shows that a muddy, warm pond is one of the places possible for the naiad and that the female willingly uses such a place for oviposition, for there were several woods streams of various sizes in the neighborhood which might have been chosen, if she had been partial to streams.

Helocordulia selysii is one of several rare North American dragonflies that have an early spring season. Those of this early spring group which the writer has studied appear to be very primitive. In some instances, as in this, the genus is small in number of species and is primitive as a whole; in other instances the early spring species is primitive in its genus, which may be large and have other more modern and more highly specialized species which come later in the season. Examples of primitive species in large genera are *Ischnura posita*, *Aeschna matuta*, *Libellula jesseana*, etc. One wonders why these are so illy adjusted to our present seasons. Apparently our longest warm season is not long enough for them to mature a brood. Are they left overs from that pre-Miocene time, when the warm season was practically continuous throughout the year? The other explanation of this early spring emergence is that these may be specialized, that emergence so early gives the adult an uncrowded habitat. This latter explanation does not agree with the writer's observations, which are that few, if any, dragonfly habitats ever suffer from lack of food for the adult. Crowding may occur among the naiads as they are confined to specific bodies of water, but the season of the adult would not seem to be related to this.

Of the two species of *Helocordulia selysii* and *uhleri*, *selysii* has the more generalized appendages. These curiously enough are almost identical with those found in another primitive Corduline, *Didymops*, which, however, Needham² and Williamson³ as well as Martin⁴ place in a different division of the subfamily Cordulinae. Perhaps *Helocordulia* and *Didymops* are each more primitive in their respective groups than has been suspected by systematists.⁵

² Needham, Critical Notes on the Classification of the Cordulinae, Ann. Ent. Soc. Amer., vol. 1, pp. 273-280. 1908.

³ Williamson, A new Dragonfly belonging to the Cordulinae, and a Revision of the Classification of the Subfamily, Ent. News, vol. 19, pp. 428-434.

⁴ Martin, Les Cordulines, in "Collections de Selys."

⁵ The writer believes that the male appendages should be considered as a check on venation in any study of the phylogeny of this subfamily. That such curious things as *Cordulephya* and *Synthemis* are apical specializations and not as primitive as some of their venational characters would suggest.

The identity of this *Helocordulia* exuvium is fairly certain, first, because of the circumstances under which it was found; second, because it is nearly identical with Needham's description⁶ of the naiad of *uhleri* and with specimens of the latter sent the writer by Doctor Walker; third, it differs in the same characters from the known *Somatochlora* naiads (*elongata*,⁷ *tenebrosa*, and *semicircularis*) as does *uhleri*. The *Helocordulia* naiads have the lateral spines on abdominal segment 9 approximately as long as the dorsum of the same segment, while in the three *Somatochloras* they are distinctly less.

The following description of the naiad of *selysii* has been drawn to parallel that of *uhleri* by Needham.⁸ The latter species has been so well described that it is needless to redescribe it here. Figures of the *uhleri* naiad are given for comparison with those of *selysi*. The exuvium of *selysii* as well as two of *uhleri* have been deposited in the United States National Museum.

DESCRIPTION OF THE NAIAD OF HELOCORDULIA SELYSII (Hagen).

Color completely obscured by a thin but complete incrustation of mud. Total length, 20 mm.; abdomen, 12 mm.; hind femur, 6.5 mm. Width of head 5.5 mm. and of abdomen 7 mm. (See pl. 1, figs. 6-12.)

Head nearly twice as wide as long. Eyes small and not prominent, their front contour continuous with the front contour of the head. Frons broadly angulate anteriorly, occiput slightly incurved, the sides of the head sloping rapidly toward the occipital angles. Each occipital prominence with a lateral and a dorsal row of long spine-like hairs.

Antennae with segments about equal in length, segments 1 and 2 being heavy while 3-7 are slender. (See fig. 11.)

Labium reaching caudad to between the bases of the middle legs, the sternal sulcus which houses the base of the labium being fringed behind by a sinuate row of long hairs between the middle coxae. Labium as broad as long with the middle lobe a right angle and its edges minutely crenulate and armed with numerous short spines. (See figs. 7 and 8.) The mental setae 13-14 in number, of which the outer 8 are very long, while the inner 5-6 are minute. The lateral setae are 7 in number and have parallel to their bases a row of short stiff spines along the dorsal edge of the lateral lobe. Movable hook slender and 2-3 times as long as the depth of its insertion. 8-9 crenulate teeth on the lateral lobe, each tooth with a graduated series of 3-5 long, slender, sharp spines, the longest of these in each series being half the length of the movable hook.

⁶ Needham, Aquatic Insects in the Adirondacks, New York State Museum, Bull. 47, p. 497, 1901.

⁷ Needham's description (N. Y. State Mus., Bull. 47, p. 500) may not be *elongata* as the individual described does not appear from the text to have been reared.

⁸ See footnote 6.

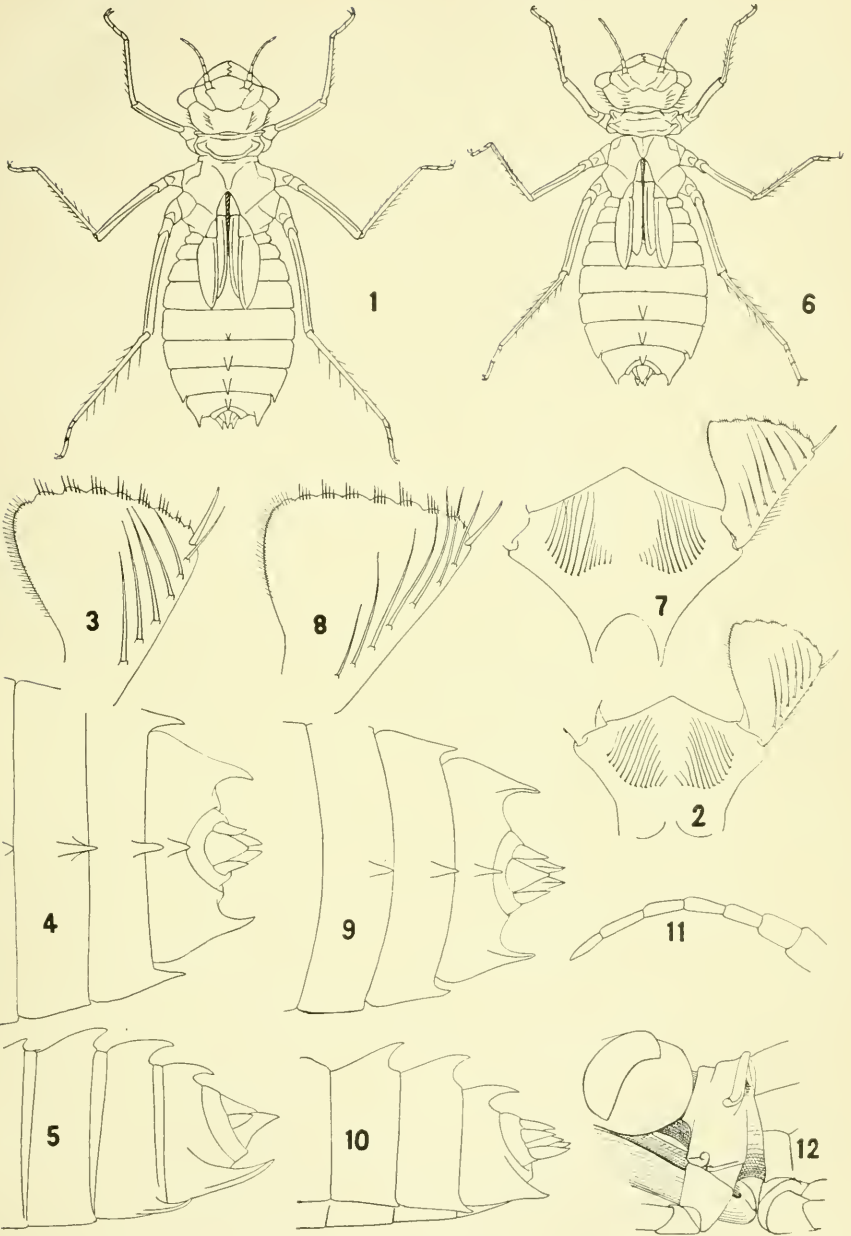
Prothorax with a sharp lateral, dorsal lobe and a large anterior, supracoxal process. (See fig. 12.) Wing pads reaching to segments 5 and 6 of the abdomen. Legs straight and slender with the tibia hairy and armed with two well-developed rows of long slender spines—a tibial armature remarkably like that of a Zygopterid imago. Tarsal claws simple.

Abdomen elliptical, widest at about segment 6, tapering regularly to segment 2 in front and to segment 9 behind. Segment 10 a narrow ring inserted into the posterior concavity of segment 9. (See figs. 9 and 10.) Large dorsal hooks on segments 7-9. A mere suggestion of a tubercle on segment 6, which was not visible until the incrusting mud had been scraped away. Segments 8 and 9 with lateral hooks, which are small on 8 but on 9 are longer than half the length of the segment. The lateral hooks slightly incurved and reaching nearly to the apex of the abdominal appendages. Segment 10 a ring whose dorsal length is about one-third of that of segment 9. Middle appendage broadly conical and more than three times as long as segment 10. Superior appendages subequal to the middle appendage, their apices acute and decurved. Inferior appendages slightly longer than the others, their apices acute but less decurved than those of the superiors.

EXPLANATION OF THE PLATE.

The drawings are by the author.

- FIGS. 1-5. *Helocordulia uhleri*. 1, mature naiad; 2, mentum and lateral lobe of labium; 3, lateral lobe of labium; 4, dorsal aspect of abdominal segments 7-10; 5, lateral aspect of abdominal segments 7-10.
- 6-12. *Helocordulia selysii*. 6, naiad; 7, labium; 8, labial lobe; 9 and 10, segments 7-10 of abdomen; 11, antenna; 12, prothorax.



NAIADS OF THE DRAGONFLY GENUS HELOCORDULIA.

FOR EXPLANATION OF PLATE SEE PAGE 4.

FOSSIL INSECTS IN THE UNITED STATES NATIONAL MUSEUM.

By T. D. A. COCKERELL,

Of the University of Colorado, Boulder.

Recent studies on the fossil insects in the collection of the United States National Museum by the writer have covered a variety of subjects, which for the sake of convenience are treated below under separate headings.

1. FOSSIL INSECTS FROM SIBERIA.

Very little is known of the fossil insects of the vast Asiatic continent. Tertiary insects have been reported from few localities. In 1860 Murray¹ described certain beetles, *Lomatus hislopi*, *Meristos hunteri*, and three unnamed weevils, from the Tertiary of Nagpur, India. In 1876 Kawall² described a fossil larva as *Tineites crystalli* from the Tertiary of Ufalei, Siberia. In 1878 Heer³ recorded a beetle as *Cistelites sachalinesis* from rocks doubtfully referred to the Oligocene, at Mgratsch, on Sachalin (Sakhalin) Island. In Nawa's "Insect World" (Gifu, Japan) for 1913 is a figure of a fossil ichneumonid labeled *Pimpla*, species. In 1910 Reis⁴ discussed fossil Coleoptera from the fish shales of the Transbaikal. In 1920⁵ T. B. Fletcher published on Indian fossil insects. The present writer (1916-1922) has recorded many species of insects from Burmese amber, the age of which is probably Eocene.⁶

Some time ago A. Kryshtofovich, of Vladivostok, sent to Dr. F. H. Knowlton two species of fossil insects collected by A. Kuznetsov on the Amagu River, Maritime Province, coast of Siberia, opposite the southern end of Sakhalin Island. These specimens were kindly transmitted to me for study and are described below. They have been placed in the United States National Museum. They are of more than ordinary interest on account of the locality and the fact that they represent new and rather remarkable

¹ Quart. Journ. Geol. Soc. London, vol. 16, pp. 182-184.

² Bull. Mosc., vol. 3, p. 171.

³ Mem. Akad. Peterst., ser. 7, vol. 25, No. 12, p. 3, pl. 15, fig. 12.

⁴ Explor. Geolog. Chem. de fer Siberie. St. Petersburg. p. 29.

⁵ Rep. Pusa, Calcutta, vol. 3, pp. 983-989.

⁶ Nature, June 3, 1922, p. 713.

genera. The rock is dense and gray, not unlike that of Florissant, but with a more irregular fracture. It is presumed to be of Miocene age and is reported to contain a flora including *Quercus platania* Heer, *Ginkgo adiantoides* (Unger) Heer, *Taxodium distichum* (Linnaeus) Richard, *Glyptostrobus europaeus* (Brongniart) Heer, *Porana*, new species, *Cornus studeri* Heer, *Grewia crenata* (Unger) Heer, *Diospyros brachysepala* Al. Braun, etc. This might be as old as Lower Miocene, but additional information is much to be desired. The flora is a warm temperate, not at all tropical, one; the insects give the same indication, but are remarkable for their relatively large size as compared with their living representatives.⁷

MECOPTERA.

Family PANORPIDAE.

DINOPANORPA, new genus.

Based on a hind wing, remarkable for its relatively gigantic size and unusual breadth; venation nearly as in *Panorpa*, except that the first cross-vein between the media and cubitus is very long and oblique, a condition somewhat approached by *Panorpa venosa* Westwood. The first division of the radius (R_1) is remarkable for ending practically parallel with the costa, forming an extremely acute angle. Sc_2 leaves the radius only a very short distance beyond the termination of Sc_1 , proceeding very obliquely to the costal margin. At the base of the wing the media fuses with the cubitus for a short distance. The wing is dark brown, with scattered light spots.

Genotype.—*Dinopanorpa megarche*, new species.

DINOPANORPA MEGARCHE, new species.

Plate 1, fig. 1.

Hind wing 30 mm. long and 11 wide in middle; dark brown, with five rather narrow hyaline transverse bands represented in part by series of spots; the first by an elongate mark on lower half of wing beginning at cubitus; the second by a longitudinally elongate stripe below the costa, a larger one below the radial sector, and a vertical series of four spots below the apical end of this; the third by two large spots above, and two still larger below and beyond them; the fourth by the upper two spots only, placed obliquely, the lower one

⁷ Kryshstofovich has described the *Porana* as *P. sichota-alinensis*; I have seen the type, a very beautiful specimen. Last July my wife and I made collections in this Siberian locality, which is on the Kudia River, a branch of the Amagu, about 4 miles from the coast. The fossil insects of this collection are now being described; the additional plants will be described by Kryshstofovich. I also visited Nawa's Museum at Gifu, Japan, and saw there a very fine series of Japanese fossil insects, apparently late Tertiary, but at present unstudied.

more apical; the fifth by a single oblique spot, divided by two nervures. The apical third of the wing is obliterated, except in the costal region. Sc_1 ending 18 mm. from base of wing; r-m cross-vein 13 mm. from base of wing; lower end of oblique m-cu. cross-vein 9 mm. from base of wing. Longitudinal veins very strong, cross-veins for the most part very faint. The cross-veins from costa to subcosta are more numerous than in *Panorpa*.

Holotype.—Cat. No. 69173, U.S.N.M.

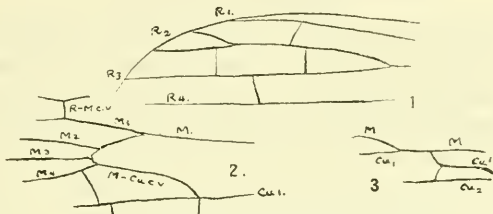


FIG. 1.—DIAGRAM OF VENATION OF *DINOPANORPHA MEGARCHÉ*. 1. COSTOAPICAL REGION. 2. REGION OF M-CU CROSS VEIN. 3. REGION OF UNION OF M WITH CU (HIND WING).

HOMOPTERA.

Family DELPHACIDÆ.

AMAGUA, new genus.

Relatively large robust insects, the anterior wings or elytra rather narrow, parallel sided (apical part lost), with distinct veins; m-cu. cross vein long, branching of cu_1 only a little beyond it; anal oblique, not in line with long axis of wing. The general structure of the elytron is not very different from that of *Stenocranus saccharivorus* Westwood, but there are numerous differences of detail. The *Stenocranus* is relatively minute.

Genotype.—*Amagua fortis*, new species.

AMAGUA FORTIS, new species.

Plate 1, fig. 2.

Probable length about 17 mm.; abdomen dark brown, 5 mm broad; elytra (tegmina) 3.7 mm. broad in middle; venation as shown in figure.

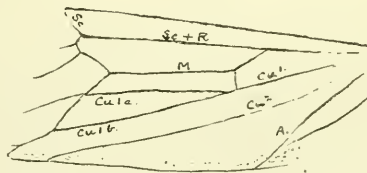


FIG. 2.—DIAGRAM OF VENATION OF *AMAGUA FORTIS*.

Holotype.—Cat. No. 69174, U.S.N.M.

2. FOSSIL INSECTS AND AN ARACHNID FROM THE EOCENE SHALES
OF COLORADO.

DIPTERA.

Family TRYPETIDAE.

EOPHLEBOMYIA, new genus.

Small robust flies, with rather short abdomen; head rather small, with short but evident bristles on vertex; antennae ordinary; the last joint elongate, broadly rounded at end, not flattened on either side; thorax elevated and gibbous anteriorly, dorsally flattened in lateral profile, beset with very small and fine hairs arranged in longitudinal rows, but scutellum with very long stout bristles; abdomen with short hairs, and no macrochetæ; legs ordinary, tibiae without preapical bristles; minute dark hairs on outer side of tibiae arranged in two fine lines; wings broad, ample, not especially long, perfectly clear, without spots or bands; auxiliary vein bent abruptly upward but not angular, reaching the costa at somewhat less than a right angle, and having at its end a group of three small black bristles, considerably larger than the costal bristles; the auxiliary is distinct throughout, but slender and pale, much weaker than the first vein; first vein reaching the costa about the middle of the wing, little curved, forming an acute angle much as in *Neospilota*, but not at all bristly; marginal cell long and narrow, apically very acute; submarginal expanded at end, much as in *Polymorphomyia*; first posterior with the veins bounding its apical part parallel; anterior cross-vein more remote from end of discoidal cell than in modern genera, and also shorter, not very oblique, the upper side of discal cell drawn upward to meet the cross-vein, and anteriorly to it curved in the fashion more exaggerated in *Glossina*; anal cell short and closed, not bulging as in Sapromyzidæ, and not produced at lower apical corner.

Genotype.—*Eophlebomyia claripennis*, new species.

EOPHLEBOMYIA CLARIPENNIS, new species.

Plate 2, fig. 7.

Length 4.5 mm. (abdomen curved downward); length of thorax 2.2 mm.; wing about 4.5 mm. long and 2.2 broad; dark brown, including legs, but face pale, and thorax dorsally with longitudinal stripes, much as in *Dacus oleae*; scutellum not prominent; first abdominal segment with a dark mark above. The specimen appears to be a male.

The following measurements are in microns: Length of hind tibiae 1,230, of hind basitarsus 720; end of auxiliary to end of first vein, 800; anterior cross-vein to base of discal cell, 1,120, to end of discal, 830; length of anterior cross-vein, 80; apical side of discal cell, 608. The discal cell is shaped like the butt of a gun.

Horizon and locality.—Green River Eocene; head of East Alkali Gulch, about 8 miles south of De Beque, Colorado (John P. Byram, 1922).

Holotype.—Cat. No. 69175, U.S.N.M.

A remarkable little fly, which I at first thought to refer to the Anthomyiidae, but it appears to be acalyptrate, and the venation agrees better with Trypetidae. In certain respects, it agrees with what we should expect to find in an ancestor of the modern Trypetidae.

Family MYCETOPHILIDAE.

ACNEMIA CYCLOSOMA, new species.

Plate 2, fig. 4.

Length about 5.5 mm.; dark brown, the under side of thorax and the femora yellowish-white; wings about 5 mm. long, broad, dilute brown, not spotted; hind tarsi, 3 mm. long. Antennae brown, over 2 mm. long, apparently 19-jointed, but the apical joints are very small; the middle joints are longer than broad, cylindrical; thorax almost exactly circular in lateral profile; subcosta absent or so faint as to be invisible in the fossil; radius reaching costa about 1 mm. before end of radial sector, the latter conspicuously and regularly curved apically; costal thickening not extending beyond end of radial sector; transverse (basal) section of radial sector 145 microns long, and a little over 2 mm. from base of wing; media with section between lower end of cross-vein to radius and fork about as long as the cross-vein; cubitus simple, arched.

Horizon and locality.—Green River Eocene; head of East Alkali Gulch, about 8 miles south of De Beque, Colorado (John P. Byram, 1922).

Holotype.—Cat. No. 69176, U.S.N.M.

Among the Mycetophilinae, *Acnemia* must be considered an advanced or specialized genus on account of the simple cubitus. In the genus *Acnemia*, the present insect is in some respects more specialized or modified than existing species, in spite of its antiquity. According to Johannsen, in all modern species of *Acnemia* the costa extends beyond the end of the radial sector (or should we say that the sector is produced beyond its junction with the margin of the wing?), but this character varies in extent. In *A. flaveola* Coquillett the extension is less than a fourth of the distance to the upper branch

of the media. It therefore seems hardly necessary to propose a new generic name for the fossil.

Acnemia is known to occur fossil in Europe; *A. bolsiusi* Meunier in Baltic amber, and *A. simplex* Cockerell in the Oligocene of the Isle of Wight.

Family BIBIONIDAE.

PLECIA RHODOPTERINA, new species.

Plate 2, fig. 6.

Female.—Length 4.4 mm., robust, with small head and stout legs, the short antennae with joints considerably broader than long; wings 5 mm. long and slightly over 2 broad, ferruginous (as in *P. fulvicollis* Fabricius); section of radial sector between anterior cross-vein and the fork distinctly but not greatly shorter than upper branch of fork; section of media between cross-vein and fork distinctly but not much shorter than fork; lower branch of cubitus strongly curved downward apically.

Horizon and locality.—Green River Eocene; head of East Alkali Gulch, about 8 miles south of De Beque, Colorado. (John P. Byram, 1922.)

Holotype.—Cat. No. 69177, U.S.N.M.

Much smaller than any of the four species previously recorded from the Green River shales and having rather the aspect of a Mycetophilid.

Family TIPULIDAE.

Genus CYTTAROMYIA Scudder.

This genus of *Cylindrotominae* was founded by Scudder for a species (*C. fenestrata* Scudder) fossil in the Green River Eocene of Fossil Canyon, Utah. Subsequently he described four additional species from the Miocene of Florissant, and remarked that he was acquainted with still other species from the White River basin (Green River Eocene). The genus is not so aberrant as Scudder believed, being in effect a *Cylindrotoma* with an additional cross-vein between R_{4+5} and the anterior branch of the media, making a closed cell above the discal. Alexander regards the *Cylindrotominae* as a decadent group, not nearly so well developed to-day as in Tertiary times. In his phylogenetic tree, he places the subfamily as an offshoot near the base of the stem, not leading to any further developments. The larvae are quite exceptional among Tipulidae in feeding on the leaves of plants. *Cylindrotoma* has six species of the North Temperate Zone, three being American.

CYTTAROMYIA RECLUSA, new species.

Plate 2, fig. 1.

Male.—Length 13.5 mm.; wings 12 mm.; slender; vertex brown, but orbits pale; thorax brown without evident markings; halteres about 2 mm. long, very slender, with large abrupt knobs; abdomen pale brown, very slender basally, broader toward the apex, where the segments show pale bands, anterior to which, laterally, are large pale areas; there are also rather indistinct pallid discal marks in pairs. The pale bands and lateral patches are similarly indicated in Scudder's *C. oligocena* from Florissant. Wings pale brownish without conspicuous markings, but the end of the marginal cell and the veins bounding the discal cell apically are somewhat clouded, the apical clouding of the marginal cell being as in *Cylindrotoma*. The discal cell is elongate, being about 1,840 microns long and 640 microns wide at the broadest (subapical) part, whereby the species is readily separated from *C. fenestrata* Scudder, which is also a considerably smaller insect. The venation is almost as in *C. oligocena*, but the discal cell is distinctly longer and more slender; the wings of *C. oligocena* are only 9.6 long. The marginal cell is distinctly longer than the width of the wing; its first section (to separation of third vein) is about 2,480 microns, the second section 1,810 microns. The third posterior cell is distinctly shorter than the discal, and thus in Scudder's key the species runs to *C. cancellata* Scudder, a species with wings 9 mm. long, from Florissant. The basal part of the marginal cell is proportionately shorter in *cancellata*.

Horizon and locality.—Green River Eocene, Roan Mountains, Colorado, collected by John Byram at Station 5, at end of spur west of that on which the Ute trail passes, opposite the head of Salt Wash.

Holotype.—Cat. No. 69178, U.S.N.M.

Family SYRPHIDAE.

SYRPHUS EOCENICUS, new species.

Plate 2, fig. 2.

Robust, 12 mm. long; abdomen 7 mm. long and 4.5 mm. wide; head and thorax black, the scutellum not pallid as in modern *Syrphus*, but appearing a shade lighter than the abdominal bands; abdomen with very well-defined markings, the three broad light bands all interrupted by a narrow median band, somewhat broader, but still very narrow, on first segment; the light bands reach the extreme margins, and are of approximately equal width, the first however conspicuously wider mesally than the others, the upper edge of the second dark band presenting a double curve on each side; the other dark bands also have a double curve on each side, but not sufficiently

to make the light bands appear arcuate; the third light band is much wider at the sides than mesally; there is a fourth light band, broadly interrupted mesally, its inner ends pointed. Wings not preserved.

Horizon and locality.—Green River (Eocene) shales, Roan Mountains, Colorado, July, 1922; Station 1, near the head of the Ute trail, above Sellers Ranch (*John Byram*).

Holotype.—Cat. No. 69179, U.S.N.M.

A beautiful specimen, although lacking the wings. It appears to be close to *S. umbellatorum* Schiner, but considerably larger, with dark scutellum. It is much larger than *S. lithaphidis* Cockerell, found fossil in the Eocene of Cathedral Bluffs.

HOMOPTERA.

THAMNOTETTIX EOCENICUS (Cockerell).

Erythroneura eocenicus COCKERELL. Proc. U. S. Nat. Mus., vol. 57, 1920, p. 246.

A second specimen was found by Mr. John Byram at Station 5 in the Roan Mountains, Colorado, July, 1922. It differs from the type in having the lower of the pale spots near middle of tegmen absent on one side, and small and round on the other. This is doubtless only an individual variation. The hind wings are well preserved, and show the neuration of the Jassini, not that of *Erythroneura*. The insect must therefore be referred to *Thamnotettix*, a genus with members so similar to the Typhlocybines that Motschoulsky (1863) described members of the latter group under the former generic name. The base of the second apical cell of the hind wing is very slender, and very narrowly truncate by a short, hardly noticeable cross-vein. The base of the fourth apical cell is oblique, not transverse, the lower corner more basad. This last character agrees with *Thagria signata* Distant from Ceylon, but in that insect the fourth apical is much shorter and broader. The base of the fourth apical in our fossil is approximately half way between those of the second and third.

PROTOLIARUS HUMATUS Cockerell.

Mr. F. Muir writes that he believes this can not be one of the Cixiidae (still less a proto-Cixiidae), but is rather a proto-Flatid or proto-Ricaniid. He considers that my subcostal vein is really the costal, which is in the membrane in many Fulgorids. The true subcosta is fused with the radius at the base, as my figure shows. Mr. Muir adds that the apparent cross-vein between the media and cubitus may be the fourth branch of the media joining the cubitus, as it often does in existing Flatidae.

THAUMASTOCLADIUS SIMPLEX Cockerell and Sandhouse.

Mr. F. Muir believes that this should go in the Flatoidinæ. So far as he can judge from the figure, it appears that the suture is indistinct, perhaps because it lies very close to the cubitus, as it does in a number of living species. He would then interpret it as follows: A large costal membrane with cross-veins, subcosta and radius free to base or near base, media branching about middle, cubitus branching much more apically. "Your reference to *Gaja* is then much more appropriate." The figure of *Thaumastocladius* is upside down, as may be readily seen by comparing the description.

LITHOPSIS DUBIOSA Cockerell and Sandhouse.

This is also referred by Mr. Muir to the Flatoidinæ, as is indicated by the shape of the head and the position of the tegmina. In this group the tegmina are carried nearly flat horizontally, and the fossil appears to have had them in this position.

HETEROPTERA.**DELPHAX SENILIS** Scudder.

Plate 2, fig. 3.

Green River Eocene; "Cathedral Bluffs south of Little Tomnies Draw, at point where samples were taken." (Winchester 17.5, U.S.G.S.) Total length 2.5 mm.; tegmina 2.6 mm. long and .70 mm. wide, uniform pale coffee-brown; abdomen with a broad dark median band, but basal and apical parts pallid. Close to *D. veterum* Cockerell, but considerably smaller, with narrower tegmina.

Plesiotype.—Cat. No. 69186, U.S.N.M.

DINIDORITES MARGIFORMIS Cockerell.

An additional specimen is U.S.G.S. 219, with reverse 220, obtained by Scudder in the Roan Mountains, Colorado.

ODONATA.**EPALLAGITES**, new genus.

Small, slender dragon-flies with dark thorax and hyaline wings; abdomen very slender, Arculus at not quite a third of distance from base to nodus; basal space not crossed; antenodal cross-veins numerous, crossing both costal and subcostal cells, continuous from one to the other, or almost so; two antenodals before arculus and one immediately above it, as in *Amphipteryx*; upper section of arculus long, as in *Rhinoceypha*; probably over 15 cross-veins between level of arculus and nodus, forming cells which are (in the case of a few

of the more basal ones) square, or broader, in the manner of *Anisopleura*. Other characters not visible.

Genotype.—*Epallagites avus*, new species.

EPALLAGITES AVUS, new species.

Plate 1, fig. 4.

Head about 5 mm. broad; about 1.4 mm. between eyes on vertex; thorax about 6 mm. long, as preserved black without bands; abdomen very slender, but only partly preserved. Wings hyaline, the veins not very dark; base to arculus 4 mm.; arculus to nodus about 9 mm.

Horizon and locality.—Green River (Eocene) shales at head of Salt Wash, Roan Mountains, Colorado, collected July, 1922 (Cockrell). The locality is a large excavation, probably 150 meters (500 feet) below top of hill, which we called Station 2.

Holotype.—Cat. No. 69180, U.S.N.M.

In Tillyard's classification, this will fall in the tribe Epallagini, except for the fact that the arculus is not so near the base. The wings can hardly be described as petiolate, though they are not broad. On the whole, *Epallagites* falls between the Epallagini and Libellagini, and possibly these tribes were not so clearly separated in the Eocene as at present. The most nearly related genus in the American Eocene is *Protamphipteryx*, but this belongs to Tillyard's tribe Amphipterygini. The definition which he gives of that tribe needs to be amended to admit the Oriental genus *Devadatta* Kirby, in which the arculus is actually nearer the nodus than to the base of the wing.

The discovery of a second genus of Epallaginæ in the Green River Eocene is of particular interest because the subfamily not only shows some very primitive characters, as Kennedy has remarked, but is actually the oldest of the living Zygopterous groups. Two genera from the Jurassic, *Euphacopsis* and *Pseudoeuphæa* of Handlirsch, are placed in the Epallaginæ, though it must be confessed that they need further investigation.

HYMENOPTERA.

AMASIS BYRAMI, new species.

Plate 2, fig. 5.

Length slightly over 8 mm.; width of head slightly over 2 mm., of the thorax about 3 mm., of abdomen 3.2 mm.; head and thorax dark brown; antenna 5-jointed, strongly clavate, pale brown; wings clear (venation not visible); abdomen pale, the sutures beyond the middle dusky. Length of antennal joints in microns: (1) about 320, (2) 112, and broader than long. (3) 560, (4) 240, (5, club), 830, and

352 broad. The club is very well preserved and is positively not divided.

Horizon and locality.—Green River Eocene, head of East Alkali Gulch, about 8 miles south of De Beque, Colorado, 1922. (John P. Byram.)

Holotype.—Cat. No. 69181, U.S.N.M.

Compared with the modern (European) *A. crassicornis* (Rossi), the second antennal joint is shorter, and the third is much longer in proportion to the fourth, while the club is broader basally. Possibly, if we had the wings, it might be necessary to describe a new genus, but so far as the specimen shows it may well go in *Amasis*. The genus *Amasis* consists to-day of 17 species and some named varieties, occupying the Palaearctic region from Siberia to Marocco and France. *Amasis dilatata* Lepeletier and *A. subflavata* Kirby, described from Brazil and Argentine, respectively, are referred by Konow to the related genus *Plagioceros* Klug. In 1909 Mocsary described *A. brasiliensis* from Brazil and *A. neotropica* from Paraguay. The distribution is somewhat analogous to that of the Camellidae, and fossil *Amasis* in America might have been expected.

Another specimen of *A. byrami*, from the same place, is 9.5 mm. long.

HOPLISUS ARCHORYCTES Cockerell.

Plate 1, fig. 5.

This remarkable specimen, described in *Nature*,⁸ was found by Mr. John Byram in the Green River shales at the head of Bear Gulch, Colorado. As the figure shows, it is entirely of a modern type, in spite of its great antiquity, no older wasp being known. For the origin of the Fossores we must evidently go back to the Mesozoic.

Holotype.—Cat. No. 69182, U.S.N.M.

COLEOPTERA.

Family MORDELLIDAE.

MORDELLA PRISCULA, new species.

Plate 1, fig. 7.

Length about 3 mm.; robust, dark brown, the elytra somewhat paler, without spots, but with the sutural margin darkened, in the manner of *Mordellistena grammica* LeConte; caudal style of moderate length (rather over half a millimeter), not very slender; legs reddish-brown; hind tibiae with a single well-developed dark ridge close to and parallel with the broad margin; hind tarsi formed as

⁸ Sept. 2, 1922, p. 313.

usual in the genus, without ridges, the basitarsi about as long as the next two joints together.

Horizon and locality.—Green River Eocene of Roan Mountains, Colorado, July, 1922, at Station 2, at head of Salt Wash.

Holotype.—Cat. No. 69183, U.S.N.M.

This little species looks like a *Mordellistena*, but the hind legs are very well shown, and are as in *Mordella*. It is the first Eocene Mordellid, the oldest members of the family hitherto known being from Baltic Amber. It is interesting to find such a well-marked and specialized family of beetles in the Eocene; one more indication that the families of insects were at least nearly all developed prior to the Tertiary. Wickham has described no less than eight species of Mordellidae from the Miocene of Florissant, but no others have hitherto been found fossil in America.

Family MELANDRYIDAE.

CICINDELOPSIS EOPHILUS Cockerell.

Dr. Walther Horn, of Berlin, the well-known specialist in Cicindelidae, wrote that he could not place *Cicindelopsis* in that family. I accordingly requested Herbert S. Barber to look at the fossil, which he very kindly did, and in his opinion it should be associated with the Melandryidae, somewhere in the vicinity of *Prothalia* LeConte. The family is new to the American Eocene, but a single species of *Synchroa* has been found in the Miocene of Florissant. The generic name, which merely indicates resemblance to *Cicindela*, is still appropriate.

Mr. Barber was able to remove a fragment of the matrix from over the base of the elytron, and decided that the humeral obliquity was mistaken by me for the scutellar emargination, so that the specimen is a left instead of right elytron.

Family CERAMBYCIDAE.

CLYTUS (?) PERVETUSTUS (Cockerell).

Plate 1, fig. 3.

Described as *Lema* (?) *pervetusta* Cockerell.⁹

Another specimen; Green River Eocene, above rich shale in Camp Gulch, Colorado (Winchester, 17-8), showing the whole elytron, which is 9 mm. long, with four pale transverse bands, the second oblique, the others transverse, except that the fourth has its outer half oblique. This can not be a *Lema*; it may possibly be a Longicorn allied to *Leptura*, but at present I find no genus in which it may

⁹ Proc. U. S. Nat. Mus., vol. 57, 1920, p. 256.

be confidently placed. The new specimen shows neither punctures nor striae. The general aspect is suggestive of the Clytini, the oblique second band being very much as in the European *Clytus* (*Anaglyptus mysticus* Linnaeus (specimen from Southwater, Sussex, compared). I provisionally transfer the insect to *Clytus*, which is at any rate more plausible than *Lema*. The elytron is not truncate as in *Clytus*, and the reference can not be more than approximate. The dark apex agrees with *Leptura*.

Plesiotype.—Cat. No. 69185, U.S.N.M.

ARACHNIDA.

Family LINYPHIIDAE.

LINYPHIA BYRAMI, new species.

Plate 1, fig. 8.

Male.—Length hardly 3 mm., the abdomen very small; color very pale, but femora dark brown, broadly pallid basally; patellae brown; tibia broad apically and pallid basally; femora very stout, patellae and tibiae with long spines, as in modern *Linyphia*. The following measurements are in microns: Length of anterior femur 1,600, width 450; length of anterior patella plus tibia about 1,520, width of tibia 240; length of spine at end of anterior patella 520; spines on outer side of anterior tibia about 320; length of second femur about 1,650; length of fourth patella plus tibia 1,200, the patella with a long spine as on front legs.

Horizon and locality.—Green River Eocene, head of East Alkali Gulch, about 8 miles south of De Beque, Colorado. (John P. Byram, 1922.)

Holotype.—Cat. No. 69184, U.S.N.M.

Although this spider fails to exhibit many of the more important diagnostic features, the general appearance, marking of the legs, and spines are so exactly those of *Linyphia* that the reference to the modern genus appears justified. Petrunkevitch (1922) records four species of *Linyphia* from the Miocene of Florissant. One species is known from Baltic amber (*L. oblonga* Berendt).

While looking up the literature of fossil spiders, I notice that the living *Phidippus formosus* Peckham, 1883, requires a new name on account of the amber *P. formosus* Berendt, 1854. Peckham's species may be designated *P. homarinus*, new name, from a certain resemblance in the marking of the abdomen to a lobster's claw. So also, *Clubiona sericea* (Cambridge, 1898), from Mexico, is preoccupied by an amber species; the name may be changed to *C. tabascana*, new name.

3. A MIOCENE EARWIG.

LABIDUROMMA EXSULATUM Scudder.

Plate 1, fig. 6.

Scudder only figured the female of this Florissant species; opportunity is taken to figure the male (U.S.G.S., 1607, with reverse, 1606). Except for the large eyes, typical of *Labiduroomma*, one might take the insect for a *Forficula*. It is possible to see the first two joints of the anterior tarsi, and the second joint is heart-shaped, as in *Forficula*. The first joint, however, is stout and swollen, pyriform in outline as seen from above. The last dorsal segment is obtusely subangulate in the middle. The very stout forceps are broad and contiguous basally, as in certain species of *Forficula*.

In the very large collections from the Green River Eocene, no Earwig has been found.

Plesiotype.—Cat. No. 69187, U.S.N.M.

4. A FOSSIL BEETLE FROM WASHINGTON STATE.

I am greatly indebted to Dr. F. H. Knowlton for the opportunity to study a fossil elytron from a new locality, Deep Creek Canon, near Spokane, Washington. It was found "in clay beds interbedded with volcanic flows of Upper Miocene age, associated with a large and beautifully preserved flora." At Doctor Knowlton's suggestion, I am very glad to name it after C. O. Fernquist, of Spokane, who collected it and has given much aid in collecting and forwarding fossil plants. The species belongs to a well-known modern genus of Carabidae.

CALOSOMA FERNQUISTI, new species.

Plate 2, fig. 8.

Elytron 20.5 mm. long, 7 broad, the apex more produced and pointed than in *C. scrutator* Fabricius; 18 longitudinal striæ, which are strongly punctured, or 19, counting the short inner basal one which is about 4 mm. long; punctures connected transversely by shallow sulci, as in living species; in middle of elytron about 11 punctures in 3 mm. longitudinally; foveae in fourth and eighth interspaces (counting from inner margin) not very distinct, but essentially as in *C. scrutator*.

The *C. scrutator* compared is from Geneva, Ohio (Mrs. Nellie B. Henderson). In the form of the elytron, with comparatively acute apex, this is much more like *C. externum* Say, of the eastern United States; it was on account of this feature that Dejean named Say's species *longipenne*. Doctor Knowlton showed the fossil to Dr. E.

A. Schwarz, who remarked that it was with difficulty separable from the modern *C. externum*.

Holotype.—Cat. No. 69218, U.S.N.M.

Three species of *Calosoma* have been described from the Florissant Miocene. The following key, based on the elytra, separates the fossil species of *Calosoma* of America.

Elytron 13 mm. long, without punctures.....*emmonsii* Scudder.
Elytron about 17 mm. long, greatest width less than 6.5 mm.

Interstices between striae divided into quadrate spaces by transverse lines (as in *C. scrutator*).....*calvini* Wickham.

Interstices not so marked.....*cockerelli* Wickham.

Elytron over 20 mm. long, 7 broad; interstices between striae divided into quadrate spaces.....*fernquisti* Cockerell.

No less than eight species of *Calosoma* are known from the Upper Miocene of Europe (Baden and Switzerland). One (*C. heeri*) was described by Scudder, the rest by Heer. One supposed *Calosoma* (*C. agassizi*) from the French Oligocene is now referred to the related genus *Calliothenes*. Handlirsch credits this species to Oustalet, 1874, but I believe it is the *Carabus agassizi* Barthelemy-Lapommeraye, 1846. (In 1850 Le Conte named a *Carabus* from Lake Superior after Agassiz, but he called it *C. agassii*. It is a form of *C. taedatus* Fabricius.)

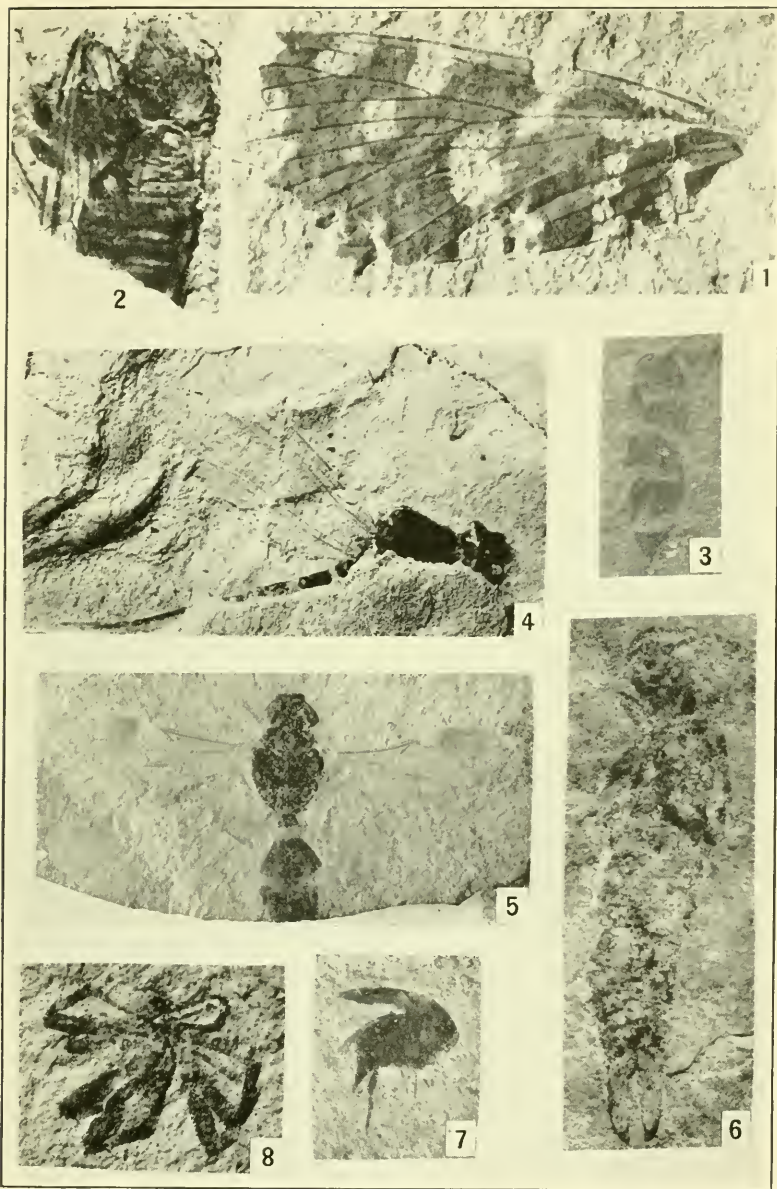
EXPLANATION OF PLATES.

PLATE 1.

- FIG. 1. *Dinopanorpha megarche* × 3.
2. *Amagua fortis* × 3.
3. *Clytus* (?) *pervetustus* × 6.
4. *Epallagites avus* × 2.
5. *Hoplisis archoryctes* × 3.
6. *Labiduroomma exsulatum* × 3.
7. *Mordella priscula* × 6.
8. *Linyphia byrami* × 6.

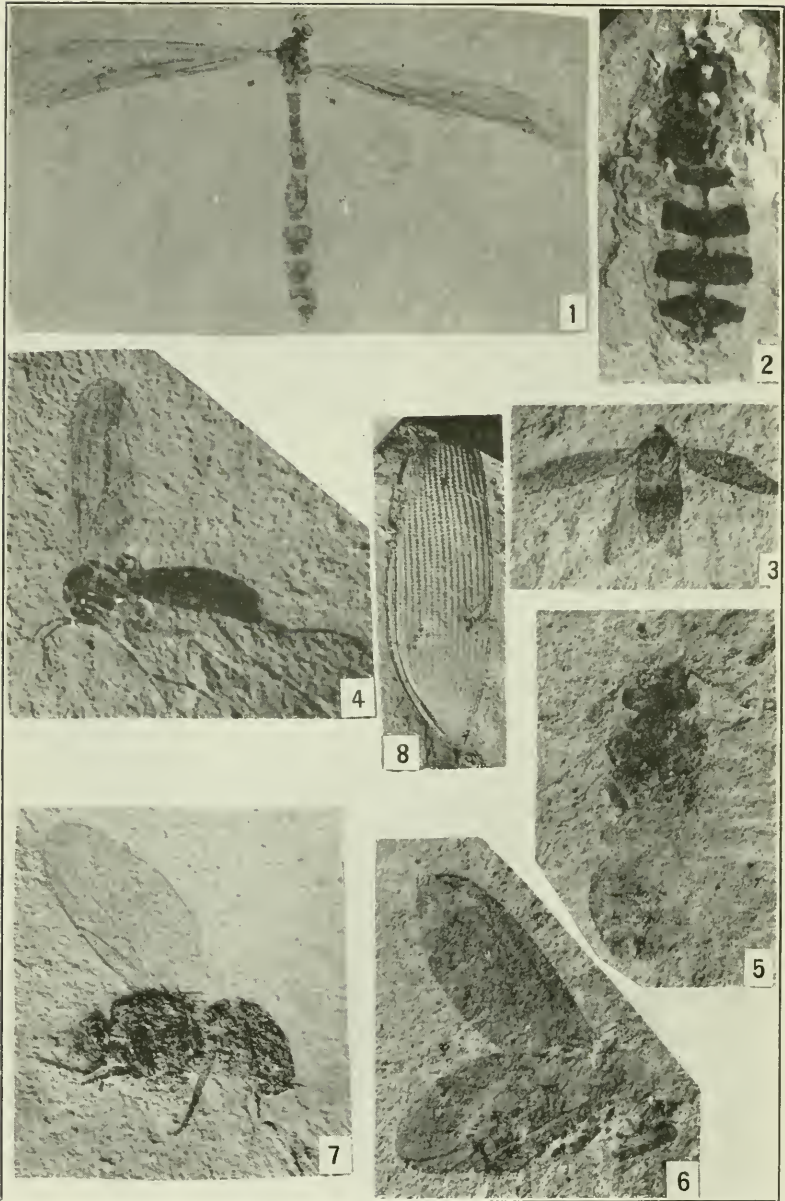
PLATE 2.

- FIG. 1. *Cyttaromyia reclusa* × 3.
2. *Syrphus eocenicus* × 3.
3. *Delphax senilis* × 6.
4. *Acnemia cyclosoma* × 4.
5. *Amasis byrami* × 4.
6. *Plecia rhodoptera* × 6.
7. *Eophlebomyia claripennis* × 6.
8. *Calosoma fernquisti* × 2.



FOSSIL INSECTS IN U. S. NATIONAL MUSEUM

FOR EXPLANATION OF PLATE SEE PAGE 16.



FOSSIL INSECTS IN U. S. NATIONAL MUSEUM

FOR EXPLANATION OF PLATE SEE PAGE 15

NEW SPECIES AND SUBSPECIES OF SPIDER CRABS.

By MARY J. RATHBUN.

Associate in Zoology, United States National Museum.

All but two of the new forms are American and will be more fully described in a monograph of spider crabs the publication of which is delayed.

PODOCHELA SIDNEYI, new species.

Holotype.—Male, Cat. No. 7253, United States National Museum. Off Cape Hatteras, North Carolina, 49 fathoms, station 2297, *Albatross*.

Measurements.—Male holotype, length of carapace 14 mm., width 10.7 mm.

Description.—Near *P. riisei*¹; differs in the longer ambulatory legs, the straighter and longer dactyls of the last three pairs, which are more than half as long as their respective propodites; cardiac and posterior gastric prominences more produced, spiniform; the flat sternal segments have sharp, cristate margins; palm less dilated than in *riisei*, gape of fingers narrower, prehensile teeth more numerous and more uniform in size.

PODOCHELA BARBARENSIS, new species.

Holotype.—Male, Cat. No. 48256, United States National Museum. Off Brockway Point, Santa Rosa Island, California, 38–45 fathoms, station 4431, *Albatross*.

Measurements.—Male holotype, length of carapace 23.8 mm., length of rostrum 9 mm., width of carapace 12.7 mm.

Description.—Rostrum a long spine; orbital arch finely spinulose; antennae filiform, the movable articles of the peduncle unusually slender. Chela widest behind middle of palm, thence tapering to end of fingers; gape correspondingly narrow. First leg three times as long as carapace with rostrum, dactyl slightly curved; dactyls of other legs falcate. Sternum deeply grooved between segments.

PYROMAIA ARACHNA, new species.

Holotype.—Male, Cat. No. 18144, United States National Museum. Gulf of Mexico, S. W. of Cape San Blas, Florida, 169 fathoms, station 2400, *Albatross*.

¹ Stimpson, Ann. Lyc. Nat. Hist. New York, vol. 7, 1860, p. 196, pl. 2, fig. 6.

Measurements.—Male holotype, length of carapace 45 mm., width without spines 35 mm.

Description.—Differs from *P. cuspidata*² in having five median spines on the carapace, only three spines on the branchial margin, a slender, acuminate rostral spine, the manus of the male cheliped elongate, an erect spine near the proximal end of the merus of the ambulatory legs, and a fringe of hair on each side of the dactyls.

EUPLEURODON PERUVIANUS, new species.

Holotype.—Female, ovigerous, Cat. No. 40462, United States National Museum. North end of Ferrol Bay (Chimbote), Peru; collected by R. E. Coker.

Measurements.—Female holotype, length of carapace to end of rostrum 10 mm., length of rostrum 2.2 mm., greatest width of carapace 8.2 mm.

Description.—Carapace narrower between the antero-lateral teeth than between the postero-lateral teeth. Rostrum a third as long as the postfrontal part of the carapace and half as broad as long. A preocular tooth present. No small tooth on lateral margin between the two large teeth or lobes.

PUGETTIA VENETIAE, new species.

Holotype.—Female, ovigerous, Cat. No. 50268, United States National Museum. Five miles off Newport Beach, California; received from the Venice Marine Biological Station.

Measurements.—Female holotype, median length of carapace 16.7 mm., length of horns 4.4 mm., width of carapace, spines excluded, 13.2 mm.

Description.—Carapace lumpy, each lump or boss furnished with one or more tubercles, as follows: Four gastric of which two are median, two lateral, a little behind the anterior median tubercle; one cardiac; three intestinal, arranged transversely; four or five branchial. Lateral spines three, one branchial, two hepatic; the branchial and the posterior of the hepatic spines are larger, curved and with slender tips directed forward; the minor hepatic spine is a little below the level of the major one and is straight. Postorbital spine isolated, a little behind the eye, slender. Supraocular eave less expanded over the eye than in typical *Pugettia*. Wrist and margins of arm spinous.

MENAETHIOPS PORTORICENSIS, new species.

Holotype.—Female, Cat. No. F2628, American Museum of Natural History. One and a half miles south of Caña Gorda Islands, near Guanica Harbor, Porto Rico, 26 fathoms.

² Stimpson, Bull. Mus. Comp. Zool., vol. 2, 1871, p. 110.

Measurements.—Female holotype, total length of carapace 5.4 mm., length of rostrum 1.6 mm., width of carapace without spines 2.7 mm.

Description.—Carapace and appendages covered with broad, flattened vesicles, the largest spatuliform. Carapace constricted behind orbit and behind hepatic regions. Four tubercles in a transverse diamond on gastric region. Rostrum divided to its middle. Preocular spine suberect, prominent. Two slender marginal hepatic spines; a larger spine near lateral angle of carapace.

CHORILIA LONGIPES TURGIDA, new subspecies.

Holotype.—Male, Cat. No. 15500, United States National Museum. Off San Diego, California, 359 fathoms, station 2936, *Albatross*.

Measurements.—Male holotype, length of carapace on median line 56 mm., width 50 mm.

Description.—Compared to typical *C. longipes*,³ the carapace is much rougher, more spinous, the tubercles replaced by short, sharp spines; the hepatic margin bears a spine instead of a tubercle or blunt ridge; the width of the carapace increases notably in proportion to the length, the branchial regions are inflated and approach nearer the median line, so that the distance between them is not more than half the greatest width of the cardiac region; the movable segments of the antennal peduncle are longer and more slender.

CHIONOECETES OPILIO ELONGATUS, new subspecies.

Holotype.—Male, Cat. No. 46636, United States National Museum. Sea of Japan, latitude 38° 09' 00" north, longitude 138° 32' 12" east, 245 fathoms, station 4819, *Albatross*.

Measurements.—Male holotype, length of carapace on median line 112 mm., width 122.5 mm.

Description.—Differs from typical *C. opilio*⁴ in the greater length of the legs, the merus of the second leg usually exceeding that of the first leg in old males; the length of the second merus is from 5.5 to 6.3 times its width, as against a length of from 4.9 to 5.2 times its width in typical *opilio*. *C. opilio elongatus* inhabits the Sea of Japan and gradually changes in the Okhotsk Sea to the typical form.

CHIONOECETES BAIRDI, new species.

Holotype.—Male, Cat. No. 5862, United States National Museum. Head of Kingcombe Inlet, British Columbia; collected by H. E. Nichols.

Measurements.—Male holotype, length of carapace and rostrum 73.3 mm., width 81.2 mm.

³ Dana, Amer. Journ. Sci., ser. 2, vol. 11, 1851, p. 269.

⁴ O. Fabricius, K. Danske Vid. Selsk. Skr., nye Saml., vol. 3, 1788, p. 182, plate.

Description.—Compared to *C. opilio*⁵ the carapace is wider owing to the greater depression of the branchial regions. The whole animal is rougher; the spines in the row leading from the pterygostomian region backward to the branchial region become suddenly larger, the last three or four spines being of considerable size; several other prominences of the antero-lateral regions are spinous instead of tuberculous. Lateral margin of carapace deeply scalloped. Outer orbital tooth curved more strongly inward, rostral teeth narrower, interspace wider. Spines of legs longer.

CHIONOECETES ANGULATUS, new species.

Holotype.—Male, Cat. No. 19303, United States National Museum. South of Pribilof Islands, Bering Sea, 1,401 fathoms, station 3604, *Albatross*.

Measurements.—Male holotype, length of carapace on median line 73 mm., width exclusive of spines 78.6 mm.

Description.—Differs from *C. tanneri*⁶ in the two dorsal rows of spines and tubercles on the branchial region meeting at the outer margin in an acute angle; interbranchial space not so deeply depressed; rostral teeth as wide as, or wider than, the length of their inner margin.

HYAS COARCTATUS URSINUS, new subspecies.

Holotype.—Female, ovigerous, Cat. No. 46493, United States National Museum. Sea of Japan, latitude 45° 24' 00'' north, longitude 140° 49' 10'' east, 325 fathoms, station 4992, *Albatross*.

Measurements.—Female holotype, length of carapace to end of rostrum 60.6 mm., width 41.8 mm.

Description.—Much more hairy than typical *H. coarctatus*,⁷ especially the legs and the ventral surface of the body; legs concealed by a dense vesicular pubescence and longer, slenderer hairs which are most abundant on the lower surface of the merus. Carapace broad behind as in *coarctatus alutaceus*⁸ but relatively narrower across the hepatic regions. Rostrum elongate, leaning toward typical *coarctatus*.

LISSA BRASILIENSIS, new species.

Holotype.—Female, Cat. No. 2055, Museum of Comparative Zoölogy. Off Cape Frio, Brazil, 35 fathoms, *Hassler Expedition*.

Measurements.—Female holotype, length of carapace 16.6 mm., width 15 mm.

⁵ O. Fabricius, K. Danske Vid. Selsk. Skr., Nye Saml., vol. 3, 1788, p. 182, plate.

⁶ Rathbun, Proc. U. S. Nat. Mus., vol. 16, 1893, p. 76, pl. 4, figs. 1-4.

⁷ Leach, Trans. Linn. Soc. London, vol. 11, 1815, p. 329.

⁸ Brandt in Middendorff's Reise in den Äussersten Norden und Osten Sibiriens, vol. 2, Zool., pt. 1, 1851, p. 79.

Description.—Carapace hairy and granulate, granules separated except on the summit of the protuberances. Protuberances arranged as in *L. tuberosa*,⁹ but the terminal protuberance of the branchial ridge is more transverse and the posterior, deflexed portion of the carapace is broader, its margin more arcuate. Anterior margin of rostrum in the form of a cupid's bow, with a small median emargination and the outer angles directed upward in a stout, curved, blunt spine. One crest on carpus of chelipeds, two crests on carpus of ambulatory legs.

TELEOPHRYS POCOCCI, new species.

Holotype.—Male, Cat. No. 25765, United States National Museum. Maceio coral reef, Alagoas, Brazil, Branner-Agassiz Expedition.

Measurements.—Male holotype, greatest length of carapace 7.3 mm., greatest width 7.7 mm.

Description.—Resembling *T. cristulipes*,¹⁰ but front less deeply bifid; only one antero-lateral spine; tooth at middle of outer margin of basal antennal article obsolescent; tubercle on palm larger and sublaminar. Legs slenderer; no lobe on posterior surface of propodites.

SOLENOLAMBRUS PORTORICENSIS, new species.

Holotype.—Male, Cat. No. 24237, United States National Museum. Mayaguez Harbor, Porto Rico, 75 to 76 fathoms, station 6063, *Fish Hawk*.

Measurements.—Male holotype, length of carapace 7.3 mm., width of same 8.5 mm.

Description.—Near *S. typicus*;¹¹ carapace wider; median gastric area narrower; no median lines; six minute teeth on posterior and postero-lateral margins. Chelipeds shorter; on outer and lower surfaces of palm a row of large granulated tubercles parallel to each margin; outer and inner margins tuberculated; dactylus at right angles with palm.

⁹ Rathbun, Proc. U. S. Nat. Mus., vol. 21, 1898, p. 574, pl. 41, fig. 3.

¹⁰ Stimpson, Ann. Lyc. Nat. Hist. New York, vol. 7, 1860, p. 190, pl. 2, fig. 2.

¹¹ Stimpson, Bull. Mus. Comp. Zool., vol. 2, 1871, p. 133.

A REVISION OF THE MUTILLID WASPS OF THE
GENERA MYRMILLOIDES AND PSEUDOMETHOCA
OCCURRING IN AMERICA NORTH OF MEXICO.

By CLARENCE E. MICKEL,

Of the Department of Entomology, University of Minnesota.

This study is the outgrowth of an attempt, several years ago, to identify a large collection of Mutillidae at the University of Nebraska. In this work it soon became apparent that accurate identification of the North American Mutillidae was hopeless, until something like order could be brought out of the chaotic condition of the generic and specific classifications. Several generic classifications have been proposed, but that outlined by Dr. J. C. Bradley (1916) seems to be the most satisfactory at present for the North American species and, in the main, is the classification followed by the writer.

Most of the genera recognized in Doctor Bradley's classification need to be studied and revised, and the present paper deals with two of these groups, *Myrmilloides* André and *Pseudomethoca* Ashmead. The species included by Fox (1899) in his *grandiceps* group is here placed in the genus *Myrmilloides* André, while those which he included under the *canadensis* and *simillima* groups, together with some others are placed in a single genus, *Pseudomethoca* Ashmead. On account of the scarcity of material from Mexico and Central America and the impossibility of examining the types of many of the species described from those regions, the work has been limited to the forms which are found in North America north of Mexico. A list of the species described from Mexico and Central America which probably belong to the genus *Pseudomethoca* Ashmead is included herein.

The females of the various species of Mutillidae are in many cases more or less superficially alike, but the males are even more so. This fact has caused a great deal of confusion in the identification of the males of this family. No less than six different species of males have been found by the writer in a series of specimens which were supposed to include representatives of a single species. In searching for characters by which the males could be separated from one another the writer was led to examine the genital structures and found

that they possessed excellent specific characters. After separating the various species of males by this means, it was found that external structural characters could be correlated with the specific characters found in the genitalia, and that keys based on external characters alone could be made.

Edward Saunders (1884) was the first to point out the taxonomic value of the male genitalia in the aculeate Hymenoptera, and he figured them for a number of families. Radoszkowski (1885) figured and described these structures for a large number of Mutillidae with the intention of revising the classification of the family. However, from that time until recently, the male genitalia of the Mutillidae do not seem to have been seriously considered as possessing good specific or generic characters, although in several cases they have been figured for a number of species.

The morphology and homologies of the male genitalia of the Hymenoptera have been discussed by Peytoureau (1895), Bordas (1895), Zander (1900), and Crampton (1919, 1920). Dufour (1834), Saunders (1884), and Radoszkowski (1885) describe their structure in the Mutillidae in considerable detail. The nomenclature of the parts (pl. 1, fig. 1) used in this paper is that given by Bradley (1917). The parts which have proved most useful for specific characters are the squama, sagitta, volsella, and ramus. In the various species these parts exhibit a great variety of form and vestiture. In the genus *Pseudomethoca* Ashmead, at least, the uncus and the cardo do not appear to be important as far as specific characters are concerned.

The external structural characters which have been found useful in separating either the females or the males are as follows: The dentate condition of the genae of the females together with the character of the longitudinal carina of the genae; the distance between the antennae at their base; the character of the frontal tubercles at the base of the antennae; the character of the cephalic margin of the propleura and the humeral angles of the pronotum; the relative width of the head and thorax; the shape of the thorax; the sculpture of the pygidium of the female; the form and sculpture of the tegulae of the males; and the sculpture and vestiture of other sclerites of the head, thorax, and abdomen.

The average worker will not find it necessary to examine the male genitalia in order to identify specimens, but an account of the technique used in removing these structures without injury to the specimen may prove of value to those who wish to examine them. The instrument used for dissection is a No. 00 white pin. The tip of this is bent to form a very minute hook, and the head of the pin is fastened into a small piece of cork, which serves as a handle. The specimen is first relaxed, then holding it in one hand, the probe

is inserted at the tip of the abdomen between the genitalia and the last sternite, until the hook is pushed beyond the base of the cardo. By a slight twist of the probe, the hook is brought into position to catch at the base of the cardo and then withdrawn from the abdomen, bringing the genitalia with it. With a little practice one soon becomes skilful enough to remove the genitalia in this manner without in any way injuring them or the specimen. The former are mounted on a paper point which is placed on the pin directly beneath the specimen from which the genitalia were removed.

On account of the fact that the various species of males may be recognized by the use of external characters alone, I have not ventured to make detailed descriptions of the genitalia. However, in each case, except two, figures of the genitalia have been drawn by the author either from the type specimen or from a specimen which has been compared with the type. These figures present the dorsal view of these structures as they lie in their normal position within the abdomen. The figures are all drawn to the same scale; 1 mm. in the drawing equals 0.0185 mm. in the genitalia.

For the loan of material and the privilege of examining type specimens in various collections I am indebted to the following: S. A. Rohwer, United States National Museum; Dr. Henry Skinner, American Entomological Society and Philadelphia Academy of Sciences; Dr. Frank E. Lutz, American Museum of Natural History; Dr. Nathan Banks, Museum of Comparative Zoology; Prof. S. J. Hunter, University of Kansas; and Dr. J. C. Bradley, Cornell University. I am also indebted to the following persons for the loan of material: Prof. Myron H. Swenk, University of Nebraska; Dr. J. Bequaert, American Museum of Natural History; Dr. C. P. Gillette, Colorado State Agricultural College; Prof. G. A. Dean, Kansas State Agricultural College; Prof. J. R. Parker and Prof. R. A. Cooley, Montana State Agricultural College; Dr. J. G. Sanders, Pennsylvania Department of Agriculture; Prof. R. W. Doane, Leland Stanford University; Prof. W. J. Chamberlin, Oregon State Agricultural College; Dr. I. W. Hawley, Utah State Agricultural College; Dr. J. McDunnough, Department of Agriculture of Canada; Prof. R. W. Harned, Mississippi State Plant Board; Prof. C. S. Brimley, North Carolina State College of Agriculture; Prof. G. M. Bentley, University of Tennessee; Prof. H. F. Wickham, Iowa State University; Prof. Don C. Mote, State Entomologist of Arizona; Mr. H. S. Smith, California State Insectary; Prof. H. J. Reinhard, Texas State Agricultural College; Prof. O. A. Stevens, North Dakota State Agricultural College; and Mr. C. N. Ainslie, Sioux City, Iowa. To all of these I wish to express my appreciation. I am also greatly indebted to Dr. William A. Riley and Dr. H. H. Knight for encouragement and helpful suggestions during the course of this work.

Genus MYRMILLOIDES André.

Myrmilloides ANDRÉ, 1903, Gen. Ins., vol. 1, fasc. 11, p. 26.—ASHMEAD, 1903, Can. Ent., vol. 25, p. 324, male; p. 332 female.—BRADLEY, 1916, Trans. Amer. Ent. Soc., vol. 42, p. 191.

Haplotype.—*Mutilla grandiceps* Blake.

The genus *Myrmilloides* was proposed by André in 1903 to include a single species.

MYRMILLOIDES GRANDICEPS (Blake).

Plate 1, fig. 2.

1872. *Mutilla grandiceps* BLAKE, Trans. Amer. Ent. Soc., vol. 4, p. 74, male.

1886. *Sphaerophthalma grandiceps* BLAKE, Trans. Amer. Ent. Soc., vol. 13, p. 244, male and female.

1887. *Sphaerophthalma grandiceps* CRESSON, Trans. Amer. Ent. Soc., suppl. vol., p. 265, male and female.

1897. *Mutilla grandiceps* DALLE TORRE, Cat. Hymen., vol. 8, p. 44, male and female.

1899. *Mutilla grandiceps* Fox, Trans. Amer. Ent. Soc., vol. 25, p. 222, male and female.

1903. *Myrmilloides grandiceps* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 27, male and female.

1903. *Mutilla grandiceps* MELANDER, Trans. Amer. Ent. Soc., vol. 29, p. 293, male and female.

Type.—Male, Texas, in collection of American Entomological Society of Philadelphia.

Plesiotype.—Male, August 24, 1916, Mitchell, Nebraska (R. W. Dawson), in entomological collection of University of Nebraska.

Specimens examined.—Colorado: Male, August 3, 1899, Sterling; 4 males, 4 females, Colorado Springs (W. M. Wheeler); female, June 1, 1921, Lamar (C. E. Mickel). Iowa: female, July 8, 1921, Sioux City (C. N. Ainslie); male, July 10, 1920, Sioux City (C. N. Ainslie); female, July 15, 1920, Sioux City (C. N. Ainslie); female, 2 males, July 15, 1922, Sioux City (C. N. Ainslie); male, August 27, 1920, Sioux City (C. N. Ainslie); male, September 7, 1920, Sioux City (C. N. Ainslie); female, September 17, 1921, Sioux City (C. N. Ainslie); female, Sioux City (C. N. Ainslie). Kansas: male and female, July 11, Riley County (Popenoe); female, July 19, Riley County (Popenoe); female, August 12, Riley County (G. A. Dean); female, Wallace County (F. X. Williams). Nebraska: female, May 27, 1916, South Bend (L. Bruner); female, July 10, 1912, Bridgeport (L. M. Gates); female, June 23, 1916, Mitchell (R. W. Dawson); female, July 8, 1915, Mitchell (L. M. Gates); female, July 26, 1916, Mitchell (C. E. Mickel); 2 females, August 1, 1916, Mitchell (C. E. Mickel); male, August 4, 1916, Mitchell (C. E. Mickel); male, August 24, 1916, Mitchell (R. W. Dawson). Oklahoma: female, June 11, South McAlester (Wickham). Texas: male, September 23, 1905, Rosser (C. R. Jones).

The genitalia of the type and the plesiotype have been compared and found to be identical. The mandibles in both sexes are distinctly bidentate, and not tridentate as indicated by Fox (1899) in his key to the groups of species. Nothing is known of the biology of this species other than the possibility suggested by Melander (1903) that it is parasitic on *Halictus pruinosus* Robertson.

Genus PSEUDOMETHOCA Ashmead.

- Pseudomethoca* ASHMEAD, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 181, male; 1899, Journ. N. Y. Ent. Soc., vol. 7, p. 55, female; p. 59 male.—ANDRÉ, 1903, Gen. Ins., vol. 1, fasc. 11, p. 27, male and female.—ASHMEAD, 1903, Can. Ent., vol. 35, p. 325, male; p. 331, female.—BRADLEY, 1916, Trans. Amer. Ent. Soc., vol. 42, pp. 191, 311, 318.—ROHWER, 1916, Hymen. Conn., p. 622.
- Nomiaephagus* ASHMEAD, 1899, Journ. N. Y. Ent. Soc., vol. 7, p. 56, female, p. 59, male; 1903, Can. Ent., vol. 35, p. 307, male; p. 309, female.—ROHWER, 1916, Hymen. Conn., p. 623.
- Ephuta* ANDRÉ, 1903, Gen. Ins., vol. 1, fasc. 11, p. 51 (part).
- Orthotype*.—*Photopsis cressonii* Fox=*canadensis* Blake.

The genus *Pseudomethoca* was proposed by Ashmead in 1896. He designated *Photopsis cressonii* Fox as the type, which subsequently was shown to be the male of *Mutilla* (*Sphaerophthalma*) *canadensis* Blake. In 1899 and in 1903 Ashmead characterized the females in his keys to the genera of Mutillidae. He stated that the females possessed a distinct pygidial area. André in 1903 recharacterized the females stating that Ashmead was in error and that the females did not possess a distinct pygidial area. I have examined a number of females of *Pseudomethoca canadensis* (Blake) under a binocular microscope and find that Ashmead was correct; the females of this species possess a distinct pygidial area bounded laterally each side by a sharp carina. This is also true of the females of other species which have been assigned to this genus. In 1899 Ashmead established the genus *Nomiaephagus* with *Mutilla* (*Sphaerophthalma*) *sanbornii* Blake as the type. In his keys to the genera of Mutillidae (1903) he placed *Nomiaephagus* in the tribe *Photopsidini* and *Pseudomethoca* he placed in the tribe *Mutillini*, making this division on the character of the eyes. Bradley (1916) has pointed out the inconsistency of this division. I have before me the specimens of *sanbornii* upon which Ashmead based his diagnosis. These specimens include both males and females which had been reared from the cells of a bee, *Nomia pattoni* Cockerell. In some of the female specimens the eyes are "highly polished with the facets vaguely defined," while in others the eyes are "distinctly faceted." Ashmead's division of genera into the tribes *Photopsidini* and *Mutillini* based on the character of the eyes, certainly can scarcely stand in the face of this evidence. The species which have been placed under *Nomiaephagus*

are very closely related to those which have been assigned to *Pseudomethoca*, and have been so treated by Fox (1899) and by Bradley (1916). Bradley (1916) reduced *Nomiaephagus* to subgeneric rank, making it a subgenus of *Pseudomethoca*. I have been unable to find characters of sufficient value for separating these two groups of species even as subgenera and therefore unite them here under the one genus *Pseudomethoca*. In the sense used in this paper the species of *Pseudomethoca* may be separated from all of the other North American forms by the following characters: eyes round or slightly oval, entire, not emarginate; pubescence of the body composed entirely of simple hairs; first segment of the abdomen entirely sessile with the second, the apex of the first segment being of the same size as the base of the second; a longitudinal carina always present on the genae of the females.

KEY TO THE SPECIES.

Females.

1. Head spinose or dentate beneath..... 2
Head not spinose or dentate beneath..... 7
2. Head thickly clothed with appressed, silvery pubescence..... 3
Head more or less bare, not thickly clothed with appressed, silvery
pubescence..... 5
3. Size large, 13 mm.; ventral, postero-lateral angles of head sharply angulate,
or dentate..... 12. *cephalargia*, new species.
Size small, 3-5 mm.; ventral, postero-lateral angles of head carinate,
but not sharply angulate, or dentate..... 4
4. Carina of postero-lateral angles prominent, sharp, extending upon the
vertex..... 6. *toumeyii* Fox.
Carina of postero-lateral angles not prominent, not extending upon the
vertex..... 7. *bequaerti*, new species.
5. Genae beneath bidentate..... 4. *nephele* Fox.
Genae beneath unidentate..... 6
6. Front produced at the base of the antennae into a thin, bidentate lamella
..... 2. *dentifrontalis* Bradley.
Front not so produced..... 1. *canadensis* Blake.
7. (1) Greater part of abdomen ferruginous, or yellowish..... 8
Abdomen black, except first and last segments.... 14. *wickhami* Cockerell.
8. Dorsum of propodeum with a large, prominent, rugose tubercle at the apex
medially..... 13. *donae-anae* Cockerell and Fox.
Propodeum without any such tubercle..... 9
9. Dorsum of body densely clothed with erect and semierect pubescence... 10
Dorsum of body thinly clothed with pubescence..... 13
10. Head distinctly wider than the thorax; pubescence of dorsum of body
fulvous..... 19. *harpalyce* Fox.
Width of head and thorax about equal..... 11
11. Pubescence of dorsum of head, thorax, and abdomen concolorous..... 12
Pubescence of head and thorax black, that of the second dorsal tergite
golden..... 22. *pigmentata*, new species.

12. Pubescence of dorsum of head, thorax and abdomen light golden. 21. *aureovestita* Bradley.
 Pubescence of dorsum of head, thorax and second tergite fiery red; third tergite with black pubescence medially, silvery pubescence laterally; remaining tergites with silvery pubescence. 20. *flammigera*, new species.
13. (9) Head thickly clothed with appressed, silvery or golden pubescence. 14 Head more or less bare, not clothed with appressed, silvery or golden pubescence..... 18
14. Size small, 3-5 mm..... 15
 Size large, 7-10 mm..... 16
15. Second abdominal tergite reticulato-punctate medially on the basal half. 8. *occulissima*, new species.
 Second abdominal tergite finely punctate throughout. 9. *scaevolella* Cockerell.
16. Second abdominal tergite with a well defined pattern of silvery maculation..... 17
 Second abdominal tergite without any well defined pattern of silvery maculation..... 17. *praeclara* Blake.
17. Second abdominal tergite with a large, basal and apical, dark macula connected by a narrow line, thereby making the form of an hourglass; the remainder of the segment filled in with silvery pubescence; punctures of the thorax coarse but rather close, not running into reticulations posteriorly..... 15. *connectens* Cresson.
 Second abdominal tergite with a transverse bar of thin, silvery pubescence a little behind the middle, which is extended near each side into a narrower stripe almost to the base of the segment, thus ll; thorax with distinct reticulations posteriorly..... 16. *contumax* Cresson.
18. (13) Size small, 3-5 mm., pygidium punctate..... 19
 Size large, 8-15 mm., pygidium rugose or striate..... 20
19. Body testaceous, second abdominal tergite without any definite pattern of silvery ornamentation..... 11. *aprica* Melander.
 Body ferruginous, second abdominal tergite with two, round, silvery spots of pubescence..... 10. *nudula*, new species.
20. Pygidium rugose..... 21
 Pygidium striate..... 26
21. Head, thorax, and abdomen for most part ferruginous..... 22
 Head and thorax black; second abdominal tergite entirely, and remaining abdominal tergites fringed at the apex, with golden pubescence. 36. *brazoria* Blake.
22. Humeral angles of prothorax with a weak, slightly elevated carina..... 23
 Humeral angles of prothorax with a strong, sharp carina..... 24
23. Propodeum with the posterior face more or less rounded into the dorsum, not at a distinct right angle with the dorsum; metapleura micropunctate, thinly clothed with silvery pile..... 34. *sanbornii* Blake.
 Propodeum with the posterior face at a distinct right angle with the dorsum; metapleura sometimes very slightly micropunctate, not clothed with silvery pile..... 35. *propinqua* Cresson.
24. Humeral angles acute..... 23. *occola* Blake.
 Humeral angles more or less rounded..... 25
25. Apex of second abdominal tergite broadly fringed with black; legs reddish..... 26. *meritoria*, new species.
 Apex of second abdominal tergite silvery pubescent, with a narrow fringe of black pubescence medially; legs blackish red. 28. *paludata*, new species.

26. (20) Pygidium with diverging striae..... 30. *aectis* Fox.
 Pygidium with longitudinal striae..... 27
27. Apex of second abdominal tergite fringed with silvery pubescence, except
 a small, black spot medially..... 32. *oculata* Banks.
 Apex of second abdominal tergite fringed with a broad band of black
 pubescence..... 31. *simillima* Smith.

Males.

1. Size small, 3-5 mm..... 2
 Size large, 7-20 mm..... 4
2. Postero-lateral angles of head dentate..... 1. *canadensis* Blake.
 Postero-lateral angles of head rounded or obtuse..... 3
3. Head quadrate, the punctures sparse, coarse, evenly distributed.
5. *gila* Blake.
 Head transverse, the punctures fine, sparse and irregularly distributed.
3. *athamas* Fox.
4. Pubescence of abdomen above, fiery red or golden..... 5
 Pubescence of abdomen above, white or black..... 8
5. Each abdominal tergite with an apical band of fiery red pubescence.
38. *vanduzei* Bradley.
 Abdominal tergites 3-5, at least, with an apical band of golden pubes-
 cence..... 6
6. Abdomen castaneous, second tergite yellowish; tegulae coarsely punctate
 throughout; second abdominal tergite with fine, sparse punctures.....
24. *flavida* Blake.
 Abdomen entirely black..... 7
7. Humeral angles rounded, punctate, without any evidence of a carina;
 dorsum of thorax usually yellowish..... 35. *propinqua* Cresson.
 Humeral angles carinate, thorax black..... 21. *aureovestita* Bradley.
8. (4) Second dorsal segment of abdomen red..... 9
 Body entirely black..... 13
9. Posterior part of tegulae bent downward so as to form a posterior face
 at a sharp angle with the dorsal surface..... 10
 Tegulae convex, without a posterior face..... 12
10. Femora densely clothed beneath with long hairs..... 23. *oceola* Blake.
 Femora sparsely pubescent beneath..... 11
11. Tegulae rugosely punctate throughout; sixth and seventh tergites with
 whitish pubescence..... 29. *scrupulosa*, new species.
 Tegulae sparsely punctate, shining; all the tergites with black pubes-
 cence..... 31. *simillima* Smith.
12. Body clothed with pale pubescence..... 39. *russeola*, new species.
 Body clothed with black pubescence..... 34. *sanbornii* Cresson.
13. (8) Body clothed with pale pubescence..... 15
 Body clothed with black pubescence..... 14
14. Sides of propodeum rugoso-striate..... 25. *nigricula*, new species.
 Sides of propodeum rugoso-punctate..... 18. *anthracina* Fox.
15. Abdominal tergites with a distinct apical band of pale pubescence..... 16
 Abdominal tergites without a distinct apical band of pale pubescence.
33. *gerjon* Fox.
16. Tegulae subhemispherical, with a distinct posterior face; wings sub-
 fuscous..... 37. *carbonaria*, new species.
 Tegulae convex, without a distinct posterior face..... 17
17. Frontal tubercles at insertion of antennae densely punctate.
40. *aegeon* Fox.

- Frontal tubercles at insertion of antennae smooth and shining----- 18
 18. Second tergite with strong, close punctures, especially at the base and
 apex----- 27. *albicoma*, new species.
 Second tergite with sparse punctures throughout-- 41. *manca*, new species.

1. PSEUDOMETHOCA CANADENSIS (Blake).

Plate 2, fig. 7.

1871. *Mutilla (Sphaerophthalma) canadensis* BLAKE, Trans. Amer. Ent. Soc., vol. 3, p. 252, female.
 1886. *Sphaerophthalma canadensis* BLAKE, Trans. Amer. Ent. Soc., vol. 13, p. 248, female.
 1887. *Sphaerophthalma canadensis* CRESSON, Trans. Amer. Ent. Soc., suppl. vol., p. 265, female.
 1890. *Photopsis cressonii* FOX, Ent. News, vol. 1, p. 138, male (not *Mutilla Cressoni* Blake).
 1895. *Sphaerophthalma alveolata* PROVANCHER, Le Nat. Can., vol. 22, p. 110, female.
 1896. *Pseudomethoca cressonii* ASHMEAD, Trans. Amer. Ent. Soc., vol. 23, p. 182, male.
 1897. *Mutilla canadensis* DALLE TORRE, Cat. Hymen., vol. 8, p. 20, female.
 1897. *Mutilla neojerseiensis* DALLE TORRE, Cat. Hymen., vol. 8, p. 65, male.
 1899. *Mutilla canadensis* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 224, female and male.
 1903. *Pseudomethoca canadensis* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 28, female.
 1903. *Mutilla canadensis* MELANDER and BRUES, Biol. Bull., vol. 5, p. 24.
 1903. *Mutilla canadensis* MELANDER, Trans. Amer. Ent. Soc., vol. 29, p. 293.
 1916. *Pseudomethoca (Pseudomethoca) canadensis* BRADLEY, Trans. Amer. Ent. Soc., vol. 42, p. 318.
 1916. *Pseudomethoca canadensis* ROHWER, Hymen. Conn., p. 622.
 1918. *Sphaerophthalma alveolata* GAHAN and ROHWER, Can. Ent., vol. 50, p. 196.
 1922. *Pseudomethoca canadensis* RAU, Trans. Acad. Sci. St. Louis, vol. 24, p. 6, females and males.
 1923. *Pseudomethoca canadensis* MICKEL, 19th Rep. State Ent. Minn., p. 100, female.

Type.—Female, Canada, in collection of American Entomological Society of Philadelphia.

Allotype.—Male, *cressonii* FOX, in collection of American Entomological Society of Philadelphia.

Plesiotype.—Male, Colorado (C. F. Baker). Collection of U. S. National Museum.

Specimens examined.—Connecticut: Female, July 4, 1893, Hartford; female, June 17, Hartford; female, September 2, 1909, Lyme (A. Champlain). District of Columbia: Female, July 23, Washington (J. C. Crawford). Georgia: Female, June 7–23, 1911, Spring Creek, Decatur County (J. C. Bradley); female, August 2, 1913, Atlanta. Illinois: Female, June 1, 1909, Tampico. Iowa: Female, July 8, 1921, Sioux City (C. N. Ainslie); female, July 15, 1922,

Sioux City (C. N. Ainslie); female, July 30, 1921, Sioux City (C. N. Ainslie); female, August 11, 1919, Sioux City (C. N. Ainslie); female, Sioux City (C. N. Ainslie). Kansas: Female, August 5, Riley County (G. A. Dean); female, May, Riley County (Marlatt); male, September, Riley County (Marlatt); female, October 1, Riley County (E. E. Faville). Louisiana: 2 males (C. F. Baker). Maryland: 3 females, June 28, 1911, Chesapeake Beach (Wm. T. Davis). Massachusetts: Female, Woods Hole. Minnesota: Female, August 1, 1922, Jordan, Scott county (A. T. Hertig); female, July 26, 1923, Fridley sand dunes, Anoka county (R. W. Dawson); 2 females, August 30, 1923, Moorhead (O. A. Stevens). Nebraska: Female, June 11, 1913, Omaha (L. T. Williams); female, June 12, 1914 Omaha (L. T. Williams); female, June, 1888, West Point; female, West Point; female, June 21, 1920, Lincoln (R. W. Dawson); 3 females, July 18, 1920, Lincoln (R. W. Dawson); female, October 20, 1894, Lincoln (R. H. Wolcott); female, August 14, 1920, Halsey (C. B. Philip). New Jersey: Female, May 30, 1912, Lakehurst; female, August 22, 1912, Lakehurst (Wm. T. Davis); female, May 21, 1910, Hackettstown; female, May 21, 1905, Brown's Mill Jc.; female, June 8, 1902, Iona; female, May 24, 1902, Clementon (J. C. Bradley); female, August 19, 1906, Mount Holly; female, August 19, 1916, Ocean Gate; male, September 1, 1916, Palisades. New York: Female, 1883, Nyack; 2 females, West Farms, New York City; female, Mosholu; female, May 29-30, Yaphank, Long Island; female, August 10, 1916, McLean; female, August 2, 1916, Rocky Glen; female, August 23, 1886, Ithaca (Comstock); female, August 10, 1916, Ithaca; 2 males, July 19, 1904, Ithaca; 2 males, July 20, 1904, Ithaca. North Carolina: Female, July 21, 1906, Valley of Black Mountains (W. Beutenmuller); female, August 10, 1906, Summit of Craggy Mountains (W. Beutenmuller). Nova Scotia: Female, June 5, 1911, Weymouth. Pennsylvania: Female, June 9, 1912, Dauphin; female, May 21, 1912, Linglestown (Champlain); female, July 7, 1910, Heckton Mills (P. R. Meyers); female, September 5, 1909, Camp Hill; 4 females (C. F. Baker). South Dakota: Female, August 10, 1922, Ravinia (C. N. Ainslie). Texas: Female, April 17, 1907, Dallas (Schwarz and Pratt); female, Austin (W. M. Wheeler); female, May 29, 1918, Richmond (J. C. Bradley); female, April 24, 1904, Paris. Virginia: 2 females, August 4, Falls Church; female, August 7, Falls Church; male, July 27, Falls Church; female, September 1, 1915, Falls Church (C. T. Greene); 2 females, September 6, Falls Church; male, August 30, Falls Church; male, August 31, Falls Church.

I have examined the types of *canadensis* and *cressonii*, the latter being an allotype. The genitalia of the allotype and the plesiotype

have been compared and found to be identical. Melander and Brues (1903) have observed this species near the nests of *Halictus*, species and have described a combat between the two species; they have therefore concluded that *canadensis* is probably parasitic on *Halictus* species.

2. PSEUDOMETHOCA DENTIFRONTALIS J. C. Bradley, new species.

Female.—Sanford brown; nearly nude, a spot of appressed white pubescence on each side of the disk of the second dorsal segment: covered with scattered, erect, long, fine, white hairs, these black on the front; front, dorsum and second dorsal segment, except for the white spots, with rather long depressed black hairs, rather dense on the second dorsal; apices of the 3rd–5th dorsal segments with a small amount of white or yellowish hairs. Length 4.5 mm.

Head very large, transversely quadrate, much wider than the thorax; its hind angles and the posterior borders of the temples strongly carinate, the carina ending below in a spine, much as in *canadensis*; width of temples twice the long diameter of the eyes, which are $3\frac{1}{2}$ times their diameter's length apart; head closely, shallowly, somewhat confluent punctate; a curved carina extending from below each eye to the antennae, at the base of which it is greatly produced and bidentate; antennae widely separated at base.

Thorax short, its margins convex, slightly contracted at the spiracles, humeri not prominent, sides of propodeum margined, its caudal face convex, rounded into the dorsal.

Holotype.—Female, Felton, Santa Cruz Mountains, California, May 15–19, 1907, at an elevation of from 92–153 meters (300–500 feet) (J. C. Bradley). Collection of Cornell University No. 655.1.

Paratypes.—Female, May 18 1913, Carmel, Monterey County, California (E. C. Van Dyke), Cornell University collection; female, May 18, 1913, Monterey County, California (E. C. Van Dyke), author's collection; female, Claremont, California (Baker), collection U. S. National Museum; 3 females, Claremont, California (Baker), Cornell University collection.

Paratype.—Cat. No. 26393, U.S.N.M.

This species comes nearest to *nephele* Fox. The prominent dentate carina at the base of the antennae will at once distinguish it from any other species. In *nephele* these carina are slightly enlarged, but not at all as in *dentifrontalis*.

Dr. J. C. Bradley had recognized this species as new and has sent me the holotype and paratype material together with the description of the species, which he had drawn up, and which is given above. I have an additional specimen, one female from San Diego County, California.

The following additional characters may also be mentioned: Propleura punctate, with sparse, long, whitish hairs; mesopleura, meta-pleura and sides of propodeum smooth and shining; dorsum of thorax shallowly and confluent punctate (similar to the puncturation of the head), becoming broadly reticulate on the dorsum of the propodeum; caudal face of propodeum smooth; second tergite with moderately deep punctures, basally and medially the punctures confluent, laterally the punctures strong but sparse.

While this species is similar to *nephele* Fox in many respects it is easily distinguished from the latter by the prominent bidentate carina at the base of the antennae mentioned in the description; by the fact that *nephele* has the carina on the genae bidentate while in *dentifrontalis* it is unidentate; and by the fact that in *nephele* the antennae are separated by a distance equal to half the length of the scape while in *dentifrontalis* they are more widely separated, the distance between them equal to the length of the scape.

3. PSEUDOMETHOCA ATHAMAS (Fox).

Plate 2, fig. 8.

1899. *Mutilla athamas* Fox, Trans. Amer. Ent. Soc., vol. 25, p. 225, male.

1903. *Pseudomethoca? athamas* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 28, male.

Type.—Male, Poway, California, in collection of American Entomological Society of Philadelphia.

Plesiotype.—Male, Laguna Beach, California (Baker), Cornell University collection.

Specimens examined.—California: Male, Claremont (Baker).

The genitalia of the type and the plesiotype have been compared and found to be identical. *P. dentifrontalis* Bradley is possibly the female of this species.

4. PSEUDOMETHOCA NEPHELE (Fox).

1899. *Mutilla nephele* Fox, Trans. Amer. Ent. Soc., vol. 25, p. 223, female.

1903. *Pseudomethoca? nephele* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 28, female.

1903. *Mutilla nephele* MELANDER, Trans. Amer. Ent. Soc., vol. 29, p. 293, female.

Type.—Female, Brownsville, Texas, in collection of American Entomological Society of Philadelphia.

Specimens examined.—Texas: Female, June 1, 1904, Elmendorf (A. W. Morrill); female, April 29, 1896, Neueces (Marlatt).

I have examined the type of this species and find that the carina on the gena is bidentate. This character is not mentioned in Fox's description and is one which distinguishes it from other related forms.

5. PSEUDOMETHOCA GILA (Blake).

1871. *Mutilla* (*Sphaerophthalma*) *gila* BLAKE, Trans. Amer. Ent. Soc., vol. 3, p. 250, male.
 1886. *Sphaerophthalma gila* BLAKE, Trans. Amer. Ent. Soc., vol. 13, p. 245, male.
 1887. *Sphaerophthalma gila* CRESSON, Trans. Amer. Ent. Soc., suppl. vol., p. 265, male.
 1897. *Mutilla gila* DALLE TORRE, Cat. Hymen., vol. 8, p. 43, male.
 1899. *Mutilla gila* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 225, male.
 1903. *Pseudomethoca?* *gila* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 28, male.

Type.—Male, Texas, in collection of American Entomological Society of Philadelphia.

I have examined the genitalia of the type specimen of this species. It is of the same general type as that found in *canadensis* Blake and *athamas* Fox. Time was not available for making a drawing of the genitalia. *P. nephele* Fox may be the female of this species.

6. PSEUDOMETHOCA TOUMEYI (Fox).

1894. *Sphaerophthalma toumeyi* FOX, Ent. News, vol. 5, p. 297, female.
 1897. *Mutilla toumeyi* DALLE TORRE, Cat. Hymen., vol. 8, p. 92, female.
 1899. *Mutilla toumeyi* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 223, female.
 1903. *Pseudomethoca?* *toumeyi* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 28, female.

Type.—Female, Tucson, Arizona, in collection of American Entomological Society of Philadelphia.

I have examined the type of this species and find that the posterior angles of the head are not spinose as Fox states in his description. The postero-lateral angles of the head are very sharply carinate, the carina extending slightly upon the vertex laterally, but they are not spinose. The clypeus is very prominent in this species, more so than in related forms, being produced at right angles to the front. Only the type and paratype have been seen.

7. PSEUDOMETHOCA BEQUAERTI, new species.

Female.—Ferruginous; size 4.5–6 mm. Head ferruginous, densely clothed with appressed, pale golden pubescence and long, sparse, erect hairs; mandibles tridentate; antennae separated at their base by a distance equal to half the length of the scape; eyes slightly ovate; front, vertex and genae with close, well defined, separated punctures; genae with a carina which originates at the postero-lateral angles of the head and terminates in a slight tooth at its cephalic end; relative widths of head and thorax, 9–6.

Thorax ferruginous; its dorsum sparsely clothed with a mixture of black and silvery pubescence, the black more apparent; thorax short, very slightly longer than wide; cephalic portion of thorax very closely, confluent punctate, the sculpture becoming striato-reticulate on the mesothoracic area, and reticulate on the propodeal

area; humeri rounded; a carina present on the cephalic margin of the propleura reaching from its ventral edge to the humeral tubercle; propleura punctate; remainder of sides of thorax smooth and shining.

Abdomen ferruginous; first segment entirely sessile with the second; first tergite with well-separated punctures, and silvery pubescence which is especially apparent at the apex; second tergite with a round spot of silvery pubescence on each side midway between base and apex; sides of second tergite with sparse, silvery pubescence; remainder of second tergite with sparse, black pubescence; confluent punctate on the basal third, and with punctures separated by about their own width on the apical two-thirds; tergites 3-5 with sparse, silvery pubescence and fine, sparse punctures; tergite 6 with black pubescence; pygidial area well defined, shining, not sculptured; second sternite sparsely punctate; all the sternites with sparse, silvery pubescence at the apex.

Legs ferruginous, clothed with sparse, silvery pubescence.

Holotype.—Female, July 15-18, 1917, Post Creek Canyon, Pipalene Mountains, Fort Grant, Arizona (J. Bequaert), author's collection.

Paratypes.—Female, August 20, Pecos, New Mexico (Cockerell), collection American Entomological Society of Philadelphia; female, July 3-6, Marfa, Texas (Wickham), collection American Museum Natural History; female, June 1, 1912, Florence, Montana, collection Montana Agricultural College.

I have named this species in honor of Dr. J. Bequaert, who collected the type specimen.

Superficially this species resembles *oculissima* Mickel and *scaevolella* Cockerell and Casad, all having essentially the same color pattern. They are very distinct in structure, however, and may be distinguished by the characters used in the key.

8. PSEUDOMETHOCA OCULISSIMA, new species.

Female.—Ferruginous; size 6 mm. Head ferruginous, densely clothed with appressed, silvery pubescence and long, sparse, erect hairs; mandibles tridentate; antennae separated at the base by a distance equal to half the length of the scape; eyes slightly ovate; front, vertex, and genae with coarse, confluent punctures, except on the cephalic portion of the genae the punctures coarse and sparse; genae with a longitudinal carina which originates at the posterolateral angles; genae not dentate; relative widths of head and thorax 9-8.

Thorax ferruginous; its dorsum clothed with sparse, long, appressed, black pubescence, and sparse, erect hairs; sides of dorsum of propodeum with sparse, appressed, silvery pubescence; thorax short, a very little longer than wide; dorsum of thorax coarsely

punctato-reticulate, the dorsum and upper third of the posterior face of the propodeum broadly reticulate; humeri rounded; propleura diagonally rugoso-punctate with a sharp carina on the cephalic margin extending from the ventral edge to the humeral tubercle; sides of propodeum with a few scattered punctures; mesopleura and metapleura smooth, shining.

Abdomen ferruginous; first segment entirely sessile with the second; first tergite with long, sparse, pale hairs throughout, and a band of black pubescence at the apex; punctate, the punctures fine and well separated; second tergite with a large triangular spot each side, and laterally, with sparse, silvery pubescence; sparsely punctate at the sides and on apical third, the remainder of the tergite coarsely punctato-reticulate; tergites 3-5 with sparse, silvery pubescence, and fine, sparse punctures; sixth tergite with black pubescence; pygidial area well defined, minutely rugose; second sternite with sparse, moderate punctures; all the sternites with very sparse, silvery pubescence at the apex.

Legs ferruginous clothed with sparse, silvery pubescence.

Holotype.—Female, September 3, Pecos, New Mexico (Cockerell), Cat. No. 26206, U.S.N.M.

This species is similar in general appearance to *scaevolella* Cockerell and Casad, and *bequaerti* Mickel, which possess the type of vestiture here described and are similar in size. *P. oculissima* may be distinguished by the fact that the genae are not dentate, and by the coarse sculpture of the second tergite noted above.

9. PSEUDOMETHOCA SCAEVOLELLA (Cockerell and Casad).

1895. *Sphaerophthalma scaevolella* COCKERELL and CASAD, Trans. Amer. Ent. Soc., vol. 22, p. 298; female.

1899. *Mutilla scaevolella* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 224; female.

1903. *Pseudomethoca? scaevolella* ANDRÉ, Gen. Ins., vol. 1, fasc. 2, p. 28; female.

1903. *Mutilla scaevolella* MELANDER, Trans. Amer. Ent. Soc., vol. 29, p. 293; female.

Type.—Female, New Mexico, in collection of American Entomological Society of Philadelphia.

Specimens examined.—New Mexico: Female, Springer (C. N. Ainslie); female, May 19, Mesilla (Cockerell); female, July 13, Mesilla Park (Cockerell). Texas: 8 females, July 11, 1917, El Paso (J. Bequaert).

10. PSEUDOMETHOCA NUDULA, new species.

Female.—Ferruginous; length, 5 mm. Head ferruginous, sparsely clothed with short, black, appressed pubescence, and sparse, erect, black hairs; mandibles much worn, dentition not apparent; antennae

separated at the base by a distance equal to half the length of the scape; eyes slightly ovate; front, vertex and genae with close, shallow, confluent punctures; genae with a longitudinal carina which originates at the postero-lateral angles, not dentate, sparsely silvery pubescent; relative widths of head and thorax 1-1.

Thorax ferruginous, distinctly longer than wide; its dorsum clothed with sparse, appressed, silvery pubescence, and sparse, erect, black hairs; dorsum of thorax with close, shallow, confluent punctures in the prothoracic and mesothoracic area, the metathoracic and propodeal area very broadly reticulate; posterior face of propodeum for the most part smooth, divided longitudinally by a carina; humeral angles dentate; propleura with separated punctures; remainder of sides of thorax smooth and shining.

Abdomen ferruginous; first tergite with sparse, silvery pubescence, closely, confluent punctured at the apex; second tergite with a round spot of appressed, silvery pubescence each side, laterally with appressed, silvery pubescence, remainder of tergite with sparse, black appressed pubescence and sparse, black, erect hairs; tergites 3 and 4 with moderate, well-separated punctures, sparse, erect hairs, and a band of silvery pubescence at the apex; tergites 5 and 6 with black pubescence; pygidial area well defined, closely and minutely punctate; second sternite with well-separated, moderate punctures; all the sternites sparsely, silvery pubescent.

Legs ferruginous, sparsely clothed with silvery pubescence.

Holotype.—Female, August 19, Pecos, New Mexico (W. P. Cockerell), in collection of American Entomological Society of Philadelphia.

Paratype.—Female, August 18, Pecos, New Mexico (Cockerell), author's collection.

This species is easily recognized by the dentate humeri, punctate pygidial area, and sparse pubescence of the head.

A note on the paratype by T. D. A. Cockerell reads: "Running around among burrows of *Melissodes sphaeralceae*. However, my wife finds that it does not enter the *Melissodes* burrows, but enters much smaller burrows, very likely of *Calliopsis*."

11. PSEUDOMETHOCA APRICA (Melander).

1903. *Mutilla aprica* MELANDER, Trans. Amer. Ent. Soc., vol. 29, p. 323, female.

Type.—Female, Texas, in Museum of Comparative Zoology, Cambridge, Massachusetts.

Specimens examined.—Texas: Female, June 2, 1909, Fedor, Lee County (Birkman): 7 females, October, 1908, Lee County (Birkman); female, 1908, Lee County (Birkman).

I have examined the type of this species and find that it is a true *Pseudomethoca* and does not belong in the "*anthophorae*" group

of Fox, where it was placed by Melander (1903). The following additional characters may be mentioned: genae with a delicate, longitudinal carina; width of head between hind margin of eyes and postero-lateral angles distinctly less than the longitudinal diameter of the eyes; humeri angulate. The pygidium is closely and minutely punctate, not granular as indicated by the original description.

12. PSEUDOMETHOCA CEPHALARGIA, new species.

Female.—Ferruginous; length 13 mm. Head ferruginous; front and vertex clothed with dense, appressed, pale golden pubescence and sparse, erect, pale hairs; genae with sparse, semierect, silvery pubescence; mandibles tridentate; antennae separated at the base by a distance equal to half the length of the scape; first segment of flagellum very long, equal in length to segments 2-4 united; pedicellum as long as segment 2 of flagellum; eyes slightly ovate; front, vertex and genae with coarse, confluent punctures; distance between hind margin of eyes and postero-lateral angles almost twice the longitudinal diameter of the eyes; genae with a prominent, longitudinal carina which originates at the postero-lateral angles; genae produced beneath ventrad of the postero-lateral angles into a sharply angulate prominence, giving the head, viewed from the side, a definite rectangular outline; relative widths of head and thorax 1-1.

Thorax ferruginous, short, its width slightly greater than its length; prothoracic area of dorsum with sparse, recumbent and erect, black hairs; mesothoracic and metathoracic area with sparse, recumbent, reddish golden pubescence, and sparse, erect hairs; propodeal area with sparse, erect, black hairs, posterior face of propodeum with long, pale, erect hairs; dorsum of thorax and posterior face of propodeum coarsely rugoso-punctate, more so on the latter; humeri angulate; the carina on the cephalic margin of the propleura strong and sharp; propleura longitudinally striato-punctate; mesepisternum finely rugose; mesepimeron transversely rugoso-striate; ventral half of metapleura transversely rugose, the dorsal half smooth and shining; cephalic half of sides of propodeum delicately rugose, the caudal half coarsely rugoso-striate.

Abdomen ferruginous; first segment entirely sessile with the second; apex of first tergite rugoso-punctate, with a band of silvery pubescence broadly interrupted medially by a band of long, stiff, black, recumbent bristles; second tergite with a small, round spot of sparse, silvery pubescence each side, silvery pubescence laterally, a distinct band of silvery pubescence at the apex interrupted medially by a spot of black pubescence, and remainder of tergite with sparse, semierect black pubescence; second tergite with coarse, confluent punctures throughout, the basal area more strongly than remainder

of tergite; tergites 3-5 with confluent punctures, the latter about half the size of those of the second tergite; tergite 3 with sparse, silvery pubescence throughout; tergite 4 with lateral thirds silvery pubescent, the median third black pubescent; tergite 5 black pubescent, except the lateral margins silvery pubescent; tergite 6 golden pubescent; pygidial area distinct, irregularly rugose; sternite 2 with large, well-separated punctures; sternites 3-6 with close, confluent punctures; all the sternites beneath with long, silvery pubescence.

Legs ferruginous, with sparse, silvery pubescence.

Holotype.—Female, July 8-20, 1916, Sabino Basin, St. Catalina Mountains, Arizona, in collection of American Museum of Natural History.

This species is not closely related to any other of the forms treated herein. It will likely be found represented in the Mexican fauna. It may be easily recognized by the structure of the head at the sides beneath.

13. PSEUDOMETHOCA DONAE-ANAE (Cockerell and Fox).

1897. *Sphaerophthalma donae-anae* COCKERELL and FOX, Proc. Acad. Nat. Sci. Phila., vol. 49, p. 137, female.

1899. *Mutilla donae-anae* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 224, female.

1903. *Pseudomethoca? donae-anae* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 28, female.

1903. *Mutilla donae-anae* MELANDER, Trans. Amer. Ent. Soc., vol. 29, p. 294, female.

Type.—Female, New Mexico, in collection of American Entomological Society of Philadelphia.

Specimens examined.—Arizona: Female, October 9, 1903, Florence (Biederman). California: Female, August 16, Calexico.

This species may be easily recognized by the prominent, rugose tubercle of the propodeum. I have examined the type specimen and find that this tubercle is not a scutellar scale as suggested by Fox (1899) but is a part of the propodeum.

14. PSEUDOMETHOCA WICKHAMI (Cockerell and Casad).

1895. *Sphaerophthalma wickhami* COCKERELL and CASAD, Trans. Amer. Ent. Soc. vol. 22, p. 297, female.

1899. *Mutilla wickhami* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 224, female.

1903. *Pseudomethoca? wickhami* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 28, female.

1903. *Mutilla wickhami* MELANDER, Trans. Amer. Ent. Soc., vol. 29, p. 294, female.

Type.—Female, Texas, in collection of American Entomological Society of Philadelphia.

Specimens examined.—Texas: Female, Fedor.

The type of this species has been examined and I find that it possesses neither a scutellar scale nor a propodeal tubercle. Attention may be called here to the fact that Fox (1899) in his key to the species of his group "*canadensis*" mentions *donae-anae* as having a scutellar scale, evidently referring to the propodeal tubercle of that species, while in a note under *wickhami* he says that the latter differs from others in the group by the well developed scutellar scale. Obviously, this note should have referred to *donae-anae* and not to *wickhami*.

15. PSEUDOMETHOCA CONNECTENS (Cresson).

1865. *Mutilla connectens* CRESSON, Proc. Ent. Soc. Phila., vol. 4, p. 387, female.
 1871. *Mutilla (Sphaerophthalma) connectens* BLAKE, Trans. Amer. Ent. Soc., vol. 3, p. 252, female.
 1886. *Sphaerophthalma connectens* BLAKE, Trans. Amer. Ent. Soc., vol. 13, p. 249, female.
 1887. *Sphaerophthalma connectens* CRESSON, Trans. Amer. Ent. Soc., suppl. vol., p. 265, female.
 1897. *Mutilla connectens* DALLE TORRE, Cat. Hymen., vol. 8, p. 26, female.
 1899. *Mutilla connectens* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 224, female.
 1903. *Pseudomethoca? connectens* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 28, female.

Type.—Female, Lower California, in collection of American Entomological Society of Philadelphia.

Specimens examined.—Female, July 22, 1919, La Rivera, District Sur, Baja California (J. F. Ferris).

This species is included here since Fox (1899) reports a specimen from California.

16. PSEUDOMETHOCA CONTUMAX (Cresson).

1865. *Mutilla contumax* CRESSON, Proc. Ent. Soc. Phila., vol. 4, p. 437, female.
 1871. *Mutilla (Sphaerophthalma) contumax* BLAKE, Trans. Amer. Ent. Soc., vol. 3, p. 252, female.
 1886. *Sphaerophthalma contumax* BLAKE, Trans. Amer. Ent. Soc., vol. 13, p. 250, female.
 1887. *Sphaerophthalma contumax* CRESSON, Trans. Amer. Ent. Soc., suppl. vol., p. 265, female.
 1897. *Mutilla contumax* DALLE TORRE, Cat. Hymen., vol. 8, p. 27, female.
 1899. *Mutilla contumax* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 224, female.
 1903. *Pseudomethoca? contumax* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 28, female.
 1903. *Mutilla contumax* MELANDER, Trans. Amer. Ent. Soc., vol. 29, p. 293, female.

Type.—Female, Colorado, in collection of American Entomological Society of Philadelphia.

Specimens examined.—Arizona: Female, Phoenix (Osler). Iowa: Female, August 27, 1920, Sioux City (C. N. Ainslie); 6 females, September 17, 1921, Sioux City (C. N. Ainslie). Kansas: Female, July 1, 1885, Gove County; 2 females, July, 1885, Wallace County; female, July 7, Wallace County; female (Popenoe). Nebraska: Female, June 24, 1913, Ogallala (R. W. Dawson). Texas: Female, June 13–17, 1908, Rio Grande, Brewster County (Mitchell and Cushman).

17. *PSEUDOMETHOCA PRAECLARA* (Blake).

1886. *Sphaerophthalma praeclara* BLAKE, Trans. Amer. Ent. Soc., vol. 13, p. 252, female.
 1887. *Sphaerophthalma praeclara* CRESSON, Trans. Amer. Ent. Soc., suppl. vol., p. 266, female.
 1897. *Mutilla praeclara* DALLE TORRE, Cat. Hymen., vol. 8, p. 74, female.
 1899. *Mutilla praeclara* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 224, female.
 1903. *Pseudomethoca? praeclara* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 28, female.
 1915. *Nomiaephagus acuum* COCKERELL, Ent., vol. 48, p. 250, female.

Type.—Female, Arizona, in collection of American Entomological Society of Philadelphia.

Specimens examined.—Arizona: Female, May 2, 1919, Tucson. Sabino Basin, St. Catalina Mountains; female. California: Female, San Diego County.

I have examined the type specimens of *praeclara* Blake and *acuum* Cockerell and find them to be identical.

18. *PSEUDOMETHOCA ANTHRACINA* (Fox).

Plate 1, fig. 3.

1892. *Sphaerophthalma anthracina* FOX, Ent. News, vol. 3, p. 172, male.
 1897. *Mutilla anthracicolor* DALLE TORRE, Cat. Hymen., vol. 8, p. 9, male.
 1899. *Mutilla anthracicolor* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 228, male.
 1903. *Ephuta anthracicolor* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 57, male.

Type.—Male, San Diego, California, in collection of U. S. National Museum.

Plesiotype.—Male, August 18, 1917, La Jolla, San Diego County, California (H. Klotz), in entomological collection of Leland Stanford University.

Specimens examined.—California: Male, August 29, 1919, La Jolla, San Diego County (H. Klotz); male, Santa Clara County.

The genitalia of the type and plesiotype have been compared and found to be identical.

19. PSEUDOMETHOCA HARPALYCE (Fox).

1899. *Mutilla harpalyce* Fox, Trans. Amer. Ent. Soc., vol 25, p. 227, female.
 1903. *Ephuta harpalyce* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 60, female.
 1903. *Mutilla harpalyce* VIERECK, Proc. Acad. Nat. Sc., Phila., vol. 54, p. 743, female.

Type.—Female, California, in collection of American Entomological Society of Philadelphia.

Specimens examined.—California: Female, April 12, 1914, Los Angeles (Fisk); 5 females, Los Angeles County; 2 females, Fresno (E. A. Schwarz); 3 females, San Bernardino County; 3 females, Claremont (Baker); 2 females, September 12, 1917, Santa Ana canon, Orange County; female, August 12, 1917, Santa Ana Canon, Orange County; female, May 13, 1907, Redwood, Corralitos, St. Cruz Mountains (J. C. Bradley); female, July 16, 1917, La Jolla, San Diego County (H. Klotz); female August 26, 1917, La Jolla, San Diego County (H. Klotz); female, August 28, 1917, La Jolla, San Diego County (H. Klotz); female, San Diego; female, San Diego County; female.

This is very probably the female of *anthracina* Fox. These are the only two species of this section of the genus that are present in collections from California.

20. PSEUDOMETHOCA FLAMMIGERA, new species.

Female.—Ferruginous; length 11 mm. Head ferruginous; front and vertex clothed with thick, fiery-red pubescence, and sparse, erect, pale hairs; genae clothed with sparse, semierect, silvery pubescence; front and vertex rugoso-punctate, the genae with close, strong, confluent punctures; mandibles tridentate; antennae separated at the base by a distance equal to half the length of the scape; length of pedicellum equal to half the length of the first segment of flagellum; eyes large, slightly ovate, the distance between the hind margins of the eyes and the postero-lateral angles slightly greater than the longitudinal diameter of the eyes; longitudinal carina of genae strong and sharp; relative widths of head and thorax 1-1.

Thorax dark ferruginous; about as long as wide; dorsum of thorax rugoso-punctate, coarsely so on the posterior face of propodeum; dorsum of thorax clothed with appressed, fiery-red pubescence and sparse, erect pubescence of the same color; posterior face of propodeum with long, sparse, black hairs; humeri rounded; cephalic margin of propleura with a sharp carina; propleura punctate; mesepisternum finely rugose and punctate; mesepimeron with large, confluent punctures; metapleura smooth and shining; sides of propodeum smooth and shining with a few sparse punctures medially and rugoso-punctate on the caudal margin.

Abdomen ferruginous; first segment completely sessile with the second; first tergite with close, confluent punctures at the apex; first tergite with sparse, long, erect, black hairs, and a band of recumbent, bristle-like hairs at the apex; second tergite with close, confluent punctures; second tergite silvery pubescent narrowly at the sides, the remainder of the tergite with thick, appressed, fiery-red pubescence, and sparse, erect hairs of the same color, the apex of the tergite with a very narrow band of silvery pubescence interrupted medially by a few black hairs; tergites 3-5 closely punctate; tergite 3 with median third black pubescent, and lateral thirds silvery pubescent; tergite 4 silvery pubescent with a narrow area of black pubescence medially; tergite 5 silvery pubescent; tergite 6 with copper-colored pubescence; pygidial area distinct, finely rugose; second sternite with large elongate, separated punctures, sparsely silvery pubescent at the apex.

Leg dark ferruginous, clothed with long sparse silvery pubescence; calcaria pale.

Holotype.—Female, July 12, Palmerlee, Arizona (H. A. Kaeber), in collection of American Entomological Society of Philadelphia.

This species is very similar to *harpalyce* Fox but may be distinguished by the fact that the head is not wider than the thorax, and by the vestiture of the abdominal tergites.

21. PSEUDOMETHOCA AUREOVESTITA J. C. Bradley, new species.

Plate 1, fig. 4.

Female.—Ground color claret brown, largely clothed with golden pubescence; front, vertex, dorsum and second dorsal segment except at sides clothed with long, matted, and moderately dense appressed golden (light cadmium) hairs; sides and back of head, scape, pleural and sternal parts, legs and ventral segments with rather long white hairs, giving them a griseous appearance, little or no appressed pubescence on these parts; caudal surface of propodeum and the petiole above with numerous erect bay hairs; apex of the third to fifth dorsal segments with short appressed white, in the middle brown and erect short and sparse brown pubescence. Length 9.5 mm.

Head seen from above transversely quadrate, 0.6 as long as broad; the temples behind the eyes approximately equal to the long diameter of the latter (0.7 mm.); the temples bordered posteriorly by a very strong carina, carried down onto the gulae, but not spined; front and vertex scabrous, the genae closely punctate; a fine carina between eyes and antennae; bases of the latter separated by about the length of the pedicel; face very short, with carinae widely diverging toward the bases of the mandibles, setting off the depressed,

impunctate short and very broad clypeus, with the anterior median lobe of which is broadly truncate, laterally subdentate; mandibles with a strong and sharp inner tooth, of the ordinary type for the genus. Scape not carinate, coarsely punctate: third segment fully as long as the fourth and fifth.

Thorax narrower than the head, widest at the tegulae, narrowest at the spiracles, behind which it is slightly widened, the anterior margin truncate, the posterior face somewhat sloping, flat, rather sharply delimited from the dorsal.

Petiole without a distinct ventral carina or tooth, pygidium with a distinct area, transversely rugose.

Holotype.—Huachuca Mountains, Arizona, August 17, 1903 (Os-lar), Cornell University No. 656.1.

Dr. J. C. Bradley had recognized this species as new and has sent me the type specimen together with the description of the species which he had drawn up and which is given above.

Specimens examined.—New Mexico: Female, May 16, 1902, Alamo-gordo.

I also have before me a specimen which is apparently the male of *aureovestita*. The two sexes were not taken in copulation, but I place it here in preference to giving it a specific name.

Male.—Black; length 11 mm. Head black; front and vertex sparsely clothed with erect, golden pubescence; genae with sparse, erect black pubescence; front and vertex with very close, confluent punctures; genae with large, separated punctures; mandibles tridentate; antennae separated at the base by a distance equal to two-thirds the length of the scape; first segment of flagellum about half the length of the second segment; eyes very slightly ovate; width of head between hind margin of eyes and postero-lateral angles a little less than the longitudinal diameter of the eyes; relative widths of head and thorax 1-1.

Thorax black; pronotum, mesonotum and scutellum with sparse, semierect, golden pubescence; closely, confluent punctured; dorsum and posterior face of propodeum reticulate; humeri rounded; propleura punctate, the cephalic margin with a strong, sharp carina; mesopleura punctate; metapleura smooth, shining; cephalic half of sides of propodeum smooth and shining, the caudal half punctate and rugoso-punctate.

Abdomen black; first segment completely sessile with the second; first tergite with distinct, separated punctures, sparse, erect, pale hairs, and a thin band of golden pubescence at the apex; second tergite punctate throughout with large, separated punctures; basal half of second tergite with sparse, black pubescence, the apical half with sparse, golden pubescence, and a distinct band of golden pubes-

cence at the apex; tergites 3-6 with thick, erect, golden pubescence; second sternite with large, separated punctures; sternites 2-4 with a thin band of golden pubescence at the apex.

Wings subhyaline; cell R4 almost obsolete; vein M 3+4 received by cell R5 at the middle.

Legs black, sparsely clothed with silvery pubescence; calcaria whitish.

Allotype.—Male, May 15, 1902, Alamogordo, New Mexico, in collection of American Entomological Society of Philadelphia.

22. *PSEUDOMETHOCA PIGMENTATA*, new species.

Female.—Black; length 10 mm. Head black, covered with sparse, erect and semierect, black hairs; front and vertex rugoso-punctate; genae with large, confluent punctures; mandibles tridentate; antennae separated at the base by a distance equal to half the length of the scape; pedicellum half the length of first segment of flagellum; longitudinal carina of genae strong and sharp; eyes slightly ovate; distance between hind margin of eyes and postero-lateral angles equal to the longitudinal diameter of the eyes; head slightly wider than the thorax.

Thorax black; dorsum of thorax and posterior face of propodeum rugoso-reticulate, the reticulations broader on the propodeum; moderately clothed with erect and recumbent, black hairs; propleura confluent punctured, the cephalic margin with a strong, sharp carina; humeri rounded; mesepisternum slightly finely rugose; mesepimeron with large, confluent punctures; metapleura polished; sides of propodeum with cephalic half polished, caudal half coarsely punctured.

Abdomen dark ferruginous; first segment completely sessile with the second; first tergite with small, separated punctures, with sparse, long, black hairs on the disk and a thin band of golden pubescence at the apex; tergite 2 confluent punctured on basal half, with separated punctures on apical half; tergites 2-6 thickly clothed with golden pubescence; pygidial area distinct, finely transversely rugose; sternite 2 with distinct, sparse punctures; sternites 2-5 with a thin band of silvery pubescence at the apex.

Legs black; anterior legs with sparse black pubescence; middle and posterior legs with sparse, silvery pubescence; calcaria pale.

Holotype.—Female, June 10-12, 1908, Chisos Mountains, Brewster County, Texas (Mitchell and Cushman), Cat. No. 26207 U. S. N. M.

Paratype.—Female, Chisos Mountains, Texas (W. B. Phillips), collection American Museum Natural History.

Superficially this species resembles *brazoria* Blake. It may be distinguished from the latter by its heavier vesture and the strong, sharp carina of the genae.

23. PSEUDOMETHOCA OCEOLA (Blake).

Plate 2, fig. 5.

1871. *Mutilla (Sphacrophthalma) occola* BLAKE, Trans. Amer. Ent. Soc., vol. 3, p. 248, male.
1886. *Sphacrophthalma occola* BLAKE, Trans. Amer. Ent. Soc., vol. 13, p. 243, male.
1887. *Sphacrophthalma ocella* CRESSON, Trans. Amer. Ent. Soc., suppl. vol., p. 266, male.
1897. *Mutilla ocella* DALLE TORRE, Cat. Hymen., vol. 8, p. 68, male.
1899. *Mutilla ocella* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 228, male.
1899. *Mutilla hippodamia* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 227, female.
1903. *Ephuta hippodamia* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 60, female.
1903. *Ephuta ocella* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 62, male.
1903. *Mutilla ocella* MELANDER, Trans. Amer. Ent. Soc., vol. 29, p. 295, male.
1903. *Mutilla hippodamia* MELANDER, Trans. Amer. Ent. Soc., vol. 29, p. 294, female.
1916. *Pseudomethoca (Nomiaephagus) ocella* BRADLEY, Trans. Amer. Ent. Soc., vol. 43, p. 319, male.
1916. *Pseudomethoca (Nomiaephagus) hippodamia* BRADLEY, Trans. Amer. Ent. Soc., vol. 43, p. 319, female.

Type.—Male, Florida, in collection of American Entomological Society of Philadelphia.

Plesiotype.—Male, August 15, 1919, Lincoln, Nebraska (R. W. Dawson); female specimen taken in copulation, on same pin; in entomological collection of University of Nebraska.

Specimens examined.—Arizona: Female. Colorado—2 females and male, August 29, Bent County; female, June 26, 1921, Rocky Ford (C. E. Mickel.) Florida—Female, November 19, 1911, Fort Myers; female, October 4-8, 1914, Monticello; female, May 1, 1905, Quincy (W. A. Hooker). Georgia—Female and male, September 3-7, 1910, Bainbridge (J. C. Bradley); male, September 10, Albany. Kansas: 2 males, August 22, Riley County (Popenoe); female, July 3, Riley County (Popenoe); 2 females, September, Riley County (Marlatt); female, September 2, Riley County, (Popenoe); female, Riley County (Popenoe); female, August 23, 1911, Clark County (F. X. Williams); female, June 28, 1912, Rush County (F. X. Williams); male, Meade County; male, July 22, Riley County (J. B. Norton); female and male, Wabaunsee County (Forest Anderson). Louisiana: Female, May 26, 1905, Natchitoches; female, May 2, 1905, Logansport; female and male. Mississippi: Female, August 5, Belsoni (H. Barber); female, May 21, 1909, Natchez (E. S. Tucker); male, August 2, 1914, Agricultural College (C. C. Green); female, August 22, 1915, Agricultural College (C. C. Green); female, September, 1915, McCondy (J. M. Pearson); female, June, 1916, Eddiceton (C. S. Whittington); female, October 2, 1915, Agricul-

tural College (W. E. McMahon); female, August, 1916, Norris (B. A. Williamson); male, July 9, 1913, Agricultural College (J. G. Hester). Nebraska: Female, August 22, 1920, Lincoln (R. W. Dawson); female, June, Lincoln; female, August, Lincoln. South Carolina: Female, August 8, 1911, Swansea (Frederick Knab). South Dakota: Female, October 1, 1913, Buffalo Valley, Stanley County (W. H. Over). Texas: Female, August 7, 1906, Jacksonville (F. C. Bishopp); male, August 11, 1906, Jacksonville (F. C. Bishopp); female, July 7, 1906, Bryan (J. C. Crawford); female, August 19, Victoria (W. E. Hinds); female, August 6, 1904, Mineola (C. R. Jones); female, August 20, 1907, Mineola (W. W. Yothers); female, September 2, 1915, Mineola; male, July 19, Mineola (F. C. Bishopp); female, June 24, 1917, Wharton; male, May 11, Beeville; male, August 22, 1907, Overton (W. W. Yothers); male, Paris (F. C. Bishopp).

Mr. R. W. Dawson has had the good fortune to collect a male in copulation with a female, the latter proving to be *hippodamia* Fox. I have examined the type specimens of both *oceola* Blake and *hipporamia*. This species is much more widely distributed than our previous knowledge has indicated. Its geographical range as known at present, presents some peculiarities not exhibited by other species of *Pseudomethoca*; thus from east to west it includes the States of South Carolina, Florida, Georgia, Alabama, Mississippi, Louisiana, Texas, and Arizona, and an extension northward into the States of Colorado, Kansas, Nebraska, and South Dakota.

24. PSEUDOMETHOCA FLAVIDA (Blake).

1871. *Mutilla (Sphaerophthalma) flavida* BLAKE, Trans. Amer. Ent. Soc., vol. 3, p. 249, male.
 1886. *Sphaerophthalma flavida* BLAKE, Trans. Amer. Ent. Soc., vol. 13, p. 244, male.
 1887. *Sphaerophthalma flavida* CRESSON, Trans. Amer. Ent. Soc., suppl. vol., p. 265, male.
 1897. *Mutilla flavida* DALLE TORRE, Cat. Hymen., vol. 8, p. 40, male.
 1899. *Mutilla flavida* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 228, male.
 1903. *Ephuta flavida* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 60, male.

Type.—Male, Texas, in collection of American Entomological Society of Philadelphia.

I have examined the type specimen and find that the genitalia are of the same general type as in *oceola* Blake. Time was not available for making a drawing of the genitalia. The species may be recognized by the characters given in the key.

25. PSEUDOMETHOCA NIGRICULA, new species.

Plate 2, fig. 6.

Male.—Entirely black with black pubescence; length 9 mm. Head black, clothed with sparse, long, erect, black pubescence; mandibles

tridentate; clypeus bidentate medially, closely and rugosely punctate; antennae separated at the base by a distance very slightly greater than half the length of the scape; first segment of flagellum slightly longer than half the length of the second segment; front with close, confluent punctures; vertex with punctures more separated than on the front and more or less confluent; genae with close, confluent punctures; postero-lateral angles of head rounded; eyes slightly ovate; distance between hind margin of eyes and postero-lateral angles about two-thirds the longitudinal diameter of the eyes: relative widths of head and thorax 11-13.

Thorax black, clothed with sparse, long, erect, black pubescence; pronotum, mesonotum and scutellum with close, confluent punctures; dorsum and posterior face of propodeum reticulate; tegulae slightly convex, punctured on the basal third, polished on the apical two-thirds: humeri rounded; propleura rugose; mesepisternum and mesepimeron punctured and striato-punctate; metapleura for the most part polished, slightly transversely striate on the ventral half; sides of propodeum coarsely, transversely striato-rugose.

Abdomen black, clothed with sparse, long, erect, black pubescence; first segment completely sessile with the second; first tergite with small, separated punctures; second tergite with deep, distinct punctures separated by about their own width; tergites 3-6 with distinct, separated punctures: second sternite with distinct, sparse, irregularly distributed punctures.

Wings very dark; cell R4 almost obsolete; vein M 3+4 received by cell R5 a little before the middle.

Legs very dark blackish-red, clothed with sparse, black pubescence.

Holotype.—Male, July 31, 1909, Willcox, Arizona (A. K. Fisher).
Cat. No. 26208 U. S.

Superficially this closely resembles *anthracina* Fox but may be at once distinguished from that species by the coarse sculpture of the sides of the propodeum. Considering the structure of the genitalia it would seem to be most nearly related to *oceola* Blake, *flavida* Blake and *aureovestita* Bradley.

26. PSEUDOMETHOCA MERITORIA, new species.

Female.—Ferruginous; length 9 mm. Head ferruginous, very sparsely clothed with semierect, short, golden pubescence, and a few erect hairs; the pubescence of the genae more of a silvery color; mandibles tridentate; antennae separated at the base by a distance equal to half the length of the scape; a prominent curved carina extending from below the eyes to the base of antennae; front very coarsely, deeply and confluent punctate; vertex and genae coarsely and confluent punctate but not so deeply as the front; longitudinal carina of genae distinct and sharp; distance between the hind

margin of the eyes and postero-lateral angles about equal to the longitudinal diameter of the eyes; relative widths of head and thorax 1-1.

Thorax ferruginous, distinctly wider than long; dorsum of thorax very sparsely clothed with short, recumbent, golden pubescence, coarsely, confluent punctate; upper one-fifth of posterior face of propodeum broadly reticulate, the remainder polished, with a few scattered punctures; humeri rounded; cephalic margin of propleura with a strong, sharp carina extending from the ventral edge to the humeral tubercles; propleura coarsely punctate; remainder of sides of prothorax polished except a row of coarse punctures at the caudal margin of the mesepimeron and a few scattered punctures near the caudal margin of the sides of the propodeum.

Abdomen ferruginous; first segment completely sessile with the second; disk of first tergite with sparse, long, erect, silvery hairs, the apex finely, rugosely punctate with a band of recumbent, stiff, black hairs; basal two-thirds of second tergite coarsely, rugosely punctate, the apical third with close, confluent punctures, except the lateral margins of the tergite which have separated punctures; sides of second tergite with sparse, silvery pubescence, a narrow band of sparse, black hairs at the base, a wide band of sparse, black pubescence at the apex, and the remainder of the tergite with short, sparse, golden pubescence; tergites 3-5 with fine, close punctures and sparse, silvery pubescence; tergite 6 with golden pubescence at the base and sides; pygidial area distinct, distinctly irregularly rugose; second sternite with large, irregularly distributed punctures; sternites 2-6 with a thin band of silvery pubescence at the apex.

Legs ferruginous, sparsely clothed with silvery pubescence; calcaria pale.

Holytype.—Female, May 12, 1906, Cotulla, Texas (J. C. Crawford), Cat. No. 26209 U. S. National Museum.

Paratypes.—2 females, May 12, 1906, Cotulla, Texas (J. C. Crawford), collection U. S. National Museum; female, May 12, 1906, Cotulla, Texas (J. C. Crawford), Cornell University collection; female, May 12, 1906, Cotulla, Texas (J. C. Crawford), entomological collection of University of Nebraska; 2 females, May 12, 1906, Cotulla, Texas (J. C. Crawford), author's collection; female, July 1, 1906, Victoria, Texas (A. McLaughlin), collection U. S. National Museum; female, February, 1909, Mercedes, Texas (F. C. Pratt), collection U. S. National Museum.

Paratypes.—Cat. No. 26209 U.S.N.M.

This species is related to *simillima* Smith. It may be distinguished from the latter by the much shorter thorax and rugose pygidium.

27. PSEUDOMETHOCA ALBICOMA, new species.

Plate 2, fig. 9.

Male.—Black with whitish pubescence; length 9 mm. Head black, clothed with sparse, long, whitish pubescence; mandibles tridentate, clypeus bidentate medially at the apex; closely punctate throughout; antennae separated at the base by a distance equal to two-thirds the length of the scape; front with close, confluent punctures; frontal tubercles smooth, shining; vertex with the punctures for the most part separated, but occasionally confluent; genae confluent punctured; eyes slightly ovate, the distance between the hind margins and the postero-lateral angles equal to two-thirds the longitudinal diameter of the eyes; relative widths of head and thorax 1—1.

Thorax black, sparsely clothed with long, whitish pubescence; pronotum, mesonotum and scutellum closely, confluent punctate; dorsum and posterior face of propodeum deeply alveolate; humeri rounded; cephalic margin of propleura not distinctly carinate; propleura, mesepisternum and mesepimeron closely punctate; metapleura polished; sides of propodeum polished, except caudal half which is rugoso-punctate; tegulae convex, polished.

Abdomen black, very sparsely clothed with whitish pubescence; first segment completely sessile with the second; first tergite with large, scattered punctures, a thin band of silvery pubescence at the apex; second tergite with large, close, separated punctures throughout, the apex with a distinct band of silvery pubescence; tergites 3–5 with distinct, separated punctures, the apex of each with a distinct band of silvery pubescence; tergites 6–7 with blackish pubescence; second sternite with large, close punctures; all the sternites with a very thin band of silvery pubescence at the apex.

Wings subhyaline; cell R4 indistinct; vein M 3+4 received by cell R5 near the middle.

Legs dark reddish, sparsely clothed with silvery pubescence; calcaria whitish.

Holotype.—Male, June 13–17, 1908, Rio Grande, Brewster County, Texas (Mitchell and Cushman), Cat. No. 26210 U.S.N.M.

This may possibly be the male of *meritoria* Mickel.

28. PSEUDOMETHOCA PALUDATA, new species.

Female.—Ferruginous; length 8–11 mm. Head ferruginous; front and vertex clothed with sparse, short, recumbent, golden pubescence and scattered, erect hairs; genae with sparse, long, silvery pubescence; mandibles tridentate; antennae separated at the base by a distance equal to half the length of the scape; segment one of the flagellum as long as segments two and three united; pedicellum equal to half the length of the first segment of the flagellum; front,

vertex and genae with coarse, close, punctures giving them a rugose appearance; longitudinal carina of genae evident but not sharp; eyes slightly ovate, distance between the hind margins and the postero-lateral angles equal to the longitudinal diameter of the eyes; relative widths of head and thorax 1-1.

Thorax ferruginous, very slightly wider than long; dorsum clothed with sparse, short, recumbent, golden pubescence and scattered, long, erect, hairs; the posterior face of propodeum with very long, sparse, erect, pale hairs; dorsum punctured like the front and vertex with close, coarse, punctures; upper one-fifth of posterior face of propodeum deeply and broadly reticulate, the remainder with scattered, deep punctures; propleura with large, deep punctures, the cephalic margin with a prominent, sharp carina extending from the ventral edge to the humeral tubercles; anterior half of mesepisternum-mesepimeron micro-punctate, the posterior half with coarse, confluent punctures; metapleura polished; sides of propodeum polished, with large confluent punctures near the posterior margin.

Abdomen ferruginous; first segment completely sessile with the second; first tergite with long, sparse, erect hairs, confluent punctate at the apex, and a thin band of silvery-golden pubescence at the apex; second tergite with the sides and apex silvery pubescent, a narrow transverse spot of blackish pubescence at the extreme apex medially, the remainder of the tergite with short, sparse, golden pubescence; sides and apex of second tergite with distinct, separated punctures, the basal two-thirds of the disc with close, coarse, confluent punctures; tergites 3-5 closely punctate, and silvery pubescent thruout; tergite 6 with golden pubescence at the base and sides; pygidial area distinct, longitudinally rugose; second sternite with sparse, distinct, irregularly distributed punctures; sternites 2-6 with a thin band of silvery pubescence at the apex.

Legs very dark ferruginous, clothed with sparse, silvery pubescence; calcaria dark (in some of the paratypes, pale).

Holotype.—Female, July 5, 1916, Mitchell, Nebraska (C. E. Mickel), in entomological collection of University of Nebraska.

Paratypes.—Nebraska: Female, June 16, 1916, Mitchell (C. E. Mickel), entomological collection of University of Nebraska; female, July 5, 1916, Mitchell (C. E. Mickel), author's collection; female, August 1, 1916, Mitchell (C. E. Mickel), entomological collection of University of Nebraska; female, August 5, 1917, Mitchell (E. J. Yates), collection U. S. National Museum; female, July 12, 1912, Mitchell (L. M. Gates), entomological collection of University of Nebraska; 2 females, June, Halsey, entomological collection of University of Nebraska; female, June, Halsey, author's collection; female, June 15, 1912, Halsey (J. T. Zimmer), Cornell University collection; female, August 24, 1911, Halsey (J. T. Zimmer), en-

tomological collection of University of Nebraska: 3 females. August 13, 1920, Halsey (C. B. Philip), entomological collection of University of Nebraska: 3 females, August 13, 1920, Halsey (C. B. Philip), author's collection; female, August 13, 1920, Halsey (C. B. Philip), collection U. S. National Museum; 2 females, August 14, 1920, Halsey (C. B. Philip), entomological collection of University of Nebraska: female August 14, 1920, Halsey (C. B. Philip), author's collection; female, June 26, 1905, Haigler, author's collection; female, Sand Hills, entomological collection of University of Nebraska. Kansas: Female, Morton county (F. H. Snow), entomological collection of University of Kansas. Wyoming: Female, July, 1895, 30 miles north of Lusk, entomological collection of University of Kansas.

Paratype.—Cat. No. 26394 U.S.N.M.

This species resembles *simillima* Smith and *propinqua* Cresson very closely. It may be distinguished from both by the characters used in the key.

29. PSEUDOMETHOCA SCRUPULOSA, new species.

Plate 4, fig. 15.

Male.—Black, with the second abdominal segment ferruginous; length 8 mm. Head black, clothed with long, sparse, erect, black pubescence; mandibles tridentate; clypeus bidentate medially at the apex, punctate throughout; antennae separated at the base by a distance equal to five-sevenths the length of the scape; scape confluent punctate; front with close, confluent punctures; vertex with distinct, separated punctures; genae closely punctate; eyes slightly ovate, the distance between the hind margins and postero-lateral angles equal to one-half the longitudinal diameter of the eyes; head not as wide as the thorax.

Thorax black, clothed with long, sparse, erect, black pubescence; pronotum, mesonotum and scutellum with close, more or less confluent punctures; dorsum and posterior face of propodeum deeply reticulate; humeri rounded; propleura punctate, without a carina on the cephalic margin; mesepisternum and mesepimeron with large, close punctures; metapleura polished; sides of propodeum rugoso-punctate, except the anterior third polished; tegulae transverse, coarsely rugoso-punctate, with a distinct posterior face.

Abdomen black and ferruginous, clothed with sparse, long, erect, black pubescence; first segment completely sessile with the second; first tergite with large, separated punctures; second tergite ferruginous, with large punctures, separated by their own diameter; tergites 3-5 black, with distinct separated punctures; tergites 6-7

with silvery pubescence; second sternite ferruginous, with large, separated punctures; sternites 3-7 black.

Wings dark; cell R4 almost obsolete; vein M 3+4 received by cell R5 at the middle.

Legs black, clothed with sparse, black pubescence; calcaria dark.

Holotype.—Male, August 20, 1906, Glen, Sioux County, Nebraska (H. S. Smith), in entomological collection of University of Nebraska.

Paratypes.—Male, August 20, 1906, Glen, Sioux County, Nebraska (H. S. Smith), author's collection; male, September, Sand Hills, Nebraska, collection U. S. National Museum, Cat. No. 26395.

This species is easily recognizable by the coarse sculpture of the tegulae and the silvery pubescence at the apex of the abdomen. It is possibly the male of *paludata* Mickel.

30. PSEUDOMETHOCA AETIS (Fox).

1899. *Mutilla aetis* Fox, Trans. Amer. Ent. Soc., vol. 25, p. 228, female.

1903. *Ephuta aetis* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 57, female.

1916. *Pseudomethoca (Nomiaephagus) aetis* BRADLEY, Trans. Amer. Ent. Soc., vol. 43, p. 320, female.

Type.—Female, Florida, in collection of American Entomological Society of Philadelphia.

Specimens examined.—Florida: 2 females, November 8, Miami (C. H. T. Townsend); female, December 5, 1912, Marathon (Frederick Knab); female, April 20, Enterprise (Dr. D. M. Castle); female, March 30–May 10, Enterprise; 2 females, May 7, 1916, Fort Meyers (J. C. Bradley); female, Lake City. Georgia: 9 females, May 18–21, 1916, Spring Creek (J. C. Bradley); female, June 7–23, 1911, Spring Creek, Decatur county (J. C. Bradley); 2 females, June, 1912, Billy's Island, Okefenokee Swamp (J. C. Bradley); 3 females, September 1–5, 1913, Billy's Island, Okefenokee Swamp (J. C. Bradley); female, August 2, 1913, Atlanta. North Carolina: Female, April 20, 1906, Southern Pines (S. W. Foster); female, April 22, 1913, Southern Pines (A. H. Manee). Texas: 4 females, July 19, 1906, Mineola (Bishopp and Jones); female, July 19, 1906, Mineola (C. R. Jones); female, August 22, 1907, Overton (W. W. Yothers); female, August 23, 1907, Palestine (W. W. Yothers); female, September 21, 1905, Lee county.

31. PSEUDOMETHOCA SIMILLIMA (Smith).

Plate 3, fig. 11.

1855. *Mutilla simillima* SMITH, Cat. Hymen. Brit. Mus., vol. 3, p. 62, female.

1871. *Mutilla (Sphaerophthalma) simillima* BLAKE, Trans. Amer. Ent. Soc., vol. 3, p. 255, female.

1886. *Sphaerophthalma simillima* BLAKE, Trans. Amer. Ent. Soc., vol. 13, p. 254, female.

1887. *Sphaerophthalma simillima* CRESSON, Trans. Amer. Ent. Soc., suppl. vol., p. 266, female.
1897. *Mutilla simillima* DALE TORRE, Cat. Hymen., vol. 8, p. 86, female.
1899. *Mutilla simillima* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 227, female.
1903. *Ephuta simillima* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 64, female.
1903. *Mutilla simillima* MELANDER, Trans. Amer. Ent. Soc., vol. 29, p. 294, female.
1916. *Pseudomethoea (Nomiaephagus) simillima* BRADLEY, Trans. Amer. Ent. Soc., vol. 42, p. 320, female.
1916. *Nomiaephagus simillimus* ROHWER, Hymen. Conn., p. 623, female.
1922. *Bruesia sparsiformis* RAU, Trans. Acad. Sci. St. Louis, vol. 25, p. 3, female and male.

Type.—Female, Massachusetts, in collection of British Museum.

I have before me the specimens mentioned by Rau (1922) and find that the female is *simillima* Smith, while the male has heretofore been undescribed.

Male.—Black, with the second segment of the abdomen ferruginous; length 9 mm. Head black, clothed with sparse, long, erect, black pubescence; mandibles tridentate; clypeus bidentate medially at the apex, closely punctate; antennae separated at the base by a distance equal to two-thirds the length of the scape; scape coarsely punctate; front and genae closely punctate; vertex with the punctures for the most part separated; eyes slightly ovate, the distance between the hind margins and the postero-lateral angles equal to half the longitudinal diameter of the eyes; relative widths of head and thorax 1-1.

Thorax black, clothed with sparse, long, erect, black pubescence; pronotum, mesonotum and scutellum with large, close, sometimes confluent punctures; dorsum and posterior face of propodeum deeply alveolate; humeri rounded; cephalic margin of the propleura rounded; propleura, mesepisternum and mesepimeron with large, close punctures; metapleura polished, with a thin microscopic silvery pile; sides of propodeum polished, the caudal half reticulato-punctate; tegulae with a few fine punctures at the base, for the most part polished, with a distinct posterior face.

Abdomen black, with the second segment ferruginous, clothed throughout with long, sparse, black pubescence; first segment completely sessile with the second; first tergite very dark red, with distinct scattered punctures; second tergite ferruginous, distinctly punctate, the punctures separated by about their own diameter; tergites 3-7 black, distinctly punctate; second sternite reddish black, with distinct, separated punctures; remaining sternites black; sternite 7 transversely concave, punctate.

Wings subfuscous; cell R4 obsolete; vein M 3+4 received by cell R5 slightly before the middle.

Legs black, clothed with sparse, black pubescence.

Allotype—Male, August 26, 1901, Lincoln, Nebraska (W. D. Pierce), in entomological collection of University of Nebraska.

The males of this species are rare in collections. Two additional specimens are known; male, August 27, St. George, Kansas; male and female, July 31, Jerseydale, Missouri (Rau). The latter is the specimen taken with the female.

Specimens examined.—Arkansas: Female, June 29, 1897, Marion County. Connecticut: Female, April 29, 1894, Hartford (S. N. Dunning); female, April 29, 1894, Hartford; female, September 15, 1895, Hartford. District of Columbia: Female, May, 1898; female May 11, (Marlatt); female, July, 1898; female, August, 1898. Florida: Female, October 4–8, 1914, Monticello. Georgia: Female, June 19–25, 1909, Tallulah (J. C. Bradley); female, August 3, 1913, Stone Mountain; female, August 27, 1910, Austell. Indiana: 3 females. Iowa: Female, June 18, Iowa City (Wickham); female, September 7, 1920, Sioux City (C. N. Ainslie); female, September 17, 1922, Sioux City (C. N. Ainslie). Kansas: Female, April, Riley County (Marlatt); female, June 5, 1919, Neosho County (Grace O. Wiley); female, July 3, Riley County (Popenoe); female, July 14, Riley County (Popenoe); female, July 17, Riley County, (Popenoe); female, August 30, 1912, Phillips County (F. X. Williams); female, Sheridan County (F. X. Williams); female, Salina (Knaus). Louisiana: Female, April 7, 1905, Calhoun (Wilmon Newell). Maryland: Female, May 18, Great Falls; female, July 19, Baltimore (F. E. Blaisdell). Mississippi: Female, May 15, 1915, Agricultural College (J. L. E. Lauderdale); female, April 18, Agricultural College (H. G. Ewell); female, October 9, 1922, Agricultural College (H. Gladney). Nebraska: Female, August 2, 1912, South Sioux City (L. T. Williams); female, September 10, 1913, Omaha (L. T. Williams); female, June 20, 1913, Omaha (L. T. Williams); female, July 2, 1915, South Bend (E. G. Anderson); female, May 8, 1909, South Bend (R. W. Dawson); female, July 6, 1915, South Bend (E. G. Anderson); female, May 17, South Bend; female, April 24, 1915, Lincoln (C. E. Mickel); female, July 11, 1920, Lincoln (C. E. Mickel); female, September 9, 1917, Lincoln (R. W. Dawson); female, May, 1888, West Point. New Jersey: Female, July 13, 1902, Iona (E. Daecke); female, April 15, 1910, Lakehurst; female, May 5, 1901, Manumuskin; female, July 22, Highlands; 2 females, August 18, 1910, Midwood; female, July 15, 1906, Wenonah; female, May 13, Andrews; female, September 3, 1906; Lucaston; female, April 22, 1906, Riverton; female, May 20, 1906; Almonessen; female, May 14, 1905, Bamber; female, September 1, 1905; Bamber; female, April 19, Westville; 2 females, May 24, 1902, Clementon; female, July 25, 1909, Delair; female, Runyon (Wm. T. Davis); female, August, 1910, Cassville (Wm. T. Davis); 4 females. New

York: Female, May 19, 1897, Flatbush, Long Island; female, May 16, 1896, Flatbush, Long Island; female, September 6, 1897, Flatbush, Long Island; female, 1887, Flatbush, Long Island; female; August 30, 1916, Selden, Long Island (Wm. T. Davis); female, September 1, 1916, Selden, Long Island (Wm. T. Davis); female, May, Wyandanch, Long Island; female, August 20, 1911, Kissena Lake, Long Island; 2 females, Long Island. North Carolina: Female, April 30, 1905, Ashville (F. Sherman); 2 females. Pennsylvania: Female, May 16, 1911, Water Tank (H. B. Kirk); female, May 6, 1909, Rockville (A. Champlain); female, May 6, 1909, Rockville (W. R. Walton); female, May 3, 1914, Rockville; female, May 31, 1909, Heckton Mills (W. R. Walton); female, September, 1909, Linglestown (Kirk and Champlain); female, June 14, 1917, Philadelphia (F. M. Trimble); female. Tennessee: Female, August, 1914, Knoxville; female, June 18, 1920, Knoxville (C. N. Ainslie); female, May 17, 1914, Knoxville. Texas: Female, April 6, 1906, Avery (F. C. Bishopp). Virginia: Female, April 22, 1913, Falls Church (C. T. Greene); female, May 11, Falls Church; female, July 2, 1913, Falls Church (Wm. Middleton); female, July 11, 1913, Falls Church (C. T. Greene); female, July 11, 1913, Falls Church; female, July 11, Falls Church; female, July 29, 1913, Falls Church (S. A. Rohwer); female, September 9, 1912, Falls Church (C. T. Greene); female, June 20, 1914, Nelson County (W. Robinson); female, July 29, 1916, Lynchburg (Wm. T. Davis); female, May 5, 1913, Veitch (C. T. Greene); female, April 27, 1884.

32. PSEUDOMETHOCA OCULATA (Banks).

1921. *Nomiaephagus oculatus* BANKS, Ann. Ent. Soc. Amer., vol. 14, p. 24, female.

Type.—Female, Georgia, in collection of Museum of Comparative Zoology, Cambridge, Massachusetts.

Specimens examined.—Florida: Female, April 25, 1905, Quincy (W. A. Hooker); female, Auburndale, Polk County. Georgia: 2 females, May 18–21, 1916, Spring Creek (J. C. Bradley); female, June 7–23, 1911, Spring Creek, Decatur County (J. C. Bradley); female, March 21, Thomasville (Morgan Hebard). North Carolina: Female, April 20, 1915, Southern Pines (A. H. Manee); female, March 10, 1909, Southern Pines (A. H. Manee); female, March 30, 1905, Raleigh (G. M. Bentley); female, April 27, 1906, Raleigh.

The form of the thorax of the type specimen of this species is quite distinct from that of *simillima* Smith. The thorax of this species is not so sharply constricted at the middle as is *similima*; also the thorax of the latter is very closely and irregularly punctate while in *oculata* the punctures are rather close but regular in distribution.

33. PSEUDOMETHOCA GERYON (Fox).

Plate 3, fig. 10.

1899. *Mutilla geryon* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 225, male.
 1903. *Pseudomethoca? geryon* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 28, male.
 1903. *Mutilla henshawi* MELANDER, Trans. Amer. Ent. Soc., vol. 29, p. 303, male.
 1910. *Mutilla daeckei* ROHWER, Proc. Ent. Soc. Wash., vol. 12, p. 49, male.
 1916. *Pseudomethoca (Nomiaephagus) geryon* BRADLEY, Trans. Amer. Ent. Soc., vol. 43, p. 318, male.

Type.—Male, Missouri, in collection of American Entomological Society of Philadelphia.

Plesiotype.—Male, September 9, 1914, Falls Church, Virginia (S. A. Rohwer). Collection of U. S. National Museum.

Specimens examined.—New Jersey: Male, September, 1905, Bamber (paratype of *daeckei* Rohwer). Virginia: Male, August 27, Falls Church; male, September 2, Falls Church; male, September 7, Falls Church; male, September 11, 1915, Falls Church (G. M. Greene); male, September 23, 1913, Veitch (C. T. Greene).

I have examined the genitalia of the types of *henshawi* Melander and *daeckei* Rohwer and find them to be identical with *geryon* Fox.

34. PSEUDOMETHOCA SANBORNII (Blake).

Plate 3, fig. 12.

1871. *Mutilla (Sphaerophthalma) sanbornii* BLAKE, Trans. Amer. Ent. Soc., vol. 3, p. 248, male.
 1886. *Sphaerophthalma sanbornii* BLAKE, Trans. Amer. Ent. Soc., vol. 13, p. 243, male.
 1887. *Sphaerophthalma sanbornii* CRESSON, Trans. Amer. Ent. Soc., suppl. vol., p. 266, male.
 1896. *Nomiaephagus sanbornii* ASHMEAD, Journ. N. Y. Ent. Soc., vol. 7, p. 59, male (Orthotype).
 1897. *Mutilla sanbornii* DALE TORRE, Cat. Hymen., vol. 8, p. 83, male.
 1899. *Mutilla sanbornii* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 228, male.
 1903. *Nomiaephagus sanbornii* ASHMEAD, Can. Ent., vol. 25, p. 307, male.
 1903. *Ephuta sanbornii* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 63, male.
 1903. *Mutilla sanbornii* MELANDER, Trans. Amer. Ent. Soc., vol. 29, p. 295, male.
 1916. *Pseudomethoca (Nomiaephagus) montivaga* BRADLEY, Trans. Amer. Ent. Soc., vol. 42, p. 320, female (not of Cresson).
 1916. *Pseudomethoca (Nomiaephagus) sanbornii* BRADLEY, Trans. Amer. Ent. Soc., vol. 43, p. 320, male.
 1923. *Nomiaephagus sanbornii* WASHBURN, 17th Rept. State Ent. Minn., p. 209, male.
 1923. *Pseudomethoca sanbornii*, MICKEL, 19th Rept. State Ent. Minn., p. 100, female and male.

Type.—Male, Massachusetts, in collection of American Entomological Society of Philadelphia.

Plesiotype.—Male, July 20, Weeping Water, Nebraska, in entomological collection of University of Nebraska.

The female which has heretofore remained undescribed is as follows:

Female.—Ferruginous; length 8–13 mm. Head ferruginous, sparsely clothed with short, semierect, golden pubescence, and scattered, erect hairs; mandibles tridentate; antennae separated at the base by a distance equal to two-fifths the length of the scape; a curved carina extending from below the eyes to the frontal tubercles; front, vertex and genae very closely, confluent punctate; longitudinal carina of genae distinct; eyes slightly ovate, the distance between the hind margins and the postero-lateral angles equal to two-thirds the longitudinal diameter of the eyes; head slightly wider than the thorax.

Thorax ferruginous, clothed with sparse, short, recumbent, golden pubescence, and scattered, erect hairs; dorsum with large, close punctures; dorsum of propodeum and extreme upper part of posterior face of propodeum reticulate, remainder of posterior face with scattered punctures; humeri rounded; propleura punctate, the cephalic margin weakly carinate; mesepisternum-mesepimeron micro-punctate, the posterior margin with large, close punctures; metapleura polished, the ventral half micro-punctate; sides of propodeum with scattered punctures.

Abdomen ferruginous; first segment completely sessile with the second; first tergite with a broad band of black; recumbent hairs at the apex, lateral extremes of the apex with silvery pubescence; sides and apical half of second tergite with well-separated punctures, the basal half rugoso-punctate, clothed with sparse, short, recumbent, golden pubescence, a subapical, broad band of sparse, black pubescence, and a narrow, apical band of silvery pubescence narrowly interrupted medially by black pubescence; tergites 3–5 with silvery pubescence; pygidial area distinct, rugose; second sternite with distinct, separated punctures; sternites 2–6 very sparsely, silvery pubescent.

Legs ferruginous; sparsely clothed with silvery pubescence.

Allotype.—Female, 1880, Selma, Alabama (E. A. Schwarz). Collection of U. S. National Museum. Reared with males from cells of *Nomia pattoni* Cockerell.

Specimens examined.—Alabama: 3 males and a female, 1880, Selma (E. A. Schwarz); male, July 31, 1916, Dothan. Arkansas: Female, September, 1890, Pine Bluffs. Connecticut: Female, September 2, 1909, Lyme (A. Champlain). Florida: Female. Georgia: 2 males, September 6, 1915, Bainbridge (Rehn and Hebard); female, June, 1912, Billy's Island, Okefenokee Swamp (J. C. Bradley); female,

September 1-5, 1913, Billy's Island, Okefenokee Swamp (J. C. Bradley); female, September 9, 1910, Stone Mountain. Illinois: Female, July, 1875, Peoria. Kansas: Female, July 23, 1901, Wellsville; female, 1915, Johnson County (R. H. Beamer). Maryland: Female, August 20, 1894, Chestertown (E. G. Vanatta). Massachusetts: Male, Nantucket Isle; female, October 5, 1910, Forest Hills; 2 females, September 20, 1905, Waquoit (Owen Bryant); female, August 4, 1902, Sconset. Minnesota: Female, July 14, 1922, Fridley sand dunes, Anoka County (A. A. Nichol); male, August 5, 1896, Gray Cloud Island. Mississippi: Male, August 14, Corinth (H. S. Barber). Nebraska: Female, July 2, 1915, Rulo (E. M. Partridge). New Jersey: 2 males, September 2, 1901, Lucaston; male, September 7, 1890, Camden County; female, August 6, 1911, Trenton; female, May 13, Andrews; female, May 23, 1904, Iona; female, August 25, 1902, Iona (E. Daecke); female, August 24, 1912, Ramsey; female, September 4, 1898, Great Notch; female. New York: Female, July 27, 1900, Cold Spring Harbor, Long Island; male, September 12, New Russia, Essex County (J. C. Bradley). North Carolina: 2 males, August 20, 1908, Raleigh; female. Pennsylvania: Female. Texas: Male, August 23, 1907, Palestine (W. W. Yothers). Virginia: Male, June 13, 1910, Falls Church (R. A. Cushman); female, July 28, Falls Church; female, August 20, 1913, Falls Church (C. T. Greene); female, September, Falls Church; 3 males, September 4, 1915, Falls Church (C. T. Greene); male, September 13, Falls Church; male, September 11, Chain Bridge.

The specimens from Selma, Alabama, 1880 (E. A. Schwarz) were reared from the cells of *Nomia pattoni* Cockerell and establish this female as that of *sanbornii*. Dr. W. H. Ashmead had these specimens before him when he worked out his classification of the Mutilidae, hence the generic name *Nomiaephagus*. This also accounts for the fact that Ashmead included the genus *Nomiaephagus* in his key to the genera based on the females, after designating *sanbornii* Blake as the type of that genus, when apparently the female of *sanbornii* was unknown to other hymenopterists.

Both sexes of this species are quite variable. Many of the southern specimens from Georgia and Alabama have the head and thorax more or less reddish, while those from the north are usually black. The male specimen from Gray Cloud Island, Minnesota, August 5, 1896, has the head and thorax reddish and also has the second, third, and fourth tergites with a band of pale golden pubescence at the apex, rather than the usual black. The genitalia of this specimen are identical with other specimens of *sanbornii* and I therefore regard it as a variant of this species. I have examined the genitalia of the type and compared them with the series I have at hand, and find them to be identical. The females vary in size from 8-13 mm.

In some specimens the apical silvery band of the second tergite is narrowly interrupted, while in others it is broadly interrupted. The legs vary from ferruginous to black.

This species is very closely related to *propinqua* Cresson. The females of this species have been confused with the females of *propinqua* in all collections. The two may be separated by the characters given in the key.

35. PSEUDOMETHOCA PROPINQUA (Cresson).

Plate 3, fig. 13.

1865. *Mutilla propinqua* CRESSON, Proc. Ent. Soc. Phila., vol. 4, p. 433, male.
 1865. *Mutilla montivaga* CRESSON, Proc. Ent. Soc. Phila., vol. 4, p. 436, female.
 1871. *Mutilla (Sphaerophthalma) propinqua* BLAKE, Trans. Amer. Ent. Soc., vol. 3, p. 248, male.
 1871. *Mutilla (Sphaerophthalma) montivaga* BLAKE, Trans. Amer. Ent. Soc., vol. 3, p. 255, female.
 1886. *Sphaerophthalma propinqua* BLAKE, Trans. Amer. Ent. Soc., vol. 13, p. 242, male.
 1886. *Sphaerophthalma montivaga* BLAKE, Trans. Amer. Ent. Soc., vol. 13, p. 254, male.
 1887. *Sphaerophthalma montivaga* CRESSON, Trans. Amer. Ent. Soc., suppl. vol., p. 265, female.
 1887. *Sphaerophthalma propinqua* CRESSON, Trans. Amer. Ent. Soc., suppl. vol., p. 266, male.
 1897. *Mutilla montivaga* DALLE TORRE, Cat. Hymen., vol. 8, p. 64, female.
 1897. *Mutilla propinqua* DALLE TORRE, Cat. Hymen., vol. 8, p. 74, male.
 1899. *Mutilla montivaga* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 227, female (part).
 1899. *Mutilla propinqua* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 228, male.
 1903. *Ephuta montivaga* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 62, female.
 1903. *Ephuta propinqua* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 63, male.
 1903. *Mutilla montivaga* MELANDER, Trans. Amer. Ent. Soc., vol. 29, p. 294, female.
 1903. *Mutilla propinqua* MELANDER, Trans. Amer. Ent. Soc., vol. 29, p. 295, male.
 1923. *Pseudomethoca propinqua* MICKEL, 19th Rept. State Ent. Minn., p. 101, male and female.

Type—Male, Colorado, in collection of American Entomological Society of Philadelphia.

Plesiotype—Male, July 10, 1911, Meade County, Kansas (F. X. Williams), in entomological collection of University of Kansas.

Specimens examined—Canada, Alberta: Female and male, August 20, 1916, Medicine Hat (Sladen); male, August 26, 1912, Lethbridge (J. B. Willis); male, August 28, 1912, Lethbridge (J. B. Willis). Arizona: Male, July 31, Winslow (Barber and Schwarz); 2 females and a male, July 30, 1919, Winslow (Rehn and Hebard); female, Saceton (C. N. Ainslee); female, Yavapai County (O. Buch-

holz); female, Douglas, San Bernardino Ranch (F. B. Snow); female. Colorado: Male, June, 1900, Nephista; male, August 9, 1905, Cope (S. A. Johnson); male, June, Turkey Creek Canyon (Oslar); male and female, August 20, 1895, Poudre River; female, June 7, 1899, Fort Collins; female, June 8, 1899, Fort Collins; female, June 27, 1904, Fort Collins; female, July 25, 1900, Fort Collins; female, August 28, 1899, Fort Collins, female, June 6, 1904, Longmont (E. S. G. Titus); female, July 20, 1916, Boulder (Bonnie Allen); female, August 13, White Rocks, Boulder County (Cockereil); 2 females, September 7, 1901, Denver; female, Denver (Oslar); female, August 31, 1906, Chimney Gulch; female, July 13, Bent County (Lantz); female, August 23, Bent County (Lantz); 2 females, July 21, 1900, Durango (Oslar); female, July 22, 1900, Durango (Oslar); 7 females. Kansas: Female, June, Riley County (Marlatt); 2 females, June 26, Riley County (G. A. Dean); female, July 12, Riley County (Popenoe); female, July 21, Riley County (Popenoe); female, July 22, Riley County (Popenoe); female, August 7, Riley County (Popenoe); female, August 9, Riley County (J. B. Norton); 2 males, August, Riley County (Marlatt); female, Riley County (Popenoe); female, August 9, 1912, Rooks County (F. X. Williams); male, August 27, Rooks County; female, July 18, 1912, Ellis County (F. X. Williams); 2 females, July 19, 1912, Ellis County (F. X. Williams); 3 females, June 28, 1912, Rush County (F. X. Williams); 2 females and a male, July 6, 1911, Kiowa County (F. X. Williams); female, May, Clark County (F. H. Snow); female, June, Clark County (F. H. Snow); female, August 23, 1911, Clark County (F. X. Williams); 5 females, Sheridan County (F. X. Williams); 2 males, Decatur County (F. X. Williams); male, August 24, 1912, Norton County (F. X. Williams); 2 females and 5 males, July 10, 1911, Meade County (F. X. Williams); male, July 12, 1911, Meade County (F. X. Williams); female, July 26, 1912, Russell County (F. X. Williams); female, Wabaunsee County (Forest Anderson); 2 females, 2 males, Rawlins County (F. X. Williams); female, July 27, 1911, Grant County (F. X. Williams); 2 males, July 23, 1911, Grant County (F. X. Williams); 2 females, 4 males, Cheyenne County (F. X. Williams); 2 females, July 7, Wallace County; 3 females, July 8, Wallace County; 3 females, July 10, Wallace County; female, July 15, Wallace County; female and male, August 31, Wallace County, 2 females, and male, Wallace County (F. H. Snow); female, Greeley County (F. X. Williams); 2 females, August 27, Hamilton County; female, Hamilton County (S. J. Hunter); female, 2 males, July 30, 1911, Stanton County (F. X. Williams); female, 4 males, August 5, 1911, Morton County (F. X. Williams); female, Morton County (F. H. Snow); 2 females.

(Snow). Minnesota: Female, August 21, 1911, Fergus Falls (Stoner). Montana: Female, June 20, 1912, Lo Lo; male, August 14, 1906, Billings; male, August 18, 1917, Musselshell. Nebraska: Female, August, Lincoln; female, September, Lincoln; female, June, 1888, West Point; 2 females, July, 1888, West Point; 2 males, West Point; female, July 7, 1915, Curtis (C. E. Mickel); female, July 1, 1911, Imperial (J. T. Zimmer); female, May 24, 1914, Haigler (L. M. Gates); male, August 19, 1909, Haigler (C. H. Gable); male, August 19, 1912, Haigler (J. T. Zimmer); female, June, Halsey; 2 females, August 13, 1920, Halsey (C. B. Philip); female, August 28, 1911, Halsey (J. T. Zimmer); female, June, Dewey Lake Township, Cherry County (R. H. Wolcott); female, June 14, 1916, Mitchell (R. W. Dawson); female, June 16, 1915, Mitchell (L. M. Gates); female, June 27, 1913, Mitchell (L. M. Gates); female, June 28, 1916, Mitchell (C. E. Mickel); female, July 5, 1916, Mitchell (C. E. Mickel); female, July 30, 1914, Mitchell (L. M. Gates); female, August 5, 1917, Mitchell (E. J. Yates); male, August 5, 1914, Mitchell (L. M. Gates); female, August 25, 1913, Mitchell (L. M. Gates); female, June 23, 1911, Monroe Canyon, Sioux County (R. W. Dawson); 2 males, August 24, 1908, Monroe Canyon, Sioux County (R. W. Dawson); 2 males, August 24, 1908, Monroe Canyon, Sioux County (J. T. Zimmer); female, August 27, 1912, Monroe Canyon, Sioux County (E. J. Taylor); male, August 10, 1908, Bad Lands, Sioux County (C. H. Gable); male, August 9, 1908, Harrison (R. W. Dawson); female, August 12, 1912, Harrison (E. J. Taylor); female, Sioux County; male, Pine Ridge. New Mexico: Female, May 30, 1913, Jemez Springs (John Woodgate); female, July 10, 1916, Jemez Springs (John Woodgate); female, July 21, 1914, Jemez Springs (John Woodgate); male, July 27, 1914, Jemez Springs; male, July 29, 1916, Jemez Springs (John Woodgate); male, July 31, 1914, Jemez Springs; female, August 7, 1916, Jemez Springs (John Woodgate); female, August 9, 1913, Jemez Springs (John Woodgate); female, September 3, 1916, Jemez Springs (John Woodgate); female, September 11, 1916, Jemez Springs (John Woodgate); female, August 19-22, 1914, Cimarron (W. R. Walton); male, Cimarron; male, August 9, 1919, Springer (C. N. Ainslie); female, Springer (C. N. Ainslie); female, August 23, Glorieta (W. P. Cockerell); female, July 23, 1902, Las Vegas (Osler); 2 females, August, 1894, Albuquerque (Snow); male, Magdalena. North Dakota: Female, June 16, 1918, Gascoyne (O. A. Stevens); female, July 4, 1918, Marmouth (O. A. Stevens); female, August 22, 1921, Beach (C. N. Ainslie); male, August 30, 1922, Cannon Ball (O. A. Stevens); 2 females. South Dakota: Female, Hot Springs; female. Texas: 2 females, July, 1905, Barstow (J. C. Crawford); female,

October 12, Barstow (J. C. Crawford); female, July 1-2, 1916, Marathon; 3 females, June 13-17, 1908, Brewster (Mitchell and Cushman); female, June 6, 1908, Marfa (Mitchell and Cushman); 3 females, July 3-6, Marfa (Wickham); female, July 11, 1907, Victoria (W. W. Yothers); 2 females, 8 males, June 22, 1917, Richmond, Fort Bend County; 4 females, July 11, 1917, El Paso, El Paso County; 2 females, June 24, 1917, Wharton; male, June 28-30, Alpine (Wickham); male, May, 1907, Lee County; male, November 26, 1905, Cotulla (F. C. Pratt). Wyoming: Female, Douglas (L. Bruner); female, July, 1895, 40 miles north of Lusk.

I consider *montivaga* Cresson the female of *propinqua* Cresson for the following reasons: The geographical ranges of the two are identical; both are found in the outlying portions of this area, that is, Texas, New Mexico, Arizona, North Dakota, Montana, and Alberta, Canada; in the case of North Dakota, Montana, and Alberta, Canada *montivaga* and *propinqua* are the only two *Pseudomethocas* which are present in collections, excepting *bequaerti* Mickel, and it belongs to another section of the genus. Fox (1899) suggested that *montivaga* was perhaps the female of *propinqua* and from the large series of specimens at hand this seems to be perfectly evident.

This species is very closely related to *sanbornii* Blake and from the distribution data at hand it seems to replace *sanbornii* throughout the area of its range.

Both the female and the male are quite variable, although in the case of the female, not so much so as former writers have indicated. The color of the female varies from ferruginous to dark mahogany red; the apex of the first tergite may have the pubescence black or golden, while that of the second may be black or silvery. I have examined the type of *montivaga* Cresson and find that it has the apex of the first tergite with golden pubescence and the apex of the second tergite with silvery pubescence. There is apparently no structural character that will serve to separate the variants. Two males from West Point, Nebraska, have the thorax and the first two abdominal segments almost entirely ferruginous. A male from Lee County, Texas, one from Meade County, Kansas, and one from Cotulla, Texas, have the thorax entirely black. The genitalia of all the specimens in the entire series are identical and the variants are therefore retained here.

36. PSEUDOMETHOCA BRAZORIA (Blake).

1871. *Mutilla (Sphaerophthalma) brazoria* BLAKE, Trans. Amer. Ent. Soc., vol. 3, p. 255, female.
1886. *Sphaerophthalma brazoria* BLAKE, Trans. Amer. Ent. Soc., vol. 13, p. 254, female.

1887. *Sphaerophthalma brazoria* CRESSON, Trans. Amer. Ent. Soc., suppl. vol., p. 265, female.
1897. *Mutilla brazoria* DALLE TORRE, Cat. Hymen., vol. 8, p. 17, female.
1899. *Mutilla montivaga* FOX, Trans. Amer. Ent. Soc., vol. 25, p. 227, female (part).
1903. *Mutilla montivaga* MELANDER, Trans. Amer. Ent. Soc., vol. 29, p. 294, female (part).

Type.—Female, Texas, in collection of American Entomological Society of Philadelphia.

Specimens examined.—Texas: Female, May 9, 1906, Cotulla (J. C. Crawford); female, July 1-2, 1916, Marathon; female, Austin; female, Round Mountain; 2 females.

This species is quite distinct from the female of *propinqua* Cresson and may be distinguished, aside from general color, by the vesture of the abdominal tergites which is almost entirely golden, and by its coarser puncturation.

37. PSEUDOMETHOCA CARBONARIA, new species.

Plate 4, fig. 16.

Male.—Black; length 8 mm. Head black, rather quadrate, clothed with long, sparse, erect, silvery pubescence; mandibles tridentate; clypeus feebly bidentate medially, obscurely punctured; antennae separated at the base by a distance equal to half the length of the scape; scape punctate and pubescent; first joint of flagellum shorter than the second; front with coarse, confluent punctures; vertex with coarse, sparse, irregularly placed punctures; genae regularly punctate; eyes slightly ovate, the distance between the hind margins of the eyes and the postero-lateral angles equal to five-sevenths of the longitudinal diameter of the eyes; head not as wide as the thorax.

Thorax black, clothed with long, sparse, erect, silvery pubescence; pronotum and scutellum with coarse, confluent punctures; mesonotum with coarse, separated punctures; dorsum and posterior face of propodeum broadly and shallowly reticulate; humeri rounded; propleura with separated punctures, the cephalic margin rounded; mesepisternum and mesepimeron with coarse, confluent punctures; metapleura polished, with a microscopic silvery pile; sides of propodeum polished, with a few scattered punctures, and rugose at the posterior margin; tegulae subhemispherical, polished, punctate and pubescent at the extreme base and sides.

Abdomen black, clothed with sparse, long, erect, silvery pubescence; first segment completely sessile with the second; first tergite with elongate punctures on the disk, a very thin band of silvery pubescence at the apex; second tergite with coarse, sparse punctures about their own diameter apart; apices of second, third,

and fourth tergites with a prominent band of silvery pubescence; tergites 3-6 distinctly punctate; sternite two with irregular, sparse punctures.

Wings subfuscous; cell R4 almost obsolete; vein M 3+4 received by cell R5 a little before the middle.

Legs black, sparsely clothed with silvery pubescence; calcaria pale.

Holotype.—Male, June, Brownsville, Texas, in entomological collection of University of Kansas.

Paratype.—Male, Texas, Cat. No. 26396 U.S.N.M.

38. PSEUDOMETHOCA VANDUZEI Bradley.

Plate 4, fig. 14.

1916. *Pseudomethoca (Nomiaephagus) vanduzei* BRADLEY, Trans. Amer. Ent. Soc. vol. 42, p. 321, male.

Type.—Male, Clearwater, Florida, in American Museum of Natural History.

Plesiotype.—Male, May 3, 1906, Lee County, Texas, in entomological collection of University of Kansas.

The genitalia of the type and plesiotype have been compared and found to be identical. This record extends the range of *vanduzei* considerably.

39. PSEUDOMETHOCA RUSSEOLA, new species.

Plate 4, fig. 19.

Male.—Black and ferruginous; length 8 mm. Head black, sparsely clothed with long, erect, silvery pubescence; mandibles tridentate; clypeus bidentate medially, distinctly punctate throughout; antennae separated at the base by a distance equal to half the length of the scape; scape punctate and pubescent; first joint of flagellum a little shorter than the second; front and genae closely, confluent punctate; vertex with large, close punctures; eyes slightly ovate, distance between the hind margins of the eyes and the postero-lateral angles equal to half the longitudinal diameter of the eyes; head not as wide as the thorax.

Thorax black, sparsely clothed with long, erect, silvery pubescence; pronotum, mesonotum and scutellum with large, close, more or less confluent punctures; dorsum and upper third of posterior face of propodeum broadly reticulate, remainder of posterior face sparsely rugoso-punctate; humeri rounded; propleura deeply, confluent punctate, the cephalic margin rounded; mesopisternum and mesepimeron coarsely, confluent punctate; metapleura polished, finely rugose on the posterior half; sides of propodeum polished, the pos-

terior half coarsely rugose; tegulae convex, polished, punctured and pubescent at the base and sides.

Abdomen ferruginous, sparsely clothed with long, erect, silvery pubescence; first segment completely sessile with the second; first tergite with elongate punctures on the disk, a very thin band of silvery pubescence at the apex; second tergite with large, shallow, separated punctures; tergites 3-6 distinctly punctate; tergites 2-5 with an obscure, thin band of black hairs at the apex; sternite two with large, separated punctures; sternites 4-7 black.

Wings subfuscous; cell R4 obsolete; vein R5 with a short vestige of a vein projecting at right angles into cell R4 midway between vein R3 and M 1+2; vein M 3+4 received by cell R5 considerably before the middle.

Legs black, sparsely clothed with silvery pubescence; calcaria whitish.

Holotype.—Male, May 4, 1901, San Diego, Texas (R. A. Cushman), Cat. No. 26211 U.S.N.M.

This species may be easily recognized by the red abdomen, and the silvery pubescence of the entire body.

40. PSEUDOMETHOCA AEGAEON (Fox).

Plate 4, fig. 17.

1899. *Mutilla aegaeon* Fox, Trans. Amer. Ent. Soc., vol. 25, p. 229, male.

1903. *Ephuta aegaeon* ANDRÉ, Gen. Ins., vol. 1, fasc. 11, p. 57, male.

Type.—Male, Tucson, Arizona, in U. S. National Museum.

Plesiotype.—Male, Tucson, Arizona (F. H. Snow), in entomological collection of the University of Kansas.

Specimens examined.—Arizona: Male, August 4-7, 1916, Coyote Mountains.

The genitalia of the type and plesiotype have been compared and found to be identical.

41. PSEUDOMETHOCA MANCA, new species.

Plate 4, fig. 18.

Male.—Black; length 8 mm. Head black, sparsely clothed with long, white, erect pubescence; mandibles tridentate; clypeus bidentate medially, finely punctate; front, vertex and genae with large, more or less confluent punctures; eyes slightly ovate, distance between hind margins of eyes and postero-lateral angles a little less than half the longitudinal diameter of the eyes; head not quite as wide as the thorax.

Thorax black, sparsely clothed with long, erect, silvery pubescence; pronotum, mesonotum and scutellum with large, confluent punc-

tures; dorsum and posterior face of propodeum broadly and shallowly reticulate; humeri rounded; propleura confluent punctate, the cephalic margin rounded; mesepisternum and mesepimeron with large, confluent punctures; metapleura polished; sides of propodeum polished on the anterior third, coarsely rugose on the posterior two-thirds; tegulae very convex, polished, punctate, and pubescent at the extreme base and sides.

Abdomen black, sparsely clothed with long, erect, silvery pubescence; first segment completely sessile with the second; disk of first tergite with large, separated punctures; second tergite with large, shallow punctures, separated by about half their own diameter; tergites 3-6 distinctly punctate; tergites 2-5 with a prominent, apical band of silvery pubescence; tergites 5-6 with blackish pubescence; sternite two with large, shallow, more or less confluent punctures; sternites 2-6 with an apical band of silvery pubescence.

Legs black, sparsely clothed with silvery pubescence; calcaria whitish.

Holotype.—Male, Utah, Cat. No. 26212, U.S.N.M.

The type specimen lacks both wings and antennae. However, the structure of the genitalia is so characteristic that it may be easily recognized from that structure alone. External structural characters are used in the key to the males to separate this from other species.

SPECIES OF MUTILLIDAE DESCRIBED FROM MEXICO AND CENTRAL AMERICA WHICH PROBABLY BELONG TO THE GENUS PSEUDOMETHOCHA.

<i>amphissa</i> Cameron.	<i>ferruginea</i> Smith.	<i>munda</i> Cameron.
<i>animosa</i> Cameron.	<i>flaviceps</i> André.	<i>odiosa</i> Cameron.
<i>areta</i> Cameron.	<i>gothica</i> Blake.	<i>panamensis</i> Cameron.
<i>auripes</i> Blake.	<i>gratiosa</i> Cameron.	<i>petricola</i> Blake.
<i>beata</i> Cameron.	<i>incognata</i> Cameron.	<i>phedyma</i> Cameron.
<i>bisignata</i> Blake.	<i>ingrata</i> Cameron.	<i>psammadroma</i> Blake.
<i>caltha</i> Cameron.	<i>inimica</i> Cameron.	<i>ravula</i> Cameron.
<i>capitata</i> Smith.	<i>intrepida</i> Cameron.	<i>respublicana</i> Cameron.
<i>caroli</i> Cameron.	<i>ipsea</i> Cameron.	<i>robinsoni</i> Blake.
<i>cephalica</i> Cameron.	<i>izucar</i> Blake.	<i>rustica</i> Cameron.
<i>chiapa</i> Blake.	<i>jaliscoensis</i> Cameron.	<i>salutatrix</i> Blake.
<i>chontalensis</i> Cameron.	<i>janira</i> Cameron.	<i>sonorensis</i> Cameron.
<i>cleonica</i> Cameron.	<i>jocularis</i> Cameron.	<i>subgracilis</i> Cameron.
<i>cordovensis</i> Cameron.	<i>laticeps</i> Blake.	<i>unicincta</i> Ashmead.
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EXPLANATION OF PLATES.

[All drawings to the same scale and made by the author.]

PLATE 1.

- FIG. 1. *Pseudomethoca*, species, male genitalia. *a*, uncus; *b*, squama; *c*, sagitta; *d*, volsella; *e*, ramus; *f*, cardo.
2. *Myrmilloides grandiceps* (Blake). Male genitalia.
3. *Pseudomethoca anthracina* (Fox). Male genitalia.
4. *Pseudomethoca aureovestita* Bradley. Male genitalia.

PLATE 2.

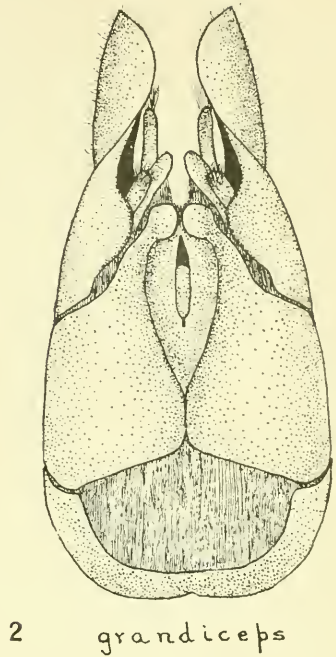
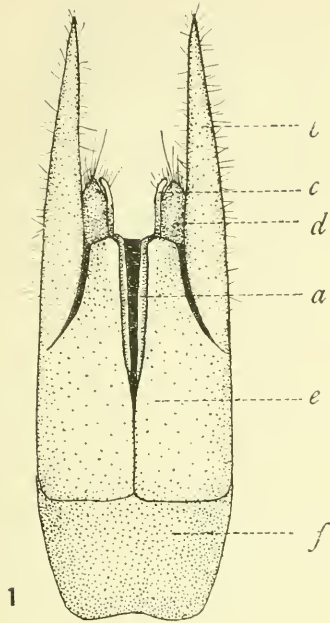
- FIG. 5. *Pseudomethoca ocoala* (Blake). Male genitalia.
6. *Pseudomethoca nigricula*, new species. Male genitalia.
7. *Pseudomethoca canadensis* (Blake). Male genitalia.
8. *Pseudomethoca athamas* (Fox). Male genitalia.
9. *Pseudomethoca albicoma*, new species. Male genitalia.

PLATE 3.

- FIG 10. *Pseudomethoca geryon* (Fox). Male genitalia.
11. *Pseudomethoca simillima* (Smith). Male genitalia.
12. *Pseudomethoca sanbornii* (Blake). Male genitalia.
13. *Pseudomethoca propinqua* (Cresson). Male genitalia.

PLATE 4.

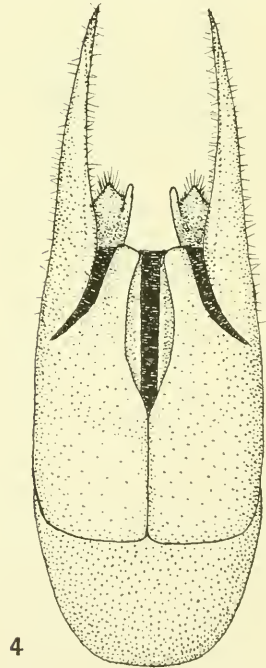
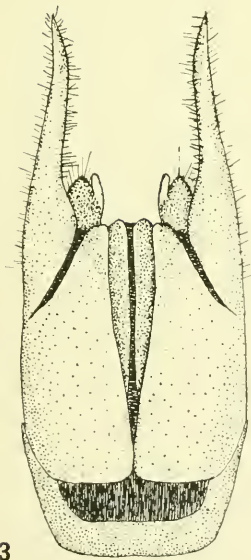
- FIG 14. *Pseudomethoca vanduzeei* Bradley. Male genitalia.
15. *Pseudomethoca scrupulosa*, new species. Male genitalia.
16. *Pseudomethoca carbonaria*, new species. Male genitalia.
17. *Pseudomethoca uegæon* (Fox). Male genitalia.
18. *Pseudomethoca manca*, new species. Male genitalia.
19. *Pseudomethoca russcola*, new species. Male genitalia.



1

2

grandiceps



3

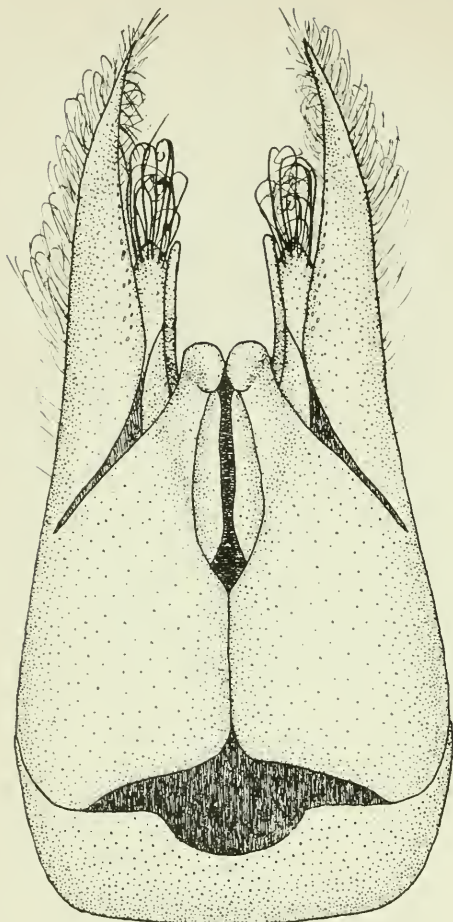
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anthracina

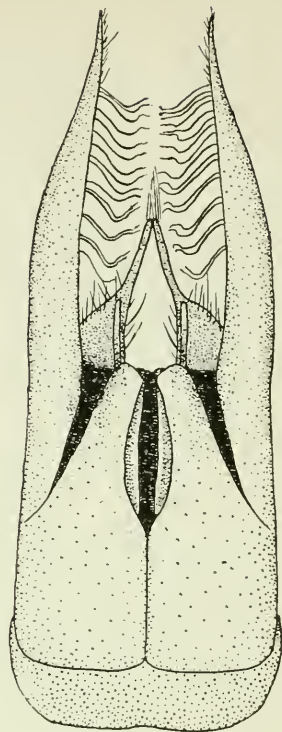
aureovestita

MALE GENITALIA OF THE MUTILLID WASPS. DORSAL VIEW.

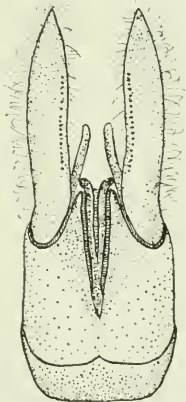
FOR EXPLANATION OF PLATE SEE PAGE 49



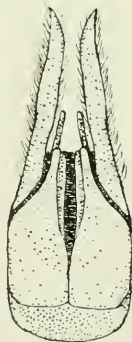
5 *oecola*



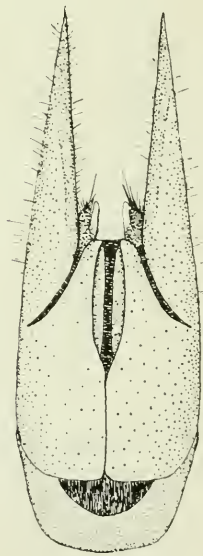
6 *nigricula*



7 *canadensis*



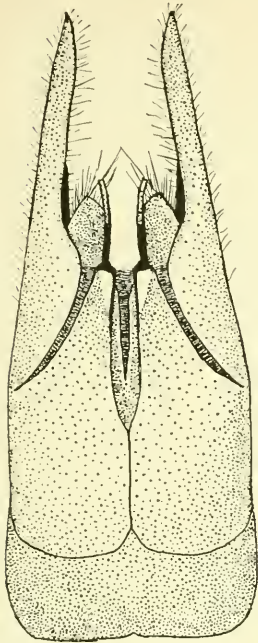
8 *athamas*



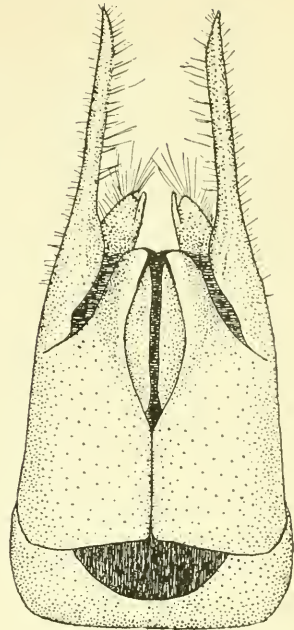
9 *albicoma*

MALE GENITALIA OF THE MUTILLID WASPS. DORSAL VIEW.

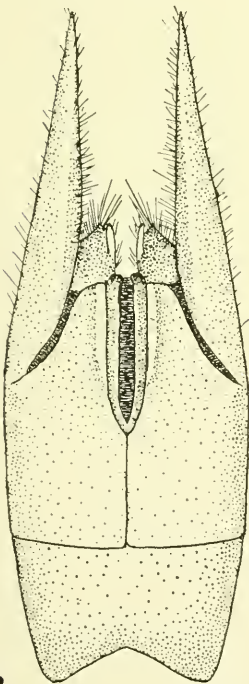
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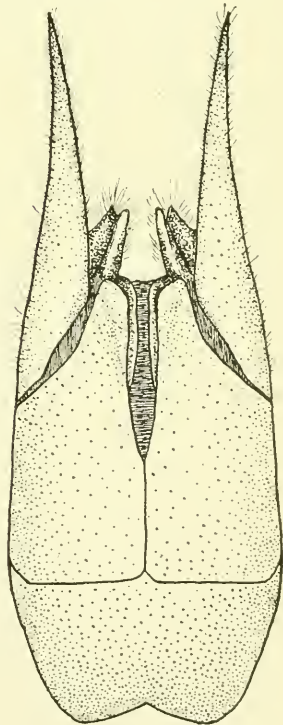
10 *geryon*



11 *simillima*



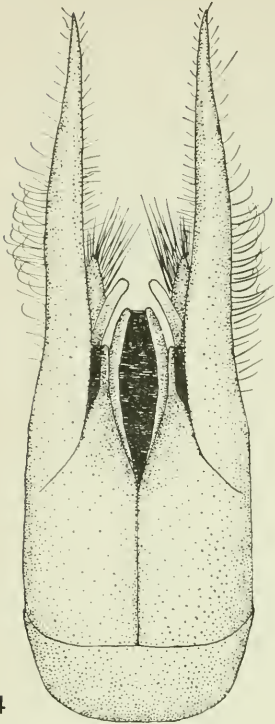
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13 *propinqua*

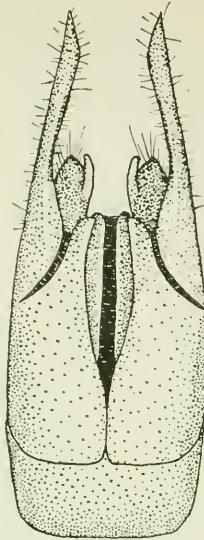
MALE GENITALIA OF THE MUTILLID WASPS. DORSAL VIEW.

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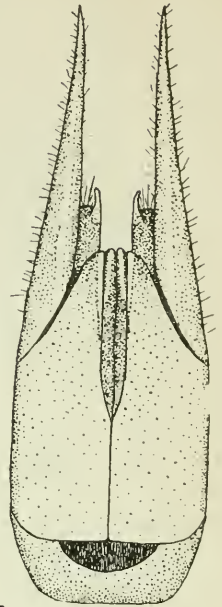
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vanduzei



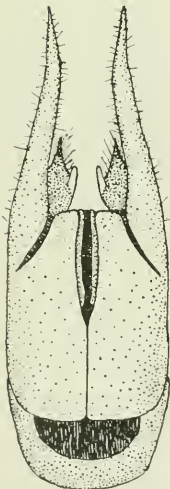
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scrupulosa



16

carbonaria



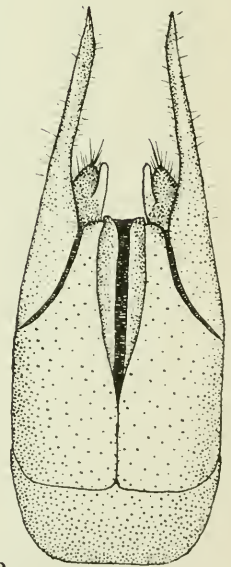
17

aegaeon



18

manca



19

russeola

MALE GENITALIA OF THE MUTILLID WASPS. DORSAL VIEW.

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[Valid genera in heavy face type; valid species in roman; synonyms in italics.]

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<i>luatha</i> Cameron	46	<i>sparsiformis</i> Rau	33
<i>ludovica</i> Cameron	46	<i>subgracilis</i> Cameron	46
<i>lycimnia</i> Cameron	46	<i>toumeyii</i> Fox	6, 13
<i>macrocephala</i> Smith	46	<i>unicincta</i> Ashmead	46
<i>manca</i> , new species	9, 45	<i>vanduzei</i> Bradley	8, 44
<i>meritoria</i> , new species	7, 27	<i>veraepacis</i> Cameron	46
<i>minutissima</i> Blake	46	<i>verticalis</i> Smith	46
<i>minutoria</i> Cameron	46	<i>volatilis</i> Cameron	46
<i>mirandillensis</i> Cameron	46	<i>vulnerifrons</i> André	46
<i>montivaga</i> Cresson	36, 39, 43	<i>wickhami</i> Cockerell and Casad.	6, 18
<i>munda</i> Cameron	46	<i>xalapa</i> Blake	46
<i>neojerseiensis</i> Dalle Torre	9	<i>xanthocerata</i> Smith	46
		<i>zapoteca</i> Blake	46

A COLLECTION OF BIRDS FROM NORTH AND NORTH-CENTRAL CELEBES.

By J. H. RILEY,

Aid, Division of Birds, United States National Museum.

When Dr. W. L. Abbott, the well-known explorer, reluctantly gave up his exploration in eastern Asia, on account of ill-health, he made arrangements with the Smithsonian Institution to have this work continued. H. C. Raven was selected to carry out his plans and started operations in northeast Borneo in 1912. After making a good collection there and becoming familiar with the Malay language and the handling of natives, he purchased a small sailing vessel and with a crew of natives sailed from Samarinda, Borneo, to Paloe Bay, Celebes, where he arrived on July 16, 1914, working northward along the west coast of the northern peninsula as far as Kwandang. He then retraced his course as far as Kampa, returned to Borneo, February 28, 1915, and came home to the United States for a well-merited vacation. On this trip Mr. Raven did not penetrate far inland and while he made a large collection of birds, it contained no novelties. He obtained material at the following localities on this voyage:

Dampelas.	Toli Toli.
Kapas Bay.	Kampa.
Kwala Besar.	Tandjong Penjoe.
Boesak.	Tandjong Tango.
Paleleh.	Soemalata.
Paleleh River.	Kwandang.

Mr. Raven next returned to Celebes and began work in the extreme northern tip at Likoepong, January 13, 1916. While in the north he collected birds at the following localities:

Likoepong.	Ayermadidi.
Teteamoet.	Goenoeng Kalabat. ¹

¹ Mr. Raven has furnished the following note on this mountain: "My camp was at about 1,700 meters (5,600 feet), where the forest is only semitropical in appearance. Practically all the trees are heavily coated with moss and are not tall. Kalabat is the highest mountain in Minahassa, having an altitude of 2,020 meters (6,617 feet)."

Koeala Prang.	Manembo Nembo.
Batoe Hangoes.	Toemaratas.
Batoe Hangoes Baroe and near by at Roemoesoem.	Temboan.
Pulo Lembeh.	Langowan.

All the above localities are in Minahassa.

Mr. Raven then left the north and went to Parigi in middle Celebes, on the Gulf of Tomini, at the base of the northern peninsula, where he arrived August 27, 1916, and worked north along the coast to Tinomboe, collecting birds at the following stations:

Parigi.	Laboea Sore.
Toboli.	Kasimbar.
Bumbaroedjaba (altitude about 915 meters (3,000 feet)).	Manilili.
	Toeriboeloe.
	Tinomboe.

From Toboli he crossed the northern peninsula to Paloe Bay and started south up the valley of the Paloe River, collecting birds at:

Dolo.	Toewoeloe.
Koelawi.	Winatoe.
Goenoeng Lechio (altitude, 7,166 feet), to the south- west of Lake Lindoe.	Rano Lindoe.

Returning to the coast, he collected at Tamboe (north of Donggala), Dampelas, and Lende, when he started up the Paloe Valley again and collected birds at the following stations:

Kalaware.	Napoe, Watoetaoe.
Gimpoe.	Rano Rano (altitude, 1,800 meters).
Toare, Bada.	Pinedapa.
Doda, Besoa.	
Taewo Mountain, Besoa.	

On this last trip inland he passed to the west of Lake Lindoe (the unnamed lake to the northwest of Lake Posso on Meyer and Wigglesworth's map) and continued south to the district of Bada, which is west of the range of mountains to the west of Lake Posso and about at the same latitude as the southern border of this lake. He then turned north and northeast, keeping to the west of the mountains west of Lake Posso until he crossed the range just to the east of Rano Rano (on the west slope of the mountains near the summit) and continued to the Gulf of Tomini at Mapane. Pinedapa is inland a short distance from Mapane. Mr. Raven furnishes the following note:

Besoa is a large level plain, undoubtedly a former lake bed, surrounded by mountains, which are covered by heavy forests; the tops of most of the

mountains are above 2,000 meters, the level plain is said to be about 1,300 meters, or perhaps more. The plain is perhaps 2 or 3 miles wide by about 3 miles long and most of the area is covered with several varieties of long coarse grasses and reeds; in several places there are wet rice fields and the natives have made a few clearings on the lower slopes of the mountains. In some places the lower slopes are covered with grass.

When the United States entered the World's War, Mr. Raven placed himself at the disposal of the authorities at Manila, but continued to collect birds until early in 1918. While awaiting orders he made a scouting voyage around the south coast of Celebes, collecting no birds, however. He then returned home.

Some of the above localities were visited several times and he seems to have crossed the northern peninsula more than once. I had hoped that Mr. Raven would supply me with detailed information on the character of the country of his various collecting stations but before he could do so he left for Africa on a long collecting trip and then for Australia. Rather than delay the report upon his Celebes work any longer, I have decided to publish this catalogue of the birds collected on the island, relying for the localities upon his field catalogues, the specimens, and a large scale map upon which Mr. Raven has marked his route.

It is quite unnecessary to say that the collections were very large; most of the species in good series of well-prepared skins. All the skins were prepared personally by Mr. Raven, who had no other white man with him and found it too difficult to teach the Buganese to skin birds. His trip to Lake Lindoe was made by pack train of ponies with pack saddles devised and made by him. On his last trip into the interior his supplies from the United States were held in Singapore on account of the war, and he had to subsist upon the country, which he found in a deplorable condition on account of a prolonged and almost unprecedented drought.

In several preliminary papers² the following birds have been named from Mr. Raven's Celebesian collection:

Scolopax celebensis.

Anas superciliosa perena.

Rhamphococcyx centralis.

Collocalia vestita aenigma.

Caprimulgus affinis propinquus.

Dendrobiastes hyperythra jugosae.

Celebesia abbotti.

Cataponera abditiva.

Megalurus celebensis.

Cryptolopha nesophila.

Pachycephala pluviosa.

Coracornis raveni.

Zosterops atrifrons surda.

Pseudozosterops striaticeps.

Munia punctulata particeps.

Lamprocorax montosa.

Enodes erythrophrys centralis.

Dicruropsis montana.

² Proc. Biol. Soc. Wash., vol. 31, 1918, pp. 155-160; vol. 32, 1919, pp. 93-96; vol. 33, 1920, pp. 55-58; vol. 34, 1921, pp. 55-58.

Two of the species required new generic names, namely, *Coracornis* and *Celebesia*; while *Scolopax celebensis* and *Megalurus celebensis* belong to genera hitherto unreported from Celebes.

Besides the above new forms, the collection contains the two following additions to the avifauna of the island: *Nyroca australis* (belonging to a probably unnamed resident form), and *Poliomyias mugimaki*. Leaving out of consideration the mere segregation of previously reported species, Mr. Raven has added 5 genera and 12 species to the avifauna. A wonderful showing, considering that he covered less than half the area of the island.

Altogether, Mr. Raven's Celebesian collections contain 202 forms of birds as at present worked out, a larger number than had been taken personally by any earlier collector in the same area. The Sarasins, apparently, have a larger number to their credit, but they covered more territory and were on the island for a longer period.

When it is taken into consideration that all of Mr. Raven's remarkable discoveries came from the mountains of the north-central part of the island, it can readily be appreciated that the avifauna of Celebes is far from well known or will be for many years to come. There are higher mountains (Latimodjong) than the Bonthian Peaks in the southwest peninsula that have not been worked, and the north-east and southeast peninsulas are almost unknown, though the latter is said to present a rather uninteresting appearance, but it should nevertheless be explored before a complete knowledge of the avifauna as a whole can be obtained. Even the north peninsula is none too well known; there has not been enough collecting done in the mountains, except at the extreme northern end in the Minahassa district. There has been considerable work done in the extreme south around Macassar and the Bonthian Peaks. The Sarasins, I understand, have made quite a thorough survey of the whole island, but they were not primarily interested in birds and outside of the records of their collections in Meyer and Wigglesworth's Birds of Celebes and two short papers by Doctor Meyer³ nothing has been published upon their bird collection as a whole. Even Meyer and Wigglesworth lament the inadequate data upon the distribution of the birds in the island and predict that it will be a hundred years before any finality is arrived at in this respect. This should only stimulate naturalists to greater exertions, because civilization is advancing at such an accelerated pace, and the introduction of exotic animals to different parts of the world is becoming so prevalent, that the balance of nature is liable to be overthrown at any time and species disappear before zoologists become aware of their existence.

³ Notes Leyden Mus., vol. 23, 1903, pp. 185-189; vol. 24, 1904, pp. 232-235.

As Meyer and Wigglesworth⁴ have already remarked, the avifauna of Celebes is more closely related to that of the Philippines than that of any of the surrounding islands; this seems to be especially true of the north. In the south, however, a southern element has worked in and quite frequently a species will have a representative form in both ends of the island. Mr. Raven's collections would seem to indicate that the southern forms extend much farther to the north than has hitherto been suspected.

Since the publication of Meyer and Wigglesworth's great work⁵ very few papers have been published upon the avifauna. Besides the two papers by Doctor Meyer mentioned above, Vorderman⁶ has published a list of 118 forms of which none appear to be described as new; Madarás⁷ named a ground thrush, *Geocichla frontalis*; Charles Hose⁸ published a list of the birds taken by him during a two months' collecting trip to the northern districts, especially on Mount Musarang, but the only new bird secured by him had already been named by Sharpe some years previously and included by Meyer and Wigglesworth; Doctor Hartert⁹ published a paper on the birds of Tukang-Besi Islands and Buton; most of the mention of Celebes otherwise has been in short notes, the revision of genera, or incidentally in papers on other regions. Naturalists seem to have conceived the idea that Celebes was well-worked so far as birds are concerned, thus instead of stimulating research, Meyer and Wigglesworth's work would seem to have discouraged it.

In the following notes upon the forms, after a list of localities represented, I have endeavored to confine myself to facts supposed to be additional to those given by Meyer and Wigglesworth, or to other items of interest to emphasize some fact. It is quite possible that I have overlooked some of the literature, but this has become so immense in recent years that it is almost inevitable; then authors have a habit of revising genera in a paper whose title would be easily passed over by an investigator dealing with a definite locality.

The species have been arranged in the order of Sharpe's hand list, though an arrangement following Meyer and Wigglesworth would have facilitated comparison with that work, but an arrangement that begins with the hawks and ends with the grebes seems so fundamentally wrong and archaic that comparisons with modern lists of other countries are too difficult to make.

⁴ Birds of Celebes, p. 130.

⁵ Birds of Celebes, 2 vols., continuously paged, quarto, 1898, pp. v-xxxii, 1-962, 7 maps, 45 colored plates.

⁶ Natuur. Tijds. Nederl. Indie, vol. 58, 1898, pp. 26-121.

⁷ Természetráji Füzetek, vol. 22, 1899, pp. 111-113, pl. 8.

⁸ Ornis, vol. 12, 1903, pp. 77-177.

⁹ Nov. Zool., vol. 10, 1903, pp. 18-38.

Mr. Raven's field notes have been put in smaller type followed by his initials.

For the loan of material used in determining some of the species and in characterizing two new forms, I am indebted to the authorities of the American Museum of Natural History, New York, and to J. H. Fleming, Toronto, Ontario.

Family MEGAPODIIDAE.

MEGAPODES.

1. MEGAPODIUS CUMINGI GILBERTII Gray.

One male, Pinedapa, February 6, 1918.

The United States National Museum contains a small series of this species from the Philippine Islands (Fuga, Luzon, and Palawan). This series shows quite a little variation, both in size and color; the birds from Fuga Island (north of Luzon) are large and dark (varying from sepia to bister brown), while those from Palawan are smaller and much lighter and more reddish brown (near tawny olive) above. The only specimen from Luzon is an unsexed bird from the Taal Volcano; it is lighter than the Fuga Island specimens but much darker than those from Palawan. It is closer to the former, however, and could be placed with them without violence. The single Celebes specimen listed above is smaller than any other in the series before me; in color it is darker above than the Palawan bird but not as dark as that from Fuga and does not fit into either series. From the above it is evident that this species needs revision, but one which my material is too scanty to undertake. As the Celebes bird is certainly not the same as that from Palawan or the northern Philippine Islands, the only safe course it seems to me is to adopt the oldest name founded upon a Celebes specimen and use it. This happens to be *Megapodius gilbertii* Gray¹⁰, which makes the distribution more intelligible also, as otherwise a closely related form (*Megapodius sanghirensis*) would come in between.

There is one egg in the collection from Celebes without definite locality. It is a light vinaceous-cinnamon and measures, 79.6 by 50.8 mm.

Meyer and Wiglesworth¹¹ have given a table of measurements of their series which, taken in connection with that in the National Museum seems to show that the Celebes bird is smaller than that of the Philippines. The series before me measures as follows:

¹⁰ Proc. Zool. Soc. Lond., 1861, p. 289. ¹¹ Birds of Celebes, vol. 2, 1898, p. 672.

Number.	Sex.	Locality.	Wing.	Tail.	Culmen.	Tarsus.	Middle toe.
			<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
201738	Male	Fuga Island	230	74.5	22.5	65.5	40.5
201739	do	do	235	61.5	22	59.5	39.5
192551	Female	do	238	73.5	19	68	41
233660	Male	Palawan	217	68.5	18	64	40
233006	do	do	214	73	18.5		
233007	do	do	207	63.5	18.5	64	39
107647	do	do	220	77	17	64.5	42
211299		Taal Volcano, Luzon	225	74	22	66	43
251687	Male	Pinedapa, Celebes	195	67.5	16	60	40

2. MEGACEPHALON MALEO (Hartlaub).

One adult female, Bumbaraedjaba, November 3, 1916; one female immature, Laboea Sore, November 14, 1916; one adult male, Koeala Prang, May 29, 1916.

The adults still show the beautiful salmon-buff of the breast and belly and the immature is tinged with pink, but of a much lighter shade.

The immature bird has the top of the head feathered, forming a crest, and the throat is also feathered. The throat is white and the forehead and crest have some white markings scattered through them. The specimen is about half grown.

Seven eggs were taken at Roemoesoem, June 10, 1916. One was broken in shipment. The remainder are of the usual megapode shape and vary in color from light vinaceous cinnamon to light pinkish-cinnamon. They measure as follows: 109.3 by 63.4; 106.1 by 61.2; 107 by 64.5; 106.3 by 60.7; 103.4 by 61; 109.6 by 62.7.

Family PHASIANIDAE.

PHEASANTS AND FOWL-LIKE BIRDS.

3. EXCALFACTORIA CHINENSIS MINIMA (Gould).

One male and two females, Toli Toli, December 10-16, 1914; one male, Dolo, December 25, 1916.

The above males have been compared with a good series from the Philippines, one skin from the Malay Peninsula, and two from Java. The single mainland bird is lighter than those from the Philippines. All the Philippine specimens agree, except one, which differs only slightly, in having no rufous in the wing and in this character agrees with the mainland bird. The Javan males are very richly colored, with the back much mixed with slate color and consequently the black markings are much reduced; the wings with much rufous; the rufous below much increased in extent. No birds

from the large series before me match them in the above characters; the bills also seem to be a little larger. This has led me to believe the Javan bird to be separable and I have named it *Excalfactoria chinensis palmeri*,¹² in honor of the late William Palmer, who collected the type.

The two Celebes males are small, the wings contain some rufous, but not to the same extent as the Javan race; the back is like the Philippine bird but not quite so dark, and they appear to be lighter below. They apparently represent a recognizable race that Gould¹³ named and which will stand as above.

I have seen no males from Australia, but judging from the plate in Mathew's Birds of Australia¹⁴ it is a very dark richly colored bird with no rufous in the wing and well worthy of subspecific recognition, if these characters hold good.

The females show considerable individual variation and the racial differences are not so well marked. The mainland bird appears to be lighter than the island forms represented in my series. One Australian female before me is very dark, but not as dark as the bird represented by Mathews.¹⁴ It can be almost matched by a specimen from Mindanao (No. 191942); in fact, the Philippine bird is possibly a little darker.

One of the females taken at Toli Toli, December 16, is a bird of the year still in the streaked plumage below.

The series available before me averages as follows:

	Wing.	Culmen.	Tarsus.	Middle toe.
MALES.				
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
One from Malay Peninsula.....	67.5	11	21	18
Two from Java.....	71.5	11.2	22.7	18.2
Nine from Luzon.....	68.6	10.2	19.1	16.4
Three from Mindanao (2) and Basilan (1).....	69.2	10.3	19.5	16.8
Two from Celebes.....	64.7	9.7	18.2	16.2
FEMALES.				
Four from Tenasserim (1) and Malacca (3).....	69.9	10	20.2	16.7
Three from Java.....	69.5	11	20.3	17.7
Four from Luzon.....	72.2	10.5	19.2	16.2
Three from Mindanao.....	69	10.5	19	16.2
One from Celebes.....	64.5	10.5	17.5	16.5
One from New South Wales.....	68.5	9.5	18	15.5

¹² Proc. Biol. Soc. Wash., vol. 32, 1919, p. 93.

¹³ Proc. Zool. Soc. Lond., 1859, p. 128.

¹⁴ Vol. 1, pt. 1, 1910, pl. 12.

4. *GALLUS GALLUS GALLUS* (Linnaeus).

One male, Kampa, February 12, 1915; one male, Tandjong Penjoe, February 27, 1915; two females, Parigi, September 12, 25, 1916; one immature male and female, Laboea Sore, November 14, 26, 1916; one downy young, Gimpoe, August 21, 1917; one immature male and one immature female, Pinedapa, January 22, 1918.

The two adult males from Celebes have been compared with one from east Sumatra and a fair series from the mainland, the Philippines, and three from Java. There is a good deal of individual variation; hardly any two specimens are exactly alike. The mainland and Philippine specimens, making allowances for variation, seem to be essentially the same, and those from Celebes are too close to those of the Philippines to warrant separation. The three Javan males differ from any before me in having the occiput darker and the neck hackles more truncate, giving to the lower border where they rest upon the back a square appearance, quite different from those of any other region. Robinson and Kloss¹⁵ have noticed this character in the Javan bird and have shown that *Gallus bankiva* Temminck is the name to use for it, and it should stand in the future as *Gallus gallus bankiva*.

The name of the red jungle fowl has received a good deal of attention in recent years, of which only the more recent need be considered. Bangs and Penard¹⁶ tried to stabilize the nomenclature of the races and reached the conclusion that the names should stand as follows:

- (a) *Gallus gallus bankiva* Temminck, for the Sundanese bird.
- (b) *Gallus gallus ferrugineus* (Gmelin), for the eastern mainland race.
- (c) *Gallus gallus gallus* (Linnaeus), for the western mainland race.

This is all very well, but Robinson and Kloss¹⁷ have called attention to the fact that Linnaeus himself in the twelfth edition of the *Systema Naturae* (p. 270), had already restricted the type locality to Pulau Condor off the mouth of the Mekong, and this applies with equal force to the tenth edition of the *Systema Naturae* (p. 158), where the same locality is given. In a later article Kloss¹⁸ says: "Nevertheless we can not accept *Phasianus gallus* of the *Systema Naturae* as the name of the Red Jungle Fowl for he had used it previously in the *Fauna Succiaca* for domesticated European birds and it can not be employed again for something else." In this

¹⁵ Records Indian Mus., vol. 19, 1920, p. 14.

¹⁶ Proc. New England Zool. Club, vol. 7, 1919, pp. 23-25.

¹⁷ Records Indian Mus., vol. 19, 1920, p. 13.

¹⁸ Idem, p. 182.

contention Kloss is in error, Linnaeus was nonbinomial in the Fauna Suecica until the 1761 edition and the names used there before that time have no standing. Now as Linnaeus himself restricted the type locality by writing: "India orientali: Pouli candor. etc.," when he named the species in the first work in which he was consistently binomial and which is universally recognized as the starting point of our modern nomenclature, it seems to me the three races of the Red Jungle Fowl that have been recognized to date should stand as follows:

(a) *Gallus gallus gallus* (Linnaeus), Syst. Nat., ed. 10, 1758, p. 158 (Pulau Condor, off the mouth of the Mekong).

(b) *Gallus gallus bankiva* Temminck, Fig. et Gall., vol. 2, 1813, pl. 87 (Java).

(c) *Gallus gallus murghi* Robinson and Kloss, Records Indian Mus., vol. 19, 1920, p. 14 (Chirala, Gya District, Bihar).

The ranges will be the same as those given by Robinson and Kloss in the last paper cited above.

Family TRERONIDAE.

FRUIT PIGEONS.

5. *DENDROPHASSA GRISEICAUDA GRISEICAUDA* (Wallace).

A good series from the following localities: Kwala Besar, August 24, 1914; Tandjong Penjoe, February 19–25, 1915; Likoepang, March 4–10, 1916; Toemaratas, July 6–8, 1916; Parigi, September 25, 1916; Toboli, October 25, 1916; Koelawi, January 31, 1917; Rano Lindoe, March 6–15, 1917; Gimpoe, August 8 and 28, 1917; Doda, Besoa, October 24, 1917; Pinedapa, February 8, 1918.

Treron griseicauda G. R. Gray¹⁹ is a nomen nudum and when Wallace²⁰ took up the name and published a description, basing it upon the Sula Island and Celebes birds (Salvadori²¹ states the types as from Macassar), he first gave it nomenclatural status, unless Schlegel's²² use of the name should prove to be prior. This would make *Osmotreron wallacei* Salvadori²³ a pure synonym of *Treron griseicauda* Wallace and the name of the Java race would become, *Dendrophassa griseicauda pulverulenta* Wallace.²⁴

A young male taken at Doda, Besoa, October 24, 1917, is not long from the nest, if indeed it had left it. It is parrot green, with the

¹⁹ List Birds Br. Mus. Columbæ, 1856, p. 10.

²⁰ Proc. Zool. Soc. Lond., 1862, p. 344, published February, 1863.

²¹ Cat. Birds Brit. Mus., vol. 21, 1893, p. 42.

²² Nederl. Tijds. Dierkunde, vol. 1, 1863, p. 66.

²³ Cat. Birds Br. Mus., vol. 21, 1893, p. 42.

²⁴ *Treron pulverulenta* Wallace, Ibis, 1863, p. 319 (Java).

mantle, wing-coverts, secondaries, and chest edged with lemon yellow, the edging on the chest very narrow; the center of the throat grayish; belly white with yellow tips to the feathers; under tail-coverts white, tipped with light yellow and with a dark green mark on the inner webs of the feathers; outer tail-feathers blackish basally with a sub-terminal gray spot edged with green and narrowly tipped with white, the outer web green; the other tail-feathers are similar, except the white edging becomes yellow and narrower as the central feathers, which are without the gray subterminal spot, are approached.

A slightly older specimen taken at Gimpoe, August 8, differs from the above in the tail pattern, the outer feathers being slate gray on the inner web with a darker subterminal bar, the tip gray, narrowly edged with yellowish white.

Dendrophassa is common at Pinedapa but as they feed mostly on fruit of the taller trees here they are difficult to shoot; in other places I have seen them feeding on the fruit of small trees and saplings. They are very fond of the small yellow fruit of the Waringan. The flight is very rapid and when taking wing they make a rather loud clapping of the wings as do nearly all the pigeons and doves in Celebes.—H. C. R.

6. DENDROPHASSA VERNANS PURPUREA (Gmelin).²⁵

One male, Kwala Besar, August 24, 1914; one male and two females, Tandjong Penjoe, February 18–20, 1915; three males, Likoepang, March 11–12, 1916; one male and one female, Parigi, September 19, and October 5, 1916.

An immature male taken at Likoepang, March 11, acquiring the adult plumage, has the gray of the throat, cheeks, and forehead mixed with light green, as also the purple jugular band, the orange breast patch is separated into two spots by a green band down the center. Several of the above males have the throats and foreheads washed with greenish, the last traces of the immature plumage.

The above series has been compared with quite an extensive one from the Philippines, the mainland, Borneo, and Java. From the mainland form the Celebes bird differs in having the top of the head, back, breast, and purple band noticeably lighter in color; in fact, the gray of the head in Celebes specimens is slightly lighter even than in the two males before me from Java, though they seem to agree in other respects and the difference is slight. Even Philippine specimens appear to be slightly lighter than birds from the mainland, especially in the southern islands. Bornean specimens seem to agree with those from Java.

²⁵ For the use of this name see Hartert and Goodson, Nov. Zool., vol. 25, 1918, p. 355. Since the above was written Oberholser (Journ. Wash. Acad. Sci., vol. 14, 1924, p. 298) has named the Celebes bird, *Dendrophassa vernans zalepta*.

The males of the series before me average as follows:

	Wing.	Tail	Culmen.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Five from Celebes.....	145. 9	85. 8	17. 2
Seven from Mindanao and adjacent islands.....	147. 5	87. 8	17. 4
Seven from Luzon.....	152. 6	90. 1	16. 7
Six from Borneo.....	142. 1	84. 6	16. 9
Two from Java.....	141. 5	87. 5	16. 7
Seven from Tenasserim and the Malay Peninsula ..	151. 2	87. 7	16. 9

7. *LEUCOTRERON FISCHERI CENTRALIS* (Meyer).²⁶

One female, Toewo Mountain, Besoa, November 3, 1917; five males and two females, Rano Rano, December 11-28, 1917.

I have none of the races of *Leucotreron fischeri* for comparison, but from the locality, the above specimens belong to Meyer's bird, which, judging from descriptions alone, is only a form of the older race.

8. *LEUCOTRERON EPIA* Oberholzer.²⁷

One male, Paleleh, November 10, 1916; one female, Laboea Sore, November 21, 1916; two males and one female, Gimpoe, August 13-22, 1917; one male and one female, Pinedapa, January 12, and February 4, 1918.

The male taken at Paleleh is immature but almost adult. The crown, occiput, and cheeks have a greenish wash; the bill is dark, otherwise it is much like the adult, though smaller. The rectrices are narrower than in the adult and are 15 in number; 14 seems to be the normal condition.

Bill in life yellow—H. C. R.

9. *HAEMATAENA*²⁸ *MELANOCEPHALUS MELANOSPILUS* (Salvadori).

A good series of both sexes and young from the following localities: Kapas Bay, November 23, 1914; Toli Toli, December 7, 1914; Tandjong Penjoe, February 19-27, 1915; Likoepang, February 26-March 12, 1916; Batoe Hangoes Baroe, June 11, 12, 1916; Toemaratas, July 4, 1916; Temboan, July 18, 1916; Gimpoe, August 7-22, 1917; Pinedapa, January 14-February 8, 1918.

In a young female obtained at Pinedapa, February 6, probably taken from the nest, though fully feathered, the under tail-coverts

²⁶ *Ptilopus centralis* Meyer, Notes Leyden Mus., vol. 23, 1901, p. 188 (Poana Mts., south of Lebani).

²⁷ Proc. Biol. Soc. Wash., vol. 31, 1918, p. 48, for *Columba gularis* Quoy and Gaimard, preoccupied.

²⁸ For the use of this name in place of *Spilotreron*, see Richmond, Proc. U. S. Nat. Mus., vol. 53, 1917, p. 593.

are light greenish tipped with yellow, the longer ones with light carmine; the greater and middle wing-coverts are narrowly edged with yellow, forming two wing-bars; the chin is grayish; otherwise the body plumage is green; the tail is a reduced replica of the adults. A slightly older specimen, a male, taken at Gimpoe, August 9, has lost one wing-bar and the edging on the greater wing-coverts is reduced; the yellow-chin mark is appearing; the forehead is becoming gray; otherwise it resembles the other young. A young female of about the same age, from Pinedapa, February 2, is without the yellow throat. A young male taken at the same place and date as the latter seems to be acquiring the gray head, yellow throat, and black occipital spot simultaneously, which does not exactly agree with what Meyer and Wigglesworth (*Birds Celebes*, vol. 2, 1898, p. 609) have written.

The distinctive sexual plumage seems to be acquired at least as early as the post juvenal molt. From the above dates of young, the breeding season probably extends more or less throughout the year.

The crop of a male taken at Pinedapa, January 14, contained several hard red fruits, each about the size of the bird's head. A remarkable swift flyer; their coloration is very protective.—H. C. R.

10. MUSCADIVORES PAULINA (Bonaparte).

One male, Kwandang, October 5, 1914; one male and two females, Likoepang, March 3-6, 1916; one female, Koeala Prang, June 8, 1916; one male and one female, Laboea Sore, November 24, 28, 1916; one female, Koelawi, February 2, 1917.

All the above series show more or less coppery iridescence on the back in certain lights and it is especially strong in one of the females from Likoepang (No. 249113) but the male from the same locality has the most uniformly green back of the whole series. I share with Meyer and Wigglesworth doubts as to the specific validity of *Carpophaga pulchella* Walden.

The United States National Museum contains a specimen from Tobeia Island, Buton Strait, Celebes (No. 234,087), which has the ear-coverts and hind-neck cinnamon-buff, deepening to cinnamon posteriorly and the specimen from Koelawi approaches it; these I consider individual variations only.

11. ZONOPHAPS FORSTENI (Bonaparte).

Two males, Toemaratas, July 6, 7, 1916; one male and one female, Rano Lindoe, March 3, 14, 1917; one male, Gimpoe, August 9, 1917.

The only species that is congeneric with the above is *Zonophaps poliocephala* (Hartlaub) of rather wide range in the Philippines; interesting as showing the close relations of the two faunas.

12. *COMPSOENAS RADIATA* (Quoy and Gaimard).

One male, Toemaratas, July 7, 1916; one male, Rano Lindoe, March 16, 1917; two males and one female, Rano Rano, December 23-27, 1917; two males Pinedapa, January 12 and 20, 1918.

As this species differs structurally from *Zonophaps* Salvadori, in having the inner web of the three outer primaries widened about the middle, then sinuated to the tips, instead of having the two outer primaries scooped out about the middle, I have erected the genus *Compsoenas*²⁹ for its reception. The only other species that appears to be congeneric with the above is, *Carpophaga mindorensis* Whitehead, of Mindoro, Philippines, but I have not handled a specimen of the latter; the plate³⁰ indicates close relationship, however, and emphasizes the derivation of the avifauna of northern Celebes.

The iris consists of two bands of color; the outer bright red, the inner black anteriorly with the posterior half orange.—H. C. R.

13. *CRYPTOPHAPS POECILORRHOA* (Brüggemann).

One male and one female, Goenoeng Kalabat, April 11 and 12 1916.

Crop filled with palm fruit.—H. C. R.

14. *MYRISTICIVORA BICOLOR* (Scopoli).

One male, Kwandang, October 5, 1914.

15. *MYRISTICIVORA LUCTUOSA* (Temminck).

One female, Kampa, February 14, 1915; one male and one female, Likoepang, February 26, 29, 1916; two males, Manembo Nembo, June 20, 1916; three males and two females, Parigi, September 19-28, 1916; one female, Toboli, October 21, 1916.

Family COLUMBIDAE.

PIGEONS.

16. *TURACOENA MENADENSIS MENADENSIS* (Quoy and Gaimard).

A good series from: Paleleh River, August 15, 1914; Kwandang, September 20, 1914; Toli Toli, December 19, 1914; Likoepang, March 9 and 12, 1916; Toemaratas, July 4, 1916; Laboea Sore, November 21, 1916; Koelawi, February 1 and 2, 1917; Gimpoë, August 20-27, 1917; Toeare, Bada, September 28, 1917; Pinedapa, February 4, 1918.

A male taken at Likoepang, March 9 (No. 249,118), has the fore-neck, chest, and occiput a beautiful iridescent magenta purple, only slightly approached by a male from Laboea Sore (No. 250,083).

²⁹ Proc. Biol. Soc. Wash., vol. 34, 1921, p. 51.

³⁰ Ibis, 1896, pl. 11.

17. *MACROPYGIA ALBICAPILLA ALBICAPILLA* (Bonaparte).

A small series of adults and young from the following localities: Paleleh River, August 8, 1914; Toli Toli, December 3, 1914; Likoe-pang, March 4-12, 1916; Kocala Prang, June 14, 1916; Temboan, July 20, 1916; Rano Lindoe, March 19, 1917; Gimpoë, August 6-12, 1917; Toare, Bada, September 18-28, 1917.

This bird has been made a subspecies³¹ of *Macropygia amboinensis* by several authors in the past, but a comparison with that species will convince any unprejudiced ornithologist that the differences between the two are more than subspecific.

Locally known (Likoe-pang) as *Koëoo*; the name being taken from its note.—H. C. R.

Family PERISTERIDAE.

DOVES.

18. *STREPTOPELIA CHINENSIS TIGRINA* (Temminck).

A good series of both sexes from the following localities: Soemalata, September 8, 1914; Toli Toli, December 10-13, 1914; Tandjong Penjoe, February 18-19, 1915; Likoe-pang, February 24-29, 1916; Manembo Nembo, June 22-24, 1916; Parigi, September 25-27, 1916; Toboli, October 25, 1916; Kasimbar, December 13, 1916; Koelawi, January 26-28, 1917; Rano Lindoe, March 7-24, 1917; Gimpoë, August 1-12, 1917; Pinedapa, February 15, 1918.

This large series seems to be subject to considerable individual variation but when compared with Javan birds, allowing for this variation, seem to be practically identical. Birds from the mainland (Malay Peninsula and Tenasserim) appears to be slightly darker and larger, but the differences are very slight and not worth recognizing by name.

The following averages will show how really close they are in size:

	Wing.	Tail.	Culmen.
	mm.	mm.	mm.
Eight males from the mainland.....	151. 6	136. 7	16. 4
Ten males from Celebes.....	146. 5	138. 7	15. 4
Two males from Java.....	148	144	15. 7

Many crops examined and found to contain paddy only.— H. C. R.

19. *CHALCOPHAPS INDICA INDICA* (Linnaeus).

One male, Gimpoë, August 5, 1917.

This specimen is lighter below than any specimen in an extensive series in the United States National Museum from various parts of

³¹ See Cat. Bds. Brit. Mus., vol. 21, p. 353 (syn.); Nov. Zool., vol. 10, 1903, p. 35, etc.

the wide range of the species, but with only one specimen it is impossible to say whether this difference is constant.

20. *CHALCOPHAPS STEPHANI STEPHANI* Reichenbach.

One male immature, Manembo Nembo, June 22, 1916; one male and three females, Pinedapa, January 11-27, 1918.

Chalcophaps stephani is a forest bird, preferring forests which offer much shade so that the ground beneath remains damp even during dry weather. When feeding they walk and act much as domestic pigeons do and when alarmed often remain motionless for a moment and then fly up rapidly, usually causing a rustle amongst the leaves. Generally they fly but a short distance and then alight again, usually close to the ground (within 6 to 20 feet of the ground as a rule). In life the bill, which is weak and soft, is yellow; eyes dark brown; skin about eyes dull reddish; feet and tarsus reddish. The food of one examined consisted of fruit and insect remains.— H. C. R.

21. *DIOPEZUS TRISTIGMATA* (Bonaparte).

One male, immature, Temboan, July 22, 1916; one female, Laboea Sore, November 14, 1916; five males and four females, Pinedapa, January 19-February 8, 1918.

The above series shows quite a little variation within certain limits. Some specimens are much darker or browner than others. The majority of the skins have the upper-parts washed with an iridescent green, only a little iridescent purple showing on the upper mantle in certain lights, while a few birds have the mantle strongly tipped with a deeper iridescent purple and very little green. Some specimens have the purple nuchal band interrupted behind, but in the majority it is entire, though often very narrow posteriorly. The yellow of the chest is more extensive in some specimens than in others. In one specimen (No. 251732) the greater wing-coverts on the right side are largely white, but not on the other and as this is one of the specimens with deep iridescent purple tips to the mantle, the yellow of the chest most highly developed, the purple nuchal band very narrow, if not interrupted behind, and the plumage of the upper parts dark, I take it to be a very old bird.

The Temboan specimen (No. 249638) is immature; the feathers of the back and wing-coverts are edged with rusty, the breast on each side has some scattered russet-vinaceous feathers, and the nuchal band is broad throughout, light seal brown, with only one or two metallic purple feathers appearing; otherwise it is like the adult, except the iridescent purple of the mantle is very faint and the tail pattern is different as mentioned beyond.

The Laboea Sore female (No. 250088) has a smaller bill than those from Pinedapa.

A female from Pinedapa (No. 251736) is unique in the series. The jugulum and breast are dark gray and the breast is crossed

from the shoulders by an irregular bar of iridescent purple, dividing the yellow breast patch, which is poorly developed; and it is very dark above with much iridescent purple on the mantle. Like some other specimens the purple nuchal band is interrupted behind.

Salvadori's³² description of the tail, which he uses as one of the characters to separate two Celebes forms in his key, is probably taken from a not fully adult bird in the case of his *tristigmata*, as none of the adults before me are as he describes this feature. All the birds before me, except the immature, have the five outer tail feathers slate gray with a subterminal black band. The immature mentioned above has only the two outer tail feathers slate gray with a subterminal black band, the next feather changing from olive to gray with a subterminal black band and gray tip, the next two olive with gray tips, and the remainder as in the adult. From the above, I judge, the skin of the northern form that he considered to be adult is not really so, and as mentioned above the nuchal band is either entire or interrupted in the same locality. As he had before him only one specimen of the northern bird and one from the south, it appears as if his *Phlogoenas bimaculata* is not well founded.

For *Phlegaenas tristigmata* Bonaparte, which differs structurally from *Gallucolumba* Heck (*Phlogoenas* of authors), in having the tarsus about a fifth longer than the middle toe with claw, instead of nearly equal, a different color pattern, and other characters, I have erected the genus *Diopezus*.³³

This pigeon is very shy and extremely alert and though I have seen it several times, I have never been able to obtain a shot. It inhabits heavy forest and flies up similar to a partridge, but before a gun could be raised it has disappeared amongst the dense foliage.—H. C. R.

The food of two birds, which were examined by Mr. Raven, consisted of hard red fruits about the size of a pea, another hard fruit somewhat larger, remains of a cicada, green grasshoppers, crickets, beetles, and small grubs.

Family RALLIDAE.

RAILS, GALLINULES, COOTS.

22. HYPOTAENIDIA STRIATA STRIATA (Linnaeus).

One male, Kwandang, September 15, 1914; one female, Rano Lindoe, March 22, 1917.

These two specimens are in widely different plumages. The male is in worn plumage and as Meyer and Wigglesworth's description³⁴ is

³² Cat. Birds Brit. Mus., vol. 21, 1893, p. 583.

³³ Proc. Biol. Soc. Wash., vol. 34, 1921, p. 52.

³⁴ Birds of Celebes, vol. 2, 1898, p. 693.

taken from a Leyte, Philippine specimen, it may be briefly described as follows: The top of the head and nape deep chestnut with a few nearly obsolete black spots; upper parts, including the wing coverts and tail, blackish, with some olive brown borders to the feathers (mostly worn off) and barred narrowly with white; remiges and wing coverts chaetura drab with broken white bars; chin and throat white; lores, side of face, fore-neck, and breast neutral gray; sides, flanks, belly, crissum, and under wing coverts chaetura black barred with white, the belly much lighter; the bill is dusky, lead color towards the tip, the base of the lower mandible horn color for two-thirds of the base (in the skin). It measures: Wing, 118; culmen, 35; tarsus, 37; middle toe, 38.

The female from Rano Lindoe is quite different. It lacks the chestnut of the head, it being similar to the back; the back, wing-coverts, and scapulars are black with broad olive-brown edges to the feathers and with a few white spots on the upper back, in a few feathers of the scapulars and wing-coverts the spots become incipient bars; the primary coverts and remiges uniform chaetura black, the first primary and a few of the inner secondaries with a few white spots on the outer web only; below it is much like the male described above, except the flanks are lighter and the belly buffy white unmarked. I take it to be a not fully adult bird.

The adult male seems to agree fairly well with Philippine specimens (the type locality of the species), except the white bars above are not interrupted (in Philippine birds the bars on the upper back are interrupted and more in the nature of spots); this may or may not be a constant variation.

An adult female in the United States National Museum from Java (No. 218,311) is quite different from the Philippine bird. The top of the head and nape are lighter; the edges of the feathers broader and hair brown (not olive-brown), the black centers more restricted and the white bars on the wing-coverts with dusky shadow bars; the bars on the sides and flanks more restricted and almost entirely absent from the belly; the bill yellow, only dusky at the tip (in the skin). If additional specimens bear out these peculiarities, the Javan race will have to be recognized and may stand as *Hypotaenidia striata gularis* (Horsfield).³⁵

23. HYPOTAENIDIA PHILIPPENSIS CHANDLERI (Mathews.)³⁶

One female, Kwandang, October 7, 1914; one male and one female, Toli Toli, December 13 and 18, 1914; one female, Koelawi, January

³⁵ *Rallus gularis* Horsfield, Trans. Linn. Soc., vol. 13, 1821, p. 196 (Java).

³⁶ *Eulabeornis philippensis chandleri* Mathews, Birds Australia, vol. 1, pt. 4, Aug. 9, 1911, p. 196 (Celebes).

31, 1917; one male and one female, Rano Lindoe, March 14 and 22, 1917.

Besides the above series, the United States National Museum contains a male, a female, and an unsexed specimen from Celebes, but I only have available for comparison two males and two females from Luzon, besides a few additional specimens from the other parts of the extensive range of the species. The latter I am disregarding and will confine myself to a comparison of the Philippine and Celebes material. Mathews's³⁷ diagnosis of the Philippine bird does not agree with the specimens before me in numerous particulars, only two of which I will mention. The secondaries in none of the specimens before me reach the tips of the primaries by a considerable margin nor are the flanks and breast washed with olive-brown. That some of the characters relied upon by Mathews as geographic are really seasonable or age characters, I am convinced. That the tawny pectoral band is not entirely absent from Celebes specimens is proven by a female (No. 248,148) from Kwandang, in which it is strongly marked.

The only differences that I can see between Celebes and Luzon birds is the darker olive edgings of the feathers of the back, the average darker head and nape, and apparently heavier barring below of the former. The measurements seem to indicate a bird with slightly longer tarsus and middle-toe in Celebes, though the series are too unequal to be conclusive.

That there are geographic forms in the extensive range of the species there is no doubt, but that Mathews's treatment of them is only tentative is equally certain, as it is not founded upon the examination of a sufficient number of specimens. I prefer to recognize a race tentatively rather than to suppress it, even though the differences are slight.

The two series average as follows:

	Wing.	Tail.	Culmen.	Tarsus.	Middle toe.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Two males from Luzon-----	137. 7	65	32. 5	40. 7	34. 2
Three males from Celebes-----	144. 2	62. 8	33	43	37. 5
Two females from Luzon-----	132. 2	63. 2	29. 2	40. 5	34. 2
Five females from Celebes-----	132. 2	58. 1	30	41. 5	35. 4

24. HYPOTAENIDIA CELEBENSIS CELEBENSIS (Quoy and Gaimard).

One adult male, Kwandang, October 24, 1914; one slightly immature male, Rano Lindoe, April 1, 1917.

³⁷ Birds of Australia, vol. 1, 1911, p. 198.

The adult has the chin and throat black, the feathers obscurely fringed with a little white; the two outer primaries are barred on the inner web with white, these bars having a little cinnamon appearing towards the rachis on the third and the bars becoming entirely cinnamon on the fifth primary; otherwise it agrees fairly well with the descriptions.

The specimen from Rano Lindoe is not fully adult; it is much browner on the back; the chin is white; only the sides of the throat are entirely black, the center being barred black and white; the primaries are narrower than in the adult, the white bars on the inner web of the two outer ones being almost obsolete, not more than spots, and the cinnamon bars on the inner web are also obscure and basal; the inner secondaries are softer and longer and the tail softer than in the adult; otherwise it is like the adult.

From the above it would appear as if the birds of this genus go through several stages of plumage before becoming adult. Naturalists describing closely related forms should bear this in mind and try to compare specimens of the same age. This is hard to determine in birds in which the young plumage resembles the adult and often can only be worked out by series taken during various seasons at or near the same locality.

Judging from descriptions, *H. saturata* of New Guinea and *H. sulcirostris* of the Sula Islands are only subspecies of the Celebes bird. *H. torquata* of the Philippines has been derived from the same stock as *H. celebensis* and only differs from it noticeably in the brown pectoral band of the former, but this difference is pronounced and constant enough to keep them apart as species.

25. GYMNOCREX ROSENBERGI (Schlegel).

One male and one female, Laboea Sore, November 16 and 21, 1916.

Both are apparently adult and measure as follows, the male placed first: Wing, 194-208; tail, 74-73.5; culmen, 36-39.5; tarsus, 67.5-69; middle toe, 36.5-39.5.

Bare skin behind eye, cobalt blue; eyelid reddish; iris brown; tarsus yellowish-green.—H. C. R.

26. RALLINA MINAHASA Wallace.

One adult female, Likoepang, March 4, 1916.

This specimen measures as follows: Wing, 132; tail, 63; culmen, 26; tarsus, 42; middle toe with claw, 42.

27. OENOLIMNAS ISABELLINA (Schlegel).

One male, Soemalata, September 3, 1914; one male and one female. Laboea Sore, November 18 and 28, 1916.

28. *POLIOLIMNAS CINEREUS Ocularis* Ingram.³⁸

One female, Toli Toli, December 10, 1914; and one male, Tandjong Penjoe, February 16, 1915.

The two specimens are darker on the head and back than three specimens from Java before me. Philippine birds are dark above like the two Celebes specimens and it seems very probable that this species breaks up into a number of local races.

29. *AMAURORNIS PHOENICURA LEUCOMELANA* (S. Müller).

One male, Kwala Besar, August 24, 1914; one male, Toli Toli, December 17, 1914; one immature male, Laboea Sore, December 14, 1916; two males and two females, Rano Lindoe, March 6–19, 1917.

Stresemann has revised the forms of this species³⁹ but the material available does not permit me to go very deeply into the subject, and my only object is to find an available name to use for the bird inhabiting Celebes. I have compared my Celebes specimens with birds from the surrounding region. I have only a pair of birds from Java, which seem to have the black line on the sides of neck less pronounced than in Celebesian specimens. Philippine and Bornean skins are somewhat intermediate between those from Java and Celebes, but probably incline more toward the former. In the Celebes series the white frontal band is very narrow, almost absent in the majority of the specimens; this also occurs in one specimen from the Philippines and one from Borneo. It may be a question of age as it is always absent in undoubted immature specimens but this seems to be approaching the adult condition in Celebes birds. Of undoubted *A. p. leucomelana*, I have no specimens for comparison, but as the Celebes bird can not be referred to the race occurring to the north or west, the only logical thing to do is to refer it for the present to the southern form. Stresemann seems to regard it as a sort of intermediate between *A. p. javanica* and *leucomelana*, with leanings toward the latter.

Oberholser⁴⁰ described *Amaurornis phoenicura cleptea*, which Stresemann⁴¹ places in the synonymy of *A. p. javanica*, but the series before me seems to show that this disposition of it is incorrect. The type of *A. p. cleptea* is a female and somewhat aberrant, as two other specimens from the same island have the lower abdomen and anal region tinged with isabella color and the lack of olive above is due to the worn condition; the females in all the races of the species are considerably smaller than the males. A small series from

³⁸ See Stresemann, Nov. Zool., vol. 21, 1914, p. 54.

³⁹ Nov. Zool., vol. 20, 1913, pp. 303–305.

⁴⁰ Smithsonian Misc. Coll., vol. 60, no. 7, 1912, p. 2.

⁴¹ Nor. Zool., vol. 20, 1913, p. 303.

Simalur Island. all males, that Oberholser refers in manuscript to the same race as the Nias bird do not bear out the character of small size, in fact they are intermediate in this respect between *A. p. chinensis* and *A. p. javanica*. *A. p. cleptea* is apparently a good race, somewhat darker and smaller than *A. p. javanica*.

Below I give the average measurements of all the sexed adults available to me:

	Wing.	Culmen.	Tarsus.	Middle toe.
MALES.				
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
One from China.....	168	39	54.5	54.5
One from India.....	163.5	38	53	53.5
One from Tenasserim.....	166	40.5	56	55.5
One from E. Sumatra.....	175	37	51.5	56
Four from Simalur Island.....	155.1	39.5	56	56
One from Java.....	145	37	51.5	53.5
Four from Borneo.....	145.5	37.2	54.5	54.9
Three from the Philippines.....	145.7	36.8	54	54
Four from Celebes.....	150.5	38	53.5	54.4
FEMALES.				
One from China.....	170	36	55.5	58
Two from Lower Siam.....	156	36.2	52.5	54
Two from Nias Island.....	136.7	35.2	51	52.7
One from Java.....	-----	34	47	51.5
Four from Philippines.....	140.4	33.6	50.9	52.2
Two from Celebes.....	137	32.2	49.2	51

30. GALLINULA FRONTATA Wallace.

Two males, Toli Toli, December 11 and 17, 1914; four males, two females, and two young, Rano Lindoe, March 20-26, 1917.

One of the young is in the black down and was taken March 20; the other young, taken March 26, is older and feathered but still with some of the down adhering to the plumage. The latter may be described as follows: Nape, hind-neck, and remaining upper-parts sooty black; forehead, sides of face, sides, flanks, and chest deep mouse gray, much darker on the forehead; throat and abdomen white, the throat with a few scattering black feathers.

31. PORPHYRIO CALVUS PALLIATUS Brüggemann.

One male, Besoa, November 9, 1917.

Besides the specimen recorded above the United States National Museum possesses an unsexed example from north Celebes and a male and female from Java. The two Celebes birds closely resemble each other and differ from the Javan pair in being considerably darker, both above and below, especially in the blue of the hind-neck; the bill is larger and the horn color of the tip more extensive.

Hartert⁴² has fixed the type locality of Viellot's *Porphyrio calvus* as Java, as was previously done by Meyer and Wigglesworth.⁴³ The latter authors at the place cited also say that individuals of this species differ in the two ends of the island of Celebes, but on this point my lack of material will not allow me to venture an opinion. I am using⁴⁴ the oldest name founded upon a Celebes specimen, since it would be unwise to lump it with the Javan bird, especially as Sharpe⁴⁵ has pointed out that the birds from south Celebes are not the same as those from Java, but this author further says that, some specimens from north Celebes appear to be the same as those from Java, while others from the same end of Celebes he refers to *Porphyrio smaragdinus*! The truth of the matter seems to be that the genus is badly in need of revision, with ample material, and that any identifications founded upon our present knowledge of the forms are merely tentative.

Measurements of the four specimens.

Museum No.	Sex.	Locality.	Wing.	Culmen and shield.	Tarsus.	Middle toe.
			<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
251679	Male ----	Besoa, Celebes-----	229	68	81	80
178002	-----	North Celebes-----	219.5	64.5	83	83
218821	Male ----	Batavia, Java-----	226	66	80	78
219157	Female --	-----do-----	218	61	81	81

Family PODICIPEDIDAE.

GREBES.

32. PODICEPS RUFICOLLIS TRICOLOR (Gray).

Four males and three females in full breeding plumage, Rano Lindoe, March 20-26, 1917.

Podiceps ruficollis philippensis has a much smaller bill and the inner web of the outer secondaries white, the latter character in *tricolor* being much reduced.

Family STERNIDAE.

TERNS.

33. THALASSEUS BERGHII PELECANOIDES (King).

One immature male, Kwandang, September 29, 1914.

⁴² Nov. Zool., vol. 9, 1902, p. 425.

⁴³ Birds of Celebes. vol. 2, 1898, p. 720.

⁴⁴ *Porphyrio indicus*, var. *palliatu*s F. Brüggemann, Abhand. natur. Ver. Bremen, vol. 5, Heft i, April, 1876, p. 89.

⁴⁵ Cat. Birds Brit. Mus., vol. 23, 1894, p. 201.

Family CHARADRIIDAE.

PLOVERS.

34. *PLUVIALIS DOMINICUS FULVUS* (Gmelin).

One female, Paleleh, November 12, 1914; two males and one female, Toli Toli, November 28–December 16, 1914; one male and two females, Rano Lindoe, March 24 and 25, 1917.

The male, one of a pair, taken March 25, has begun to acquire a few black feathers of the breeding plumage on the chest and breast.

35. *CHARADRIUS DUBIUS* (Scopoli).

One female in worn plumage, Gimpoe, August 21, 1917.

Similar to Luzon specimens (the type locality of *dubius*). It measures: Wing, 113; tail, 53.5; culmen, 14.

36. *CHARADRIUS PERONI* (Bonaparte).

One immature female, Tamboe, June 13, 1917.

This specimen was bred on the island without a doubt, as it is a young bird in juvenal plumage, which is becoming somewhat worn.

Family RECURVIROSTRIDAE.

AVOCETS AND STILTS.

37. *HIMANTOPUS LEUCOCEPHALUS TIMORENSIS* Mathews.

A good series of adults of both sexes and one immature female, Rano Lindoe, March 3–26, 1917.

Mathews⁴⁶ has separated the Timor bird with which he doubtfully includes that from Celebes. I have no Timor specimens and only one sexed specimen of typical *H. l. leucocephalus*, but have three males and one female from Mindanao and one male from Java. The two latter fall within the variations of my Celebes series and undoubtedly belong to the same form. My single sexed specimen, a male, from New South Wales also falls within the variations of the males of the Celebes series, except the black hind-neck patch is more extensive; in fact it has some black-tipped feathers on the occiput; this is unusual and no other specimen before me shows anything approaching this condition. The New South Wales bird may be aberrant, as three unsexed specimens (but probably males) from Australia do not seem to have the black hind-neck patch so pronounced. Until a larger series of Australian specimens has been examined, the only logical course is to recognize the northern bird as a distinct form from the southern, though it seems to rest upon rather slender characters. To show the range of variation,

⁴⁶ Birds Australia, vol. 3, pt. 2, 1913, p. 150.

the largest, smallest, and average dimensions are given of eight males from Celebes: Wing, 205-234 (223.4); tail, 65-74.5 (70.8); culmen, 58.5-66 (62.4); tarsus, 110-124.5 (116.9); middle toe, 34-40 (36.4).

Below, for comparison, are given the averages of the males available from the surrounding region:

	Wing.	Tail.	Culmen.	Tarsus.	Middle toe.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Three from Mindanao-----	229	72.7	61	120	38.7
One from Java-----	220	69.5	-----	101	35.5
One from New South Wales-----	228.5	68	64.5	119	40

Family SCOLOPACIDAE.

SNIPES, ETC.

38. NUMENIUS CYANOPUS Vieillot.

One female, Dampelas, July 17, 1914.

This was the first bird collected by Raven in Celebes.

39. PHAEOPUS PHAEOPUS VARIEGATUS (Scopoli).

One male, Kwandang, September 19, 1914.

40. VETOLA LAPPONICA BAURI (Naumann).

One male and two females, Toli Toli, December 16 and 17, 1914.

41. TOTANUS TOTANUS EURHINUS Oberholser.

One male and one female, Kwandang, October 9, 1914.

42. ACTITIS HYPOLEUCOS (Linnaeus).

Two females, Toli Toli, December 16, 19, 1914; one female, Likoe-pang, February 26, 1916; one male, Toboli, October 23, 1916; two males and two females, Koelawi, February 3-12, 1917; one male, Rando Lindoe, March 25, 1917; one male, Gimpoë, August 21, 1917.

Mathews⁴⁷ has recognized an eastern race of this little sandpiper, but upon what grounds he bases this assumption he fails to state. I have measured an equal number of males of both races and there seems to be no difference in size worth mentioning as the following will show, the western race being listed first: Wing, 109.7-106.4; tail, 54.8-54.8;; culmen, 26-25.7; tarsus, 24.6-24; middle-toe, 20.6-20.1. In color the two series are equally close and for the present I do not see the utility of recognizing an eastern race unless some definite characters can be shown.

⁴⁷ Birds Australia, vol. 3, pt. 3, 1913, p. 216; List of Birds Australia, 1913, p. 66.

43. RHYACOPHILUS GLAREOLA (Linnaeus).

A good series from Koelawi, January 30–February 10, 1917; and Rano Lindoe, March 3–25, 1917.

Mathews⁴⁸ recognizes an eastern race of the well-known Wood Sandpiper, claiming that it is smaller and paler, but after carefully comparing an equal number of adults of both supposed races, I am unable to appreciate any tangible differences in support of his contention, either in plumage or size.

I have taken four adult specimens of each sex from the two extremes of the range of the species and carefully measured them, with the following result:

	Wing.	Tail.	Culmen.	Tarsus.	Middle toe.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Eight adults, west-----	122. 7	47. 6	29. 2	36. 9	26. 8
Eight adults, east-----	124. 7	51. 2	30	38. 6	28. 6

44. CAPELLA MEGALA Swinhoe.

One male and four females, Toli Toli, December 10–18, 1914; five males and four females, Rano Lindoe, March 7–23, 1917.

45. SCOLOPAX CELEBENSIS Riley.⁴⁹

One male, Rano Rano, December 22, 1917. The original description is as follows:

Similar to *Scolopax saturata* but russet notches on primaries much larger and deeper in color; wing and culmen longer. Wing, 188; culmen, 86.5 mm.

Mr. Raven found this woodcock inhabiting bamboo thickets in the mountains of the type locality, where they only come out at night to feed. The only specimen he succeeded in recovering had been badly eaten by ants, as it had been shot the evening before, and made into a rough skeleton. The flight feathers had been left on the wing and some feathers around the base of the bill and the end of the tibia. The flight feathers alone show this to be a very distinct species of woodcock, quite different from *Scolopax saturata* and more like *rusticola*, having the russet notches on both webs of the primaries, but of a much deeper color; the wing-coverts are of a different pattern, the russet darker and confined to notches along the border not bars, the rest of the feather brownish-black, like the primaries.

Judging from the plate⁵⁰ and remarks, *Scolopax rusticola mira* Hartert approaches the Celebes species, but the latter has a much darker wing, and as the former is supposed to be a resident on the Island of Amami in the northern Riu Kiu group, it is not likely to reach Celebes.

⁴⁸ Birds Australia, vol. 3, pt. 3, 1913, p. 230.

⁴⁹ Proc. Biol. Soc. Wash., vol. 34, 1921, p. 55.

⁵⁰ Nov. Zool., vol. 24, 1917, p. 437, pl. 2.

To the above I would add that the lesser wing-coverts in the plate of *Scolopax rusticola mira* are of the usual "*rusticola*" type, while, as remarked above, in *Scolopax celebensis* they are of a different pattern, but I made a mistake in calling them notches, for further examination shows them to be really bars. The pattern is quite different, however, the black bars wide and the russet narrower; there are no gray bars bordered by narrow black ones as in *Scolopax rusticola*. The feathers remaining at the base of the forehead of *Scolopax celebensis* are similar to the same area in *Scolopax rusticola*, if not identical, but quite different from this area in *Scolopax saturata*.

Scolopax apparently has not been recorded from Celebes before and a more perfect specimen is much desired.

Family JACANIDAE.

JACANAS.

46. IREDIPARRA GALLINACEA GALLINACEA (Temminck).

Two males, Toli Toli, December 13, 1914; and one female, Rano Lindoe, March 26, 1917.

These appear to be considerably darker above, especially on the rump and tail, when compared with *Irediparra gallinacea novae-hollandiae* (Salvadori).

Comb bright red in life and loses its color within a few minutes after death.—H. C. R.

Family PLEGADIDAE.

IBISES.

47. PLEGADIS FALCINELLUS PEREGRINUS (Bonaparte).

Three adult males, two adult females, one immature male, and two immature females, Rano Lindoe, March 7-13, 1917.

The series available for comparison, consisting of one male from Europe and one male and two females from North America, is much too small to reach any definite conclusions regarding the forms, if any, that this species might develop. The North American male is slightly darker than the specimen of the same sex from Europe; the Celebes males appear slightly darker than the North American bird. Whether these slight differences would hold in a larger series only the future can decide. The measurements are too scattered to be of any value and are not given. I am following Hartert⁵¹ in recognizing an eastern form.

Birds in the Celebes series with the top of the head greenish, instead of washed with a purplish gloss, prove to be not fully adult,

⁵¹ Vögel paläarkt. Fauna, vol. 2, pt. 4, 1920, p. 1222.

such specimens having the remains of a few very fine white stripes on the face and neck and a few black feathers scattered through the underparts.

Family CICONIIDAE.

STORES.

48. DISSOURA EPISCOPUS NEGLECTA (Finsch).

One female, Toli Toli, December 16, 1914; one male and one female, Tandjong Penjoe, February 17, 1915; one male, Gimpoe, August 13, 1917.

The above series, when compared with a male and female from the mainland (Trong and Tenasserim), a male from Mindoro and an unsexed specimen from Mindanao, appears to be slightly smaller and the bills (in the dried skin) differently colored. The bill in the Celebes bird is red for nearly two-thirds of its length from the tip and this color runs back along the culmen considerably further, only the basal third of the bill black, while in the mainland and Philippine specimens the bill is black or dusky for nearly its whole length, only the extreme tip and a narrow line along the culmen running back as far as the nostril, being reddish. The purplish gloss to the upper mantle seems to be less extensive in the Celebes bird. The mainland and Philippine specimens seem to be the same, though the specimen from Mindanao has the tip of the bill more extensively reddish and in this respect approaches the Celebes bird.

Doctor Finsch⁵² in describing *D. neglecta* gave no definite type locality but simply cited the range as Java, Sumbawa, Lombok, Celebes, Philippines. Stresemann⁵³ in recording it from Bali questioned the two latter localities and for the Philippines correctly so, as I have shown above. It is certain, however, that the Celebes bird is not the same as that from the mainland and until we know the exact locality of the type of *D. neglecta* and compare typical specimens, I can not do otherwise than place it where the original describer did.

Dissoura stormi is represented in the United States National Museum by specimens from Borneo and E. Sumatra. It is quite a different species, smaller than *Dissoura episcopus*, the bill entirely red in the skin, with numerous other differences.

The Asiatic specimens of *Dissoura episcopus* in the United States National Museum measure as follows:

⁵² Orn. Monats., vol. 12, 1904, p. 94.

⁵³ Nov. Zool., vol. 20, 1913, p. 332.

No.	Sex.	Locality.	Wing.	Tail.	Culmen.	Tarsus.	Middle toe.
			<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
252537	Male---	Gimpoe, Celebes-----	485	183	152	161	80
248940	---do---	Tg. Penjoe, Celebes---	471	175	149	163	78
248941	Female---	-----do-----	475	195	147	155	74
248939	---do---	Toli Toli, Celebes-----	460	194	146	153	70
153617	Male---	Trong, L. Siam-----	507	205	161	177.5	81
180313	Female---	Tg. Badak, Tenasserim---	480	193	147	166	78
201662	Male---	Calapan, Mindoro-----	490	205	185	176	85
192101	-----	Zamboanga, Mindanao---	466	195	180	164	83

Family ARDEIDAE.

HERONS, BITTERNS, ETC.

49. PYRRHERODIAS PURPUREA MANILENSIS (Meyen).

One male, Soemalata, September 6, 1914; one male, Kapas Bay, November 19, 1914; one adult and one immature female, Rano Lindoe, March 3 and 8, 1917; one female, Pinedapa, January 31, 1918.

50. TYPHON SUMATRANA SUMATRANA (Raffles).

One adult female, Batoe Hangoes Baroe, June 11, 1916.

51. EGRETTA GARZETTA NIGRIPES (Temminck).

One female, Toboli, October 26, 1916; one male, Rano Lindoe, March 23, 1917.

The female is a young bird with the basal third of the maxilla light colored; the outer primary slightly shorter than the second, the tarsus scutellate both before and behind, differing in this respect from *Hemigarzetta*. The male measures: wing, 258; tail, 88; culmen, 81; tarsus 89.5; middle toe, 68.5; and the female: wing, 265; tail, 87; culmen, 77.5; tarsus, 94; middle toe, 59.5 mm.

52. HEMIGARZETTA EULOPHOTES (Swinhoe).

One male, Kwandang, October 7, 1914.

This specimen measures: wing, 265; tail, 89; culmen, 89; tarsus, 89; middle toe with claw, 64.5.

The tarsus is scutellate in front and reticulate behind in which respect it agrees with a specimen in the United States National Museum from Fusan, Korea. The Celebes bird has the first primary slightly the longest in one wing but slightly shorter than the second in the other.

53. DEMIGRETTA SACRA SACRA (Gmelin).

One female, Koeala Prang, June 14, 1916; one male, Toboli, October 21, 1916.

While the United States National Museum contains quite a series of these herons, mostly from the northern part of the range of the species, it is yet inadequate for the working out of the various forms and I am referring the Celebes birds for the present to the typical form, as Wetmore⁵⁴ has done for birds from the eastern Carolines and other Pacific islands.

I am convinced, however, that Mathews⁵⁵ is in error in regarding the white plumage as a separate species from the dark. The series before me seems to indicate that the white birds are only immatures or at most only a phase of the slate-colored birds. There are several specimens in pied plumage, and even amongst the dark birds there are at least two plumages—the well-known slate-colored adult and a lighter-colored bird with considerable admixture of brownish feathers in the plumage. The Celebes specimens, listed above, illustrate the two phases of the dark plumage, and all indications point to the lighter-colored bird being immature. It lacks the elongate scapular plumes, and the other specimens in this plumage are similar; one of the inner secondaries of the left wing is edged with white at the tip. Of course the absence of the elongate scapular plumes may be due to the nonbreeding season, but the general body plumage has the fluffy appearance of immaturity which can be better told than described. The evidence seems to show that the species goes through several plumage changes; that it breeds in the white phase is no doubt true, but this does not prove that it is a different species. Several North American herons have more than one phase of plumage; *Dichromanassa rufescens*, for instance, and the young of *Florida caerulea* are always white, eventually assuming the slate plumage of the adults.

54. NYCTICORAX MANILLENSIS MINAHASSAE Meyer and Wiglesworth.

One adult male, one adult female, and one immature female, Likiepang, February 22 and 24, 1916.

The above two adults when compared with two adult males and three adult females from the Philippines differ as follows: They have a pronounced whitish superciliary; the throats are broadly white, and this white continues down the foreneck in a narrow uninterrupted line until it merges into the white of the breast. In the Philippine bird the superciliary is narrow and poorly defined (in one specimen entirely absent) and cinnamon-rufous; the throats not pure white and in one specimen from Luzon (No. 211274) with no white at all; and there is no white line down the foreneck. In fact, the Celebes bird forms a transition toward *Nycticorax caledonicus* but

⁵⁴ Bull. Mus. Comp. Zool., vol. 63, No. 4, 1919, p. 171.

⁵⁵ Birds Australia, vol. 3, pt. 6, 1914, p. 456.

is darker than that form, especially on the sides of neck, and the tips of the long nuchal plumes are blackish. It would perhaps be nearer the truth to treat both the above and *Nycticorax manillensis* as only forms of the wide-ranging *N. caledonicus*.

The adult male from Celebes has the back warm blackish brown with a plumbeous cast that varies in different lights; this is probably due to age, as one of the Philippine birds shows an approach to this condition. The type of *N. minahassae* is evidently an extreme manifestation of this plumage.

55. BUTORIDES JAVANICA JAVANICA (Horsfield).

One male, Kapas Bay, July 22, 1914; three males (one immature) and one female, Koecala Prang, June 4 and 13, 1916; one male, Toboli, October 21, 1916.

I have compared this series with two adult males from Java, and the latter appear to have a little more pronounced white edging to the wing-coverts; otherwise they are similar, and until the species has been revised they had better remain as above.

Since the above was written, Hartert has published⁵⁶ a review of the species and has reduced them all to forms of *Butorides striatus*, a South American species; a proceeding to which naturalists will hardly agree.

56. ARDEOLA SPECIOSA (Horsfield).

Four males and four females Toli Toli, December 13–18, 1914; one male, Toboli, October 23, 1916; three females, Koelawi, January 26, and February 1, 1917; one male and one female, Rano Lindoe, March 4 and 10, 1917.

This series, with a small series from Java, the latter consisting of young not yet from the nest and adults, convinces me that Meyer and Wiglesworth's⁵⁷ description of what they call the winter plumage is really that of the immature. All the birds in the Celebes series taken in October and December are just like the breeding adults, except they lack the long nuchal plumes, the dorsal plumes are a little shorter and have more of a brownish tinge, and the scapulars usually lack the buff. The specimens taken in January and March have the head and neck more or less marked with blackish; the back blackish-brown; the scapulars hair brown with some slight buffy shaft streaks. The specimen taken March 4 (No. 250729) has begun to assume the adult plumage; the blackish streaks have almost entirely disappeared from the head and neck, the slaty back plumes have begun to appear, and there are buffy feathers present in the

⁵⁶ Vögel paläarkt Fauna, vol. 2, pt. 4, 1920, p. 1250.

⁵⁷ Birds of Celebes, vol. 2, 1898, p. 830.

scapulars. A nestling with the pin-feathers just appearing was taken in Java, March 25, another slightly older, July 9, and another from the same island, completely feathered but with stubby tail, and the remains of the nestling plumage still adhering to the mesoptiles, July 8. The latter has the head and hind-neck tawny streaked with blackish, the jugulum and foreneck with feathers broadly streaked centrally with ochraceous-buff, the back mummy brown with a cinnamon-rufous wash, and the outer primaries tipped with hair-brown. In the next stage the back, scapulars, and tips of the primaries are drab, the neck has become almost white with only a few buffy and dusky streaks, the top of head darker and the dusky streaks more pronounced. After this stage the slaty dorsal train begins to appear, the jugulum deepens, and the streakings on the head and neck becomes more pronounced, and then the markings on the head and neck gradually decrease again as the adult plumage is assumed. Most of the foregoing remarks on the plumage of the young are founded on Javan birds taken in spring or summer, in conjunction with our Celebes birds. As a matter of fact, the Celebes birds are browner on the back, not so slaty as the breeding Javan birds, but this is doubtless due to season.

57. *BUBULCUS IBIS COROMANDUS* (Boddaert).

Two males and two females, Rano Lindoe, March 8-13, 1917.

These are often seen about wet rice fields and follow horses and water buffaloes to eat flies and ticks.—H. C. R.

58. *IXOBRYCHUS SINENSIS ASTROLOGUS* Wetmore.

One immature male, Toli Toli, December 10, 1914.

This specimen is too immature to show the characters of the race and I am placing it here solely on geographic grounds.

59. *NANNOCNUS CINNAMOMEUS* (Gmelin).

One male, Toli Toli, December 16, 1914.

In this specimen the wing-coverts are lighter than the back, about the same as the sides of the neck. There is a specimen from Java that is similar and one from Mindanao that has the wing-coverts partially lightened, but in a second specimen from Java the wing-coverts are as dark as the back or nearly so; from this I conclude it is a matter of age. The Celebes bird is evidently fully adult as there is no dark line down the center of the fore-neck.

60. *DUPETOR FLAVICOLLIS FLAVICOLLIS* (Latham).

One male, Rano Lindoe, March 20, 1917.

Family ANATIDAE.

DUCKS, GEESE, ETC.

61. DENDROCYGNA ARCUATA ARCUATA (Horsfield).

Six males and four females, Paleleh, November 12 and 13, 1914; two males and one female, Likoepang, February 23–25, 1916.

The United States National Museum possesses only two unsexed Australian specimens of this duck, amongst a large series from the wide range of the species. These seem to have lighter and more heavily spotted breasts than birds from the northern parts of its range.

Mathews⁵⁸ has rejected *Anas arcuata* because Horsfield⁵⁹ only intended to rename or rather use what he considered an earlier manuscript name of Cuvier for his *Anas javanica*,⁶⁰ but Horsfield defeated his purpose when he published a named plate and diagnosis of an entirely different species. Salvadori⁶¹ was correct in accepting Horsfield's name for the present species founded upon the plate. As *Dendrocygna arcuata* and *javanica* are perfectly distinct species, both occurring in Java, and as the Australian form is a race of the former, it will become *Dendrocygna arcuata australis* Reichenbach.⁶²

62. DENDROCYGNA GUTTATA Schlegel.

One male and one female, Likoepang, January 19, 1916.

The first description of this duck is apparently that of Schlegel;⁶³ all previous uses of the name being nomina nuda.

63. ANAS SUPERCILIOSA PERCNA Riley.⁶⁴

Two males and two females, Dolo, December 26, 1916; one male, Winatoe, January 21, 1917; three males, two females, and downy young, Koelawi, February 2–3, 1917; one male, Rano Lindoe, March 13, 1917.

This series, while showing quite a little variation, agrees in being darker and smaller than the Australian form (*Anas superciliosa rogersi*); the throats are noticeably of a deeper buff, more pinkish.

There is apparently no difference in the sexes worth mentioning, even in size. The seven males measure: Wing, 240–266 (249.3); tail, 86–107.5 (97.4); culmen, 45–52.5 (49); tarsus, 42–45 (43.3);

⁵⁸ Nov. Zool., vol 18, 1911, p. 9.

⁵⁹ Zool. Research. Java, 1824, pl. 64.

⁶⁰ Trans. Zool. Soc. Lond., vol. 13, 1821, p. 199.

⁶¹ Cat. Birds Br. Mus., vol. 27, 1895, p. 153.

⁶² Nov. Syn. Av., No. 4, Dec., 1850, [4], pl. 335, fig. 2650–51, ex Gould.

⁶³ Mus. Pays-Bas, vol. 6, No. 31, liv. 8, 1866, p. 85.

⁶⁴ Proc. Biol. Soc. Wash., vol. 32, 1919, p. 93 (Koelawi, Celebes).

middle toe, 48-53.5 (51.6). The four females measures: Wing, 231-256 (249.7); tail, 92-100 (97.2); culmen, 48.5-52 (50.2); tarsus, 40.5-45.5 (42.2); middle toe, 46-55.5 (51.6). Three specimens from Australia (only one sexed and that a female) measure: Wing, 275-255 (263.3); tail, 99.5-108.5 (103); culmen, 53-58.5 (54.8).

Anas superciliosa pelewensis is still smaller than the Celebes form, the buff of the throat is lighter, the auriculars and sides of neck more heavily streaked, and there are other differences.

The downy young taken at Koelawi, February 2, may be described as follows: Above sepia, darker on the rump; sides of face and lower parts, cream-buff, deepening on sides of face; an obscure band across chest and a very narrow line down the center of breast, cinnamon-buff; a dark line from bill under and through the eye to the nape; a rictal spot and another on the auriculars, of the color of the back; superciliary stripe, creamy buff; a line across hinder border of wing, a small streak on the back on each side opposite the wing, and another small streak on each side of rump, cream-buff; flanks and crissum, a little lighter than the back.

For a fuller discussion of the forms of this duck the reader is referred to Mathew's Birds of Australia,⁶⁵ where references to the pertinent literature will be found.

64. NETTION GIBBERIFRONS GIBBERIFRONS (S. Müller).

A good series of both sexes from: Toli Toli, November 28-December 12, 1914; Kampa, February 14, 15, 1915; Tandjong Penjoe, February 16, 1915; Winatoe, January 21, 1917; Koelawi, February 23, 1917; Rano Lindoe, February 24-March 13, 1917; Gimpoë, August 4, 1917.

The above birds when laid out in series show quite a little variation. The specimens taken in January, February, and the early part of March are much lighter below, without any chestnut wash on the breast, and the throats are much lighter, also, almost white. The birds taken in the latter part of March and December have the underparts strongly washed with chestnut and the throats tinged with rusty, but in my opinion this difference in color is due to stain caused by iron in the water. The males have the foreheads considerably swollen, much more pronounced in some specimens than in others; it is very noticeable in the skeleton, but poorly developed or almost entirely absent in the females.

A pair in the United States National Museum from Java are considerably darker on the back, wings, scapulars, and tail than any of our Celebes specimens and probably represent a distinct form.

⁶⁵ Vol. 4, pt. 2, 1915, pp. 85-94.

Three skins marked as males, one female and four unsexed specimens (which from the absence of the swelling on the foreheads I take to be females) before me from Australia have the edges of the feathers of the back and breast lighter and the throats more extensively whitish than in Celebes birds. Mathews⁶⁶ has named this race *Nettion castaneum rogersi*, but does not point out in the original description how it differs from *N. g. gibberifrons*; later under *Virago gibberifrons rogersi*⁶⁷ he concludes the Australian birds are larger and this seems to be borne out by the above series. It is possible that the majority of our Australian specimens are really females of *N. castaneum*, but the bird marked as a female (No. 85928) is quite a little smaller than the others and is probably *N. gibberifrons*. She is larger than any female I have measured from Celebes and the buffy margins of the feathers above and below are much lighter; as this agrees with Mathews conclusions it is wiser to recognize the Australian race for the present at least.

A fine male specimen (No. 278783) of *N. castaneum* from Port Lincoln, South Australia, before me shows a great reduction in the size of the swelling on the forehead, so pronounced in *N. gibberifrons*, causing the head to appear of quite a different shape. In the old males of *N. gibberifrons*, where the above character is best developed, the forehead rises almost vertically while in *N. castaneum* it slopes gradually back to the crown. In my opinion both the above species belong to the same genus, and lacking any other good characters to separate them from *Nettion*, it would appear that the genus *Virago* is not well-founded.

Five young in the down taken at Gimpoe, with the adult female, August 4, may be described as follows: Above fuscous-black with a brownish wash, darker on the head; two narrow white lines (one on each side) from near posterior base of wing to sides of rump; a superciliary streak extending from lores to auriculars, chamois; a streak from forehead through eye to nape and an incomplete "rictal" stripe that does not quite reach the rictus are the color of the back; a spot on the outer border of wing and a stripe across middle of wing to back, buffy white; lower-parts, buffy-white, the chest crossed by a narrow seal brown band, shading below into a slightly wider band of a much lighter brown.

Ten adult males measure: Wing, 179–192.5 (187.2); tail, 84–94 (88.3); culmen, 34.5–40 (37.6); tarsus, 32.5–35.5 (33.9); middle-toe, 38.5–43.5 (42); and 10 adult females; wing, 170–183 (176.8); tail, 79.5–90 (80.2); culmen, 32.5–38 (34.5); tarsus, 31–34.5 (32.5); middle-toe, 37.5–42 (39). From the above it will be seen the female is

⁶⁶ Aus. Av. Record, vol. 1, 1912, p. 86.

⁶⁷ Birds Australia, vol. 4, pt. 2, 1915, p. 102.

smaller than the male. The female from Australia referred to above measures: Wing, 194; tail, 84; culmen, 36.5; tarsus, 32; middle-toe, 37.

65. *NYROCA AUSTRALIS* (Eyton).

One male, Rano Lindoe, March 26, 1917.

This is an extension of the range of this species to the northward. When compared with Australian examples, the above specimen is much darker on the head and back and the primaries are more extensively white on the inner web with little or no drab shading, except on the outer primary and even then it is not so pronounced. It evidently represents a breeding form which for the present is best not named until more material can be examined.

Band on forward part of bill almost white in life.—H. C. R.

Family ANHINGIDAE.

DARTERS.

66. *ANHINGA MELANOGASTER* Pennant.

Two males, Rano Lindoe, February 24, and March 26, 1917.

Family FREGATIDAE.

MAN-O'-WAR-BIRDS.

67. *FREGATA ARIEL ARIEL* (Gray).

One male, Toeriboeloe, December 16, 1916.

I have no Australian specimens available but have a male from the Amirante group, Seychelles, taken August 29 (*Fregata ariel iredalei*), and a male from Makemo, Paumotu Islands. From the former, the Celebes bird differs in being much glossier above and on the wing-coverts, the lanceolate feathers on the head and back being a dusky bluish-green with purplish reflections in certain lights, the lesser wing-coverts bronzy-green, while in the Amirante specimen there is little gloss above, the lanceolate feathers of the head and back being a dull black with only a slight greenish sheen, and the feathers of the back with a subterminal band of iridescent purple; the lesser wing-coverts dull black with little bronzy green. The Celebes skin has a larger and heavier bill. The Paumotu bird when compared with that of Celebes, is duller, the lanceolate feathers of the mantle with more of a steely purple gloss. It more closely resembles the Celebes specimen than that from Amirante as was naturally to be expected. The bills of the three specimens measure as follows:

Celebes, culmen, 91; width at base, 28.

Paumotu, culmen, 88.5; width at base, 23.

Amirante, culmen, 85; width at base, 24.

As the specimens at hand are so few I can not do better than Wetmore,⁶⁸ who reported upon the Paumotu specimen, in arriving at any definite conclusions and assign the Celebes bird to the typical form.

Family FALCONIDAE.

HAWKS, EAGLES, ETC.

68. *CIRCUS ASSIMILIS QUIRINDUS* Mathews.⁶⁹

One adult male, one adult female, and one immature female, Parigi, September 12-25, 1916; one adult male, Toboli, October 26, 1916; one immature male, Rano Lindoe, March 10, 1917.

The only Australian specimen available for comparison is an immature, sex undetermined, but probably a female. It is in about the same stage of immaturity as the immature female from Parigi. When compared, the Celebes bird is darker, especially on the lower-parts; in size there is not much difference, the Australian specimen being slightly the larger.

As the immature plumages of hawks are very puzzling the two mentioned above may be roughly described as follows: The male taken at Rano Lindoe differs from the adult male in being blackish seal brown above; the top of the head heavily streaked with the color of the back; the throat and foreneck the color of the back, the latter with the feathers edged with cinnamon rufous; remainder of the underparts cinnamon rufous streaked with white, the sides and flanks beginning to break up into bars and spots as in the adult. The immature female taken at Parigi is blackish seal brown above; the head much lighter than in the adult, especially on the nape, the dark streaks broader, and of the color of the back or even darker; the feathers of the mantle edged with drab; the scapulars and wing coverts rather broadly tipped with cinnamon, fading to buffy on the outer margin; the rump and upper tail coverts the color of the back tipped with orange-cinnamon, the longer tail coverts with white; the lower parts are cinnamon, fading to cinnamon-buff on the lower breast and belly, and streaked with seal brown, the streaks becoming narrower on the abdomen and fading out on the belly; the tail is the color of the back with darker shadow bars.

This is more common about the villages and rice fields than elsewhere and catch a great many young domestic chicks.—H. C. R.

69. *LOPHOSPIZA GRISEICEPS* (Schlegel).

One immature female, Laboea Sore, November 15, 1916.

This specimen measures: Wing, 201.5; tail, 164; culmen from cere, 18.

⁶⁸ Bull. Mus. Comp. Zool., vol. 63, No. 4, 1919, p. 171.

⁶⁹ Birds Australia, vol. 5, pt. 1, 1915, p. 23.

70. ACCIPITER RHODOGASTER RHODOGASTER (Schlegel).

One adult male, Toemaratas, July 7, 1916; one adult female, Parigi, September 19, 1916.

The female is much darker above than the male; the chest lighter; the bars on the outer rectrix, both above and below, much better defined; and the difference in size between the sexes is remarkable. They measure: Male—wing, 164; tail, 119; culmen from cere, 13.5; female—wing, 210; tail, 151.5; culmen from cere, 16.

71. TACHYSPIZA SOLOENSIS (Horsfield).

One immature male, Kwandang, October 16, 1914; one immature male, Kapas Bay, November 21, 1914; one adult male, Likoepang, March 12, 1916.

The adult male is very dark slate color above and vinaceous cinnamon below and has the inner web of the outer tail-feather marked with six bars, the last two bars reduced to spots; the majority of the adult specimens of this species in the United States National Museum collection have this feather unmarked or with only three or four basal bars, except one adult male (No. 178,458) from Little Nicobar, Nicobars, which is very much like the Celebes specimen but has one less bar. It would appear as if the unbarred outer tail feather is acquired only after several moults.

72. SPILOSPIZA TRINOTATA TRINOTATA (Bonaparte).

One immature male, Paleleh River, August 11, 1914; one adult male, Kapas Bay, November 20, 1914; one adult male, Toemaratas, July 3, 1916; one adult male, Teteamoet, January 25, 1916; one immature female, Rano Lindoe, March 26, 1917; one adult male, Pinedapa, February 21, 1918.

The male from Teteamoet agrees with the description of *Spilospizias trinotatus haesitandus* Hartert⁷⁰ described from Bonthain Peak and would seem to discredit the form. It is lighter on the back than any of the other specimens in the series before me, the vinaceous-cinnamon confined almost exclusively to jugulum and chest; the breast, under tail-coverts, and thighs being white, faintly tinged with buff on the upper breast. The Kapas Bay specimen is darker below, with the crissum whitish; the Toemaratas bird still darker below, but with the crissum whitish; while the specimen from Pinedapa is the darkest below of any with little or no whitish on the crissum. From the above it would appear as if the southern race was founded upon individual variation rather than geographic differences.

These little hawks seem common; I have several times seen them darting through the open forest.—H. C. R.

⁷⁰ Nov. Zool., vol. 3, 1896, p. 162.

73. *ICTINAËTUS MALAYENSIS MALAYENSIS* (Temminck).

One female, Napoe, Watoetaoe, November 20, 1917.

This specimen is not quite adult. The abdomen has a few cinnamon-buff streaks; the bend of the wing with whitish markings along the margin; the auriculars with some clay color streaks; and the nape with a few slight buffy markings. It is molting and the new tail and primaries have already been acquired and the wing-coverts, scapulars, secondaries, and back-feathers are in process of renewal. The new feathers are sooty-black with a greenish sheen in certain lights and show conspicuously amongst the older dark brown feathers of the plumage; the tail with dark grayish irregular shadow bars. It measures: Wing, 520; tail 290; culmen from cere, 29, which is considerably smaller than an unsexed specimen from Darjeeling, India, with which I have compared it.

74. *SPIZAËTUS LANCEOLATUS* Temminck and Schlegel.

One adult male, Molengkapoti, Kwandang, October 25, 1914; one immature female, Laboea Sore, November 20, 1916.

75. *SPILORNIS RUFPECTUS RUFPECTUS* Gould.

One male, Kwandang, October 9, 1914; one female, Laboea Sore, November 21, 1916; one male, Koelawi, January 6, 1916; one female, Gimpoë, August 23, 1917; one female, Pinedapa, January 31, 1918.

The specimen from Kwandang has not quite acquired the fully adult plumage. The back and chest are lighter than in the adult; a patch in the center of the chest and under primary coverts white, the latter with a few brown spots; the feathers of the nape margined with cinnamon; and the bars on the underside of the tail much fainter than in the adult. The bars on the tail of the female from Gimpoë are very faint and on the two outer feathers on each side are reduced to two, very narrow, near the tip; the chest is darker than in the other adult specimens. It is molting, and the old, worn feathers of the back are being replaced by dark new ones.

76. *CUNCUMA LEUCOGASTER* (Gmelin).

One immature male, in the brown plumage, Kapas Bay, November 18, 1914.

77. *HALIASTUR INDUS AMBIGUUS* Brüggemann.

One male, Kwandang, October 7, 1914; one male, Koeala Prang, June 4, 1916; one female, Toboli, October 26, 1916; one male, Toare, September 20, 1917.

The above specimens have been compared with a good series of adults from the Philippines, one from Java, and one from Borneo. The Bornean skin does not seem to differ from those from the Philip-

piners; the Javan bird resembles those from the Philippines very much, except that the shaft lines on the feathers of the head, neck, and chest are more pronounced. The four Celebes specimens have the shaft lines of the white areas very fine, in fact almost obsolete; this sometimes occurs in Philippine birds, but not so generally or to so pronounced an extent; the Celebes birds are also somewhat smaller. Only one specimen of the Australian form, without definite locality, has been available for comparison. It is entirely without shaft stripes on the white areas. As the Celebes bird does not seem to be the same as that from Java, the Philippines, or Australia, I am using Brüggemann's name, founded upon Celebes specimens, as the only safe course.

Mathews⁷¹ unites the Celebes form to that of the Philippines, but there is no evidence in his work that he actually compared series of specimens from the two localities, apparently relying more upon the literature. He may be right in assigning Javan specimens to a different form than that of the Philippines but he is not justified in uniting the latter to that of Celebes.

78. ELANUS HYPOLEUCUS Gould.

Three males and two females, Parigi, September 12-23, 1916; one male, Gimpoe, August 20, 1917.

Philippine and Javan specimens do not appear to differ in any way from those of Celebes.

The crops of the two specimens examined by Mr. Raven both contained the remains of quail (*Excalfactoria*).

79. MILVUS MIGRANS AFFINIS Gould.

One male, Parigi, September 3, 1916; one male and five females, Laboea Sore, November 19-December 4, 1916; one female, Winatoe, January 21, 1917; one male, Koelawi, February 3, 1917; two males and one female, Gimpoe, August 3, 23, 1917.

No Australian specimens of this race have been available for comparison.

Never seen until a deer or other large specimen is being skinned.—H. C. R.

80. PERNIS CELEBENSIS CELEBENSIS Wallace.

One female, Koelawi, February 8, 1917; one female, Gimpoe, August 23, 1917.

The specimen from Koelawi is much like the plate in Meyer and Wigglesworth,⁷² except the black streaks on the throat and chest are more numerous and broader, while the Gimpoe female has them

⁷¹ Birds Australia, vol. 5, pt. 2, 1916, p. 156.

⁷² Birds of Celebes, vol. 1, 1898, pl. 2.

less numerous and narrower. The Koelawi bird has the outer tail-feather worn off at the tip and the web worn down to the shaft for quite a distance. The two specimens measure as follows (the Koelawi bird first): Wing, 370-375; tail, 260-265; culmen from cere, 24-25.

Crops contained larvae of bees.—H. C. R.

81. LOPHASTUR CELEBENSIS (Schlegel).

One adult male, Gimpoe, August 22, 1917.

It measures: Wing, 300; tail, 205; culmen from cere, 23.

English ornithologists generally persist in using Sharpe's name for this hawk, though Meyer and Wigglesworth⁷³ had gone into the matter and shown that Schlegel's name had priority. As my data is somewhat different from theirs, though the results are the same, I will give them as follows: Sharpe⁷⁴ described *Baza erythrothorax* from Celebes. The paper in which it was described was received June 13, but it was published in part 3 of the Proceedings, which did not appear until April, 1874. In the meanwhile Schegel⁷⁵ had described it as *Baza celebensis*. This livraison is dated July, 1873, and the copy in the United States National Museum was certainly received within the year. Even if it should have come out much later in the year than the ostensible date it would have clear priority over Sharpe's name and should be employed.

82. CERCHNEIS MOLUCCENSIS OCCIDENTALIS (Meyer and Wigglesworth).

One female, Kapas Bay, November 18, 1914; two females, Tandjong Penjoe, February 19 and 23, 1915; one male, Temboan, July 20, 1916; one female, Winatoe, January 10, 1917; one female, Koelawi, January 31, 1917; one male, Rano Lindoe, March 30, 1917; one female, Dampelas, June 14, 1917, one male, Gimpoe, August 20, 1917.

The above series shows some little variation. The female is more heavily streaked below, the bars on the back are heavier, and the tail is narrowly barred with black, the male having the latter plain gray with a subterminal black bar and the top of the head with a grayish tinge. A specimen (No. 250766), marked as a female, and the measurement of the wing and barring of the back would indicate that it is such, from Koelawi, January 31, has the middle pair of tail feathers as in the male and only a few very faint indications of bars on the inner web of the other tail feathers. This bird is approached by another female from Tandjong Penjoe, February 23, and it would

⁷³ Birds of Celebes, vol. 1, 1898, p. 75.

⁷⁴ Proc. Zool. Soc., 1873, p. 625.

⁷⁵ Mus. Pays-Bas, No. 36, livr. 10, 1873, p. 135.

appear as if old females approach the males in this character. A male from Temboan, July 20, has the back barred and the breast streaked as in the females, and the tail feathers narrowly barred on the inner web. It is in worn plumage and may be a bird of the year. A female from Tobeia Island, Buton Strait, South Celebes, November 14 (No. 234092), is darker on the back than any specimen in the above series, but it is in fresher plumage, before much fading has set in. A Javan female, No. 218358, Buitenzorg, June 2, can not be distinguished from Celebes examples in the same stage of plumage, except for the thighs which are more heavily spotted.

Oberholser⁷⁶ described *Cerchneis moluccensis microbalia* from Solombo Besar, a small island between Borneo and Java. He evidently founded this race upon a single male specimen, the type, which I have carefully compared with our Celebes material. None of the sub-specific characters given in the original description seem to hold. The top of the head is rusty like the back as in the female, not with a grayish tinge like the fully adult male from Celebes, and the breast is more heavily streaked. These slight differences may prove to be individual, not geographic. It might well be that Bornean specimens may prove to be separable from those of Celebes, as the two islands have so little in common; if so, Oberholser's name may be available for such a race, but until that time there is no advantage in recognizing a form on mere conjecture. In any event Oberholser admits that the ranges for the three races will have to be redrawn, as they appear to be more or less speculative.

A specimen of *Cerchneis moluccensis moluccensis* from Ternate (No. 125027), marked as a male, but, judging from the color of the top of the head and the barred tail, is probably a female, is darker both above and below and is less streaked on the breast than any female in the Celebes series.

The two extremes of the series before me are given in the measurements below:

	Wing.	Tail.	Culmen from cere.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Three males from Celebes.....	200-228	136-150	15-16
Type of <i>Cerchneis m. microbalia</i>	230	152	15
Six females, Celebes.....	210-240	140-162.5	14.5-16.5
One female, Java.....	214	141	15
One female, Ternate (<i>Cerchneis m. moluccensis</i>).....	227	143	16

83. *ICTHYOPHAGA HUMILIS HUMILIS* (Müller and Schlegel).

Two adult females, Toli Toli, November 28, and December 22, 1914.

⁷⁶ Proc. U. S. Nat. Mus., vol. 54, 1917, p. 178.

Dr. C. W. Richmond⁷⁷ has already pointed out that *Ichthyophaga* Lesson⁷⁸ is the proper generic term to be employed for this genus of eagles, but he does not seem to have been followed by subsequent authors. *Ichthiaetus* Lafresnaye⁷⁹ is preoccupied by *Ichthyaetus* Sweeting⁸⁰ and is a nomen nudum, anyway.

These two specimens measure as follows:

	Wing.	Tail.	Culmen from cere.	Tarsus.	Middle toe.
No. 248224.....	415	218	26	81	51
No. 248225.....	390	201	25	81	51.5

There appear to be some discrepancies in the descriptions of this species that I have consulted, probably due to the age of the specimens used for description. The above two specimens have the base of the tail, except the two central feathers, mottled with white, more pronounced in the smaller specimen and more noticeable below than above. Indeed the white mottling above is confined to the inner web of the feathers. They appear to be adult. Sharpe,⁸¹ Meyer and Wigglesworth,⁸² and Kirke Swann⁸³ do not mention this white mottling at the base of the tail in their descriptions but it is mentioned by Blanford.⁸⁴

Family PANDIONIDAE.

OSPREYS.

84. PANDION HALIAETUS CRISTATUS (Vieillot).

One male and one female, Tandjong Penjoe, February 24, 25, 1915.

I have no Australian birds for comparison but the above two specimens have the top of the head white with a dark narrow nuchal stripe in the center, quite different from the more or less heavily streaked heads of more northern birds; they also appear to be somewhat smaller. The male measures: Wing, 418; tail, 207; culmen from cere, 30.5—the female: Wing, 440; tail, 227; culmen from cere, 33.

⁷⁷ Proc. U. S. Nat. Mus., vol. 26, 1903, p. 492.

⁷⁸ L'Écho du Monde Savant, ser. 2, vol. 7, No. 1, January 5, 1843, col. 14.

⁷⁹ Rev. Zool., 1839, p. 196.

⁸⁰ N. Wood's Nat., vol. 2, 1837, p. 303.

⁸¹ Cat. Birds Brit. Mus., vol. 1, 1874, p. 454.

⁸² Birds of Celebes, vol. 1, 1898, p. 43.

⁸³ Syn. List Acclipitres, pt. 4, 1920, p. 164.

⁸⁴ Fauna Brit. India, vol. 3, 1895, p. 371.

H. Kirke Swann has informed me, since the above was written, that the above specimens are smaller than Australian birds and that he now believes the Celebes bird belongs to the form described by Brasil⁸⁵ from New Caledonia as *Pandion haliaëtus microhaliaëtus*, but for the present I prefer to leave them as above. Otherwise the distribution would be hard to understand.

Family STRIGIDAE.

HORNED OWLS, ETC.

85. OTUS MENADENSIS MENADENSIS (Quoy and Gaimard).

A male not long from the nest, Likoepang, March 11, 1916; one adult male, Kalawara, July 22, 1917; one immature male molting into the first adult plumage, Gimpoë, August 12, 1917.

86. NINOX SCUTULATA JAPONICA (Temminck and Schlegel).

One male and one female, Kapas Bay, November 21 and 22, 1914. These specimens are apparently identical with birds from Corea.

87. NINOX OCHRACEA (Schlegel).

One adult female, Toli Toli, November 25, 1914; one young female, Gimpoë, August 11, 1917; one adult male and one young male, Pinedapa, January 12, and February 28, 1917.

The female taken at Toli Toli differs somewhat from the adult on plate 4, of Meyer and Wigglesworth's Birds of Celebes. The buff of the chest and belly is much deeper and extends in a narrow line almost to the chin, separating the dark chest band, the feathers rather broadly streaked centrally with brussels brown; and there is not so much white on the chin. It measures: Wing, 188.5; tail, 106; culmen from cere, 13.5. The adult male from Pinedapa is very similar to the above female but is even darker above and below, especially on the chest and belly. It measures: Wing, 184; tail, 108.5; culmen from cere, 13.

The young female, taken at Gimpoë, August 11, is slightly younger than the young male from Pinedapa, February 28; both have some of the downy first plumage still adhering to the lower parts. They are similar to the adults but of a darker brown above; the chest and belly pinkish buff with some almost obsolete cloudings of sepia.

The adults of this species are commonly heard during the night and are easily recognizable by their plaintive one syllabled note, which late at night is often the only sound heard, other than that of insects and batrachians.—H. C. R.

⁸⁵ Rev. Franç. Orn., vol. 4, 1916, p. 201.

Family TYTONIDAE.

BARN OWLS.

88. *TYTO ALBA ROSENBERGI* (Schlegel).

One female, Manembo Nembo, June 28, 1916; one male, Parigi, September 20, 1916.

The above female has the facial disk, back, and lower parts darker than in the male, especially the face and lower parts; the tarsus is more heavily feathered and deeper in color, the lower parts more heavily spotted with dark brown, the spots having more a tendency to form bars. It may be that more than one form of the species occurs in Celebes.

A single male of the Javan race (*Tyto alba javanica*) before me is much lighter in every way than my Celebesian male, but whether this would hold in a larger series it is impossible for the present to say.

The Celebesian race is so very different in color and size from true *Tyto alba* that it is very doubtful indeed if the former should be made a race of the latter, but I prefer to make no change for the present.

Family LORIIDAE.

LORIES.

89. *TRICHOGLOSSUS ORNATUS* (Linnaeus).

A good series from the following localities: Kwala Besar, July 29–31, 1914; Soemalata, September 4–8, 1914; Kwandang, September 16–October 7, 1914; Paleleh, November 13, 1914; Toli Toli, December 18, 1914; Tandjong Penjoe, February 17–20, 1915; Likoepang, January 17–March 12, 1916; Manembo Nembo, June 22–24, 1916; Toemaratas, July 5–9, 1916; Parigi, September 20–October 5, 1916; Toboli, October 20–25, 1916; Rano Lindoe, March 3–23, 1917; Gim-poe, August 3–28, 1917; Pinedapa, February 1–6, 1918.

Common about clearings and villages and very noisy; food mostly soft fruit, buds, and sweet blossoms.—H. C. R.

90. *EUTELIPSITTA MEYERI MEYERI* (Walden).

Five males and four females, Toemaratas, July 5–8, 1916; three males and one female, Laboea Sore, December 18, 1916; one male Lindoe Trail, February 25, 1917.

This series is very uniform and the only variation is such as would be accounted for by age. The yellow subterminal bar on the feathers of the mantle is much reduced in some specimens, probably birds not fully adult.

Mathews⁸⁶ has shown that *Psittuteles* can not be used for this genus and has proposed *Eutelipsitta* in its place.

If this genus is to be retained, it would seem to me that *Trichoglossus johnstoniae* Hartert of Mindanao should be placed in it.

Family CACATOIDAE.

COCKATOOS.

91. CACATOES SULPHUREA (Gmelin).

A good series of both sexes from the following localities: Kwala Besar, August 24, 1914; Kwandang, September 17-19, 1914; Tandjong Penjoe, February 17-20, 1915; Parigi, September 20-27, 1916; Toboli, October 21-26, 1916; Laboea Sore, November 21-26, 1916.

This does not occur in Minahassa, but is common at Kwandang.—H. C. R.

Family PSITTACIDAE.

PARROTS, PARAKEETS, ETC.

92. PRIONITURUS PLATURUS PLATURUS (Vieillot).

A good series of both sexes and young from the following localities: Kapas Bay, July 22 and November 20-23, 1914; Kwandang, September 17-October 26, 1914; Paleleh, November 9-13, 1914; Toli Toli, November 28-December 18, 1914; Teteamoet, February 1-3, 1916; Likoepang, March 11, 1916; Rano Rano, December 20, 1917.

The series of males varies considerably. The occipital spot ranges from mineral gray through light violet plumbeous to slate blue, the majority being light violet plumbeous. The wing coverts vary from pea to vertiver green, with the bend of the wing not conspicuously different to strongly marked with light violet plumbeous or slate blue. The back is more or less washed with a grayish cast to plain parrot green.

These parrots may be considered common in this locality (Teteamoet), and though often difficult to reach are heard almost continually during the day and often seen flying in numbers high above the heavy forest. It is here known as *keli keli*.—H. C. R.

93. PRIONITURUS FLAVICANS Cassin.

A fair series from the following localities: Tandjong Tango, August 28, 1914; Kwandang, October 8-26, 1914; Paleleh, November 13, 1914; Likoepang, January 13 and March 4-11, 1916; Toemaratas, July 9, 1916; Temboan, July 20, 22, 1916.

94. TANYGNATHUS MUELLERI MUELLERI (Temminck).

A good series from the following localities: Paleleh, August 19, 1914; Kwala Besar, August 23, 1914; Soemalata, September 4, 1914;

⁸⁶ Nov. Zool., vol. 18, 1911, p. 10.

Kwandang, September 17–October 9, 1914; Kapas Bay, November 21–22, 1914; Toli Toli, December 1–20, 1914; Tandjong Penjoe, February 16–18, 1915; Likoe pang, March 4–12, 1916; Manembo Nembo, June 24, 1916; Parigi, September 9–26, 1916; Toboli, October 18–27, 1916; Laboea Sore, November 12–28, 1916; Koelawi, January 26, 1917; Rano Lindoe, March 22, 1917; Gimpoë, August 5–23, 1917; Pinedapa, February 3, 1918.

A male taken at Koelawi (No. 250820) differs from any other in the series in having the fore neck and chest strongly suffused with apricot orange, overlaid with green. A female taken November 12 (No. 250133) has the pileum strongly washed with venetian blue and the feathers of the upper back edged with the same color; one or more other specimens have the feathers of the upper back edged with blue, but the above specimen is unique in the color of the pileum.

All the specimens marked as females by the collector have the bill horn color; only the adult males have it red.

95. LORICULUS STIGMATUS (Müller and Schlegel).

A good series from the following localities: Paleleh River, August 11, 1914; Kwandang, September 16–29, 1914; Toli Toli, December 11, 1914; Tandjong Penjoe, February 18–26, 1915; Likoe pang, January 21–March 11, 1916; Manembo Nembo, June 24, 1916; Toemaratas, July 5–8, 1916; Parigi, October 5, 1916; Toboli, October 19–22, 1916; Toewoeloe, January 16, 1917; Gimpoë, August 3–26, 1917; Toare, Bada, September 20–28, 1917.

The immature, able to fly, only differ from the adults in being duller and having the throats yellow, instead of red; the red throat apparently being the last adult character to appear.

Family CORACIIDAE.

ROLLERS.

96. CORACIAS TEMMINCKI (Vieillot).

A good series of both sexes and young from the following localities: Tandjong Tango, August 28, 1914; Kwandang, September 17, October 7 and 16, 1914; Palaleh, November 13, 1914; Toli Toli, December 6 and 20, 1914; Kampa, February 14, 1915; Teteamoet, February 2, 1916; Likoe pang, February 19–March 6, 1916; Manembo Nembo, June 24, 1916; Toemaratas, July 7–9, 1916; Temboan, July 28, 1916; Kasimbar, December 13, 1916; Dampelas, June 14, 1917; Pinedapa, February 8, 1918.

Two young taken July 30, 1916, have the blue crown washed with dusky; the throats and chests dusky with only a slight purplish wash, and the throats quite heavily streaked with light blue.

The majority of the adults have the throats sparsely streaked with light blue, but a few have not; the latter are probably old birds, as judging from the young the more dusky chest and streaked throats are remains of the immature dress.

A specimen (No. 248434) taken December 20, 1914, differs from any other in the series in having the throat more heavily streaked; the tail tipped narrowly on the outer and broadly on the central feathers with dusky blue-green; and an elongated spot on the outer web of the outer tail-feather near the tip bremen blue. That it is an immature bird is shown by its dusky throat and chest, less bright crown, the olive-brown tinge to the back, and the greater and lesser wing-coverts tipped with green. From the two younger birds mentioned above, it differs in the green tips to the outer tail-feathers, but as these are worn in the younger birds they were probably lost by abrasion.

Coracias temmincki differs structurally from *Coracias garrulus*. The bill in the former is stronger and heavier; the outer tail-feather in *C. garrulus* is slightly narrowed towards the tip and none of the tail-feathers are especially broad, while in *C. temmincki* all the tail-feathers are broad and rounded. *C. temmincki* has the fourth primary longest, the third a little shorter, while *C. garrulus* has the second primary longest, the third a little shorter. As at present constituted it would be a very hard matter to draw up a diagnosis of *Coracias*. The long-tailed African species are even more aberrant than *C. temmincki*.

The two young taken at Temboan, July 30, are three days out of the nest, a hollow tree near the edge of a clearing.—H. C. R.

97. EURYSTOMUS ORIENTALIS CONNECTENS Stresemann.⁸⁷

A fair series from the following localities: Toli Toli, December 17, 1914; Likoepang, January 17-19, 1916; Batoe Hangoes Baroe, June 12, 1916; Parigi, September 16, 1916; Gimpoe, August 2-25, 1917.

Family ALCEDINIDAE.

KINGFISHERS.

98. RAMPHALCYON MELANORHYNCHA MELANORHYNCHA (Temminck).

One male, Kwala Besar, August 23, 1914; one female, Kampa, February 15, 1915; one male, Batoe Hangoes Baroe, June 2, 1916; one male and two females, Dampelas, June 4 and 14, 1917; one male, Pinedapa, January 21, 1918.

⁸⁷ Nov. Zool., vol. 20, 1913, p. 302.

The specimens from Dampelas are very much faded, the blue has almost entirely disappeared from the scapulars, leaving them drab; one of the females has the tail much worn.

A female in the United States National Museum (No. 234102) from Dodepo Island, Gulf of Gorontalo, November 16, has the top of the head more extensively gray than any in the series collected by Raven; the culmen is longer and the base of the bill seems to have been of a different color in life. These differences may be individual. The bill is malformed, the lower mandible being considerably longer than the upper.

Interior of the bill and mouth salmon colored; exterior of bill black; feet salmon colored, except the toes and lower part of tarsus above, which are washed with blackish.—H. C. R.

99. *ALCEDO ATTHIS HISPIDOIDES* Lesson.

Three males from: Tandjong Tango, August 28, 1914; Kwandang, September 15, 1914; Koeala Prang, June 14, 1916.

A female in the United States National Museum, No. 234,101, from Anboina, when compared with the three Celebes males has a shorter and heavier bill; the lower mandible ochraceous for about half the length from the base; and the patch of specialized feathers on the sides of the neck behind the ear-coverts, white. In all three of the Celebes males the lower mandible is black to the base and the patch of specialized feathers on the sides of the neck, buffy. Whether the above differences are sexual or not I am not prepared to state.

The race is so very different from *Alcedo atthis* that I have grave doubts whether it should be only recognized as a form of that species. but follow Hartert⁸⁸ and Stresemann.⁸⁹

100. *CEYCOPSIS FALLAX* (Schlegel).

One male, Paleleh River, August 10, 1914; one male, Kwandang, October 9, 1914; one, male, Laboea Sore, November 15, 1916.

The male from Laboea Sore (No. 250218) has a shorter bill than the other two and it is black, horn color for a short distance at the extreme tip; the back is much darker; the blue spotting on the top of the head is heavier and extends further back onto the nape. It apparently is not fully adult.

101. *ENTOMOTHERA COROMANDA RUFA* (Wallace).

One female, Likoepang, March 9, 1916, and one female, Laboea Sore, December 1, 1916.

⁸⁸ Vögel paläarkt, Fauna, Heft 7, 1912, p. 882.

⁸⁹ Nov. Zool., vol. 20, 1913, p. 315.

In establishing the generic name *Entomothera* Horsfield⁹⁰ says on the page opposite to the one on which he proposed the name: "*Alcedo sacra* furnishes a sample of this genus." To my mind this is fixing the type but it is not in accordance with the International Code. He should have said "type," a term probably unknown to him in the modern sense. If the common-sense view of the matter was taken *Entomothera* should be used in place of *Sauropatis* Cabanis and Heine⁹¹ and the generic name for the Ruddy Kingfishers would be *Calialcyon* Bonaparte.⁹²

102. SAUROPATIS SANCTA (Vigors and Horsfield).

Five males, Koeala Prang, June 4-18, 1916.

The Australian material available consists mostly of females. The only male from New South Wales in the lot when compared with the Celebes series appears to be bluer on the wings and to be lighter below. A male from northern Australia (Port Darwin) is duller than the New South Wales male with a broader black nuchal collar; the former is in more worn plumage, however. There seems to be no constant difference in size between Celebes and Australian birds. Anyway the material at my command is inadequate to work out the various forms into which this kingfisher has been divided. There is some doubt as to whether it is resident in Celebes.

103. SAUROPATIS CHLORIS FORSTENI (Bonaparte).

A good series of both sexes from: Toli Toli, December 10-18, 1914; Kampa, February 14, 1915; Tandjong Penjoe, February 19, 1915; Likoe pang, February 23-March 11, 1916; Ayemadidi, May 5, 1916; Koeala Prang, June 18, 1916; Manembo Nembo, June 23, 1916; Toemaras, July 3, 1916; Toboli, October 17-23, 1916; Dolo, December 26, 1916; Lindoe Trail, February 25, 1917; Rano Lindoe, March 3-15, 1917; Gimpo, August 1-25, 1917; Napoe, Watoetaoe, November 20, 1917; Pinedapa, January 13, and February 13, 1918.

104. CITTURA CYANOTIS (Temminck).

One male, Kwala Besar, July 31, 1914; one male, Paleleh, November 12, 1914; one female, Teteamoet, January 23, 1916.

The male from Kwala Besar is darker on the head, back, and tail than the one from Paleleh, but as it has a black bill, I presume it is immature, though it shows no other sign of not being fully adult.

105. MONACHALCYON MONACHUS INTERMEDIUS Hartert.

One male, Laboea Sore, November 15, 1916; one female, Parigi, September 22, 1916.

⁹⁰ Zool. Research. Java, 1824, text to *Alcedo biru*.

⁹¹ Mus. Hein., pt. 2, 1860, p. 158, type *Halcyon sanctus* Vigors and Horsfield).

⁹² Consp. Av., Vol. 1, 1850, p. 156, type *Alcedo coromanda* Latham.

The male has the top of the head very deep indigo blue, shading off into a blackish tinge on the crown and forehead, the lower part much lighter than in the typical form. In the female the blue on the head is much lighter but still darker than in northern birds. They both probably belong to the above race.

Bill bright red; feet reddish flesh color below and behind, brown above. Very shy.—H. C. R.

Family BUCEROTIDAE.

HORNBILLS.

106. RHABDOTORRHINUS EXARATUS (Temminck).

One female, Paleleh River, August 8, 1914; one male and one female, Teteamoet, February 4, 1916; one female, Koeala Prang, May 8, 1916; one male, Temboan, July 30, 1916; one male and one female, Loboeba Sore, November 28, 1916; one male, Koelawi, February 1, 1917; three males and one female, Rano Lindoe, March 21–22, 1917.

107. CRANORRHINUS CASSIDIX (Temminck).

A fair series of males and females from: Paleleh River, August 9–15, 1914; Kwandang, October 24, 1914; Paleleh, November 10, 1914; Teteamoet, January 25 and 29, 1916; Koeala Prang, May 28, 1916; Pinedapa, January 10–February 8, 1918.

The smooth, peculiarly shaped casque and the fact that it has the corrugations at the base of both maxilla and mandible entitle this species to stand alone. The other species usually placed in the genus, with the corrugations at the base of the mandible only, I have proposed to remove and have named *Cranobrontes*,⁹³ with *Buceros leucocephalus* Vieillot as the type.

Family MEROPIDAE.

BEE-EATERS.

108. MEROPS PHILIPPINUS JAVANICUS Horsfield.

Five males and seven females from the following localities: Koeala Prang, May 28, 1916; Parigi, September 12, 1916; Rano Lindoe, March 6–26, 1917.

When laid out in series alongside birds from the Philippines and viewed from one side, the Celebes bird appears to be of a deeper green; the rump, tail, and under tail-coverts a purer blue; and the breast more greenish. Two Javan specimens seem to agree best with the Celebes series, and so for the present I am assigning the latter to the same race.

⁹³ Proc. Biol. Soc. Wash., vol. 34, 1921, p. 52.

A female taken at Koeala Prang, May 28, is an immature molting into the adult plumage and was undoubtedly bred on the island.

The various series average as follows:

	Wing.	Tail.	Culmen.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Four males, Celebes.....	132. 8	140	43. 2
Eleven males, Philippines.....	130. 8	146. 3	40. 6
One male, Java.....	131	128	42. 5
Four males, lower Siam and Malay Peninsula.....	137. 7	144. 4	40. 9
Two males, south Pagi and Simalur.....	134. 5	145. 5	40. 4
Three males, Nicobars.....	137. 2	150	42. 5
Four females, Celebes.....	128. 9	132. 9	39. 6
Five females, Philippines.....	128	137. 7	39. 5
One female, Java.....	138	150. 5	44
One female, West Sumatra.....	128. 5	136. 5	41. 5

109. MEROPS ORNATUS ORNATUS Latham.

One male and one female, Soemalata, September 5 and 8, 1914.

The small series of this species from Australia available for comparison varies quite a little individually; specimens from north Australia (Port Darwin), West Australia and South Australia have a more bluish cast above and on the belly than the only two specimens in the series from New South Wales. The western bird has been named, *Merops ornatus shortridgei* Mathews.⁹⁴ The Celebes male has a more ochraceous cast to the green and less blue on the lower back and tertials; the top of the head is also more extensively cinnamon rufous and the blue rictal stripe narrower than in a male from New South Wales. Nevertheless it seems to be nearer this form than the one from western Australia but my series is too small to determine the various races into which the species may be divided. It is probably only a migrant in Celebes. A male from Port Moresby, New Guinea, closely resembles the male specimen from New South Wales; it has a more bluish cast to the belly and the top of the head is browner.

110. MEROPOGON FORSTENI CENTRALIS Meyer.⁹⁵

One male and one female, Rano Lindoe, March 21, 1917; five males and two females, Toewo Mountain, Besoa, October 24–November 3, 1917; one male and two females, Pinedapa, February 1, 1918.

In the above series the females have the central tail feathers less narrowed and the blue toward the tip less evident than in the males.

A pair of young, not long from the nest, taken at Toewo Mountain, October 24, have the top of head dusky, the feathers tipped with dusky-green blue (more greenish in the female), shading to dusky

⁹⁴ Nov. Zool., vol. 18, 1912, p. 290.

⁹⁵ Notes Leyden Mus., vol. 23, 1901, p. 186 (Takala Mountains).

greenish on the nape and hind-neck; the gorget with the blue less intense than in the adult and the feathers tipped with dusky green-blue; otherwise much as in the adult except the central feathers are not produced beyond the remainder. An immature female taken at Pinedapa, February 1, is molting into the adult plumage. It has acquired the chestnut hind-neck band; the blue of the top of the head and gorget of the adult is appearing; the breast and belly are still strongly tinged with green; the central tail-feathers have already been acquired.

I have no specimen of *Meropogon forsteni forsteni* for comparison.

The measurements of the undoubted adults in the above series are given below :

Cat. No.	Sex.	Locality.	Date.	Wing.	Tail.	Culmen.
				mm.	mm.	mm.
251875	Male	Besoa	Oct. 27	112.5	151	41.5
251877	do	do	Oct. 28	115	153.5	43
251878	do	do	Nov. 1	116	168	45.
251879	do	do	Nov. 3	115	169	43
251881	do	Pinedapa	Feb. 1	115	146	45.5
250826	Female	Rano Lindoe	Mar. 1	108	146	43
251876	do	Besoa	Oct. 28	111	136	41.5
251880	do	Pinedapa	Feb. 1	111	130.5	43

Family CAPRIMULGIDAE.

GOATSUCKERS.

111. LYNCORNIS MACROPTERUS Bonaparte.

One male, Soemalata, September 6, 1914; one female, Kwandang, October 25, 1914; one male, Parigi, September 19, 1916; one male and one female, Pinedapa, February 2 and 15, 1918.

112. CAPRIMULGUS AFFINIS PROPINQUUS Riley.⁹⁶

One male, Parigi, September 28, 1916.

As the above specimen apparently differed considerably from the form with which it has usually been identified, I have ventured to describe it as follows:

Similar to *Caprimulgus affinis griseatus* but buff of belly unbarred, the ear-coverts and sides of neck more heavily marked with buff; the buffy spotting on the wing-coverts more numerous and pronounced; the white of the outer tail-feather more extended basally. Wing, 171; tail, 101; culmen, 10 mm.

Remarks.—I have been able to compare this specimen with three males of *Caprimulgus affinis affinis* from Java and one from Borneo and seven males of *Caprimulgus affinis griseatus* from Sibuyan and Luzon, Philippines. From the former it is much lighter, both above and below, and the buffy spots on the chest and wing-coverts are more numerous and pronounced and much

⁹⁶ Proc. Biol. Soc. Wash., vol. 31, 1918, p. 155.

lighter, the vermiculations on the back finer and the tail-bars above narrower. From the latter it is much closer in color and forms a connecting link; the chief difference is the unbarred belly.

Caprimulgus affinis mindanensis Mearns⁹⁷ is a dark bird like true *affinis* but with finer vermiculations above and with the belly barred, with which the present form hardly needs comparison. It seems strange that the Celebes bird should resemble the one from Luzon rather than that from Mindanao.

Since writing the above, I have reexamined the above forms but can add little to the published descriptions. The only resemblance between *Caprimulgus affinis affinis* and *Caprimulgus affinis propinquus* is the unbarred belly in the two forms.

113. CAPRIMULGUS CELEBENSIS Grant.

One male, Soemalata, September 6, 1914; one male, Kwandang, October 25, 1914.

The character of the length of the rictal bristles relied upon by Ogilvie-Grant to separate this from all other species of *Caprimulgus* does not hold true; they are just as long and heavy in *C. macrurus macrurus* and in *C. manilensis*. The present species resembles *C. manilensis* very much, the chief difference being that in the latter the white tip to the outer tail-feather does not extend across the outer web. I agree with Meyer and Wigglesworth⁹⁸ that both will eventually only be ranked as forms of *C. macrurus*, as has been done by Hartert⁹⁹ but not by Oberholser.¹

Family HEMIPROCNIIDAE.

TREE SWIFTS.

114. HEMIPROCNE WALLACEI (Gould).

One male, Likoepang, January 13, 1916.

Family MICROPODIDAE.

SWIFTS.

115. COLLOCALIA ESCULENTA ESCULENTA (Linnaeus).

One male and two females, Goenoeng Kalabat, April 9, 1916; one male, Koeala Prang, June 5, 1916; two males and two females, Toewo Mountain, Besoa, October 31, 1917.

The male from Koeala Prang (No. 249748) has the light spot at the base of the outer tail feather on the inner web much restricted and gray like the outer web (seen from below), only showing whitish along the shaft; on the next two feathers the white is more pronounced. It differs also from the other males as follows: the primaries and their coverts are largely dusky slate-violet; the wing-

¹ Proc. U. S. Nat. Mus., vol. 48, 1915, pp. 587-599.

⁹⁷ Proc. Biol. Soc. Wash., vol. 18, 1905, p. 85.

⁹⁸ Birds of Celebes, vol. 1, 1898, p. 321.

⁹⁹ Nov. Zool., vol. 13, 1906, p. 296.

coverts, secondaries, and scattering feathers on the back and head are tipped with a brighter violet; the tail is washed with violet. It is evidently an immature bird and is smaller than the other males. The remaining males are probably adult and are of a shining dusky dull bluish-green above; the wings and tails with a steely-blue cast in certain lights; the basal spot on the inner web of the outer tail feathers is pure white. Two of the females in color are precisely like the adult males, while two are like the immature male, except the basal spot on the inner web of the outer tail feathers is more pronounced, though reduced in size. This can hardly be due to immaturity as one taken at Besoa, October 31, has the outer tail feather and tips of the primaries worn while the other is one of the birds taken April 9. It may be that it takes more than a year to acquire the fully adult plumage. The males average larger than the females. The three adult males measure: Wing, 102–105 (103.5); tail, 37–43 (39.2); culmen, 3.5–4 (3.8). The four females measure: wing, 96.5–101 (98.9); tail, 37.5–40 (39.1); culmen, 3–4 (3.5). The immature male measures: wing, 94.5; tail, 37; culmen, 4.

From the above it would appear that some of the very small measurements accorded the wing by authors, along with normal measurements in the various forms of this genus, was due to the inclusion of immature specimens, as in most of the races the only way to tell the adults from birds of the year is by size.

I have been unable to compare the above series with any other specimens of the species.

These probably nest in holes in the rock on the slopes of the crater (Kalabat).—H. C. R.

116. *COLLOCALIA VESTITA AENIGMA* Riley.²

Two males and three females, Parigi, September 10, 1916; one male and two females, Gimpoe, August 1 and 29, 1917; one male and two females, Pinedapa, February 13 and 21, 1918.

The above series is very uniform in color. Four specimens of *Collocalia vestita vestita* from Java before me are olivaceous black No. 1 above; sooty hair brown below, the throats little lighter than the breast, while in *Collocalia vestita aenigma* the back is a shining black with little or no olivaceous sheen; the lower parts smoke gray, the chin and throat a silvery pale smoke gray or even whitish. The upper surface of the wings and tail in *Collocalia vestita aenigma* has a more deep dusky violet cast, not so olivaceous as in *Collocalia vestita vestita* from Java. There is apparently no difference in size. To *Collocalia vestita mearnsi* of the Philippines, the Celebes race is more closely related, but differs in being darker above, the wings externally with a more dusky violet gloss; below it is lighter, especially on the throat. The Celebes form is slightly larger.

² Proc. Biol. Soc. Wash., vol. 31, 1918, p. 156 (Parigi, Celebes).

Collocalia vestita aenigma belongs to the feathered-tarsi section of the genus, and in the above series I can only find three specimens that have the tarsi apparently bare, but the series is more or less in molt and some specimens that at first sight have this member apparently denuded when examined under a glass show one or two minute feathers. The three specimens above alluded to are so much like the rest of the series in every other way that this condition is probably due to loss by molt.

In the original description only the measurement of the type was given. The four males measure: Wing, 133-122 (117.9); tail, 46-50 (48); culmen, 4.5-5 (4.8); the seven females: wing, 112-120.5 (116.7); tail, 46.5-50.5 (48.6); culmen, 4-5 (4.6).

117. HIRUNDAPUS CELEBENSIS (Sclater).

One male (?), Ayermadidi, May 18, 1916.

The above specimen, though marked as a male is probably a female, as the lores are a dirty brown; the body a greenish black; a patch on the lower flanks and under tail-coverts white. It measures: Wing, 188, tail, 59; culmen, 9.5. The outer primary has been lost and is being replaced by a new one.

I have a specimen from Mindoro (topotype of *Chaetura dubia* McGregor) and two specimens from Basilan; they are probably all males, though the two latter are unsexed. I can detect no difference between the Mindoro and Basilan birds; both are a beautiful purplish black, the rump and back more sooty and inclining to brownish, the wings and tails steely black with purplish and greenish reflections, the lores, under tail-coverts, and lower flanks white, quite different from the Celebes specimen, but the latter is probably a female. There is an indication that the Philippine bird may prove to be racially different as all the measurements are greater than those indicated by Meyer and Wiglesworth³, in which case the Philippine race would stand as *Hirundapus celebensis dubia* McGregor.

The males available measure as follows:

	Wing.	Tail.	Culmen.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
No. 201931, male, Alag River, Mindoro-----	223	59	10.5
No. 192474 [male], Basilan Island-----	220	64	9
No. 192475 Do-----	215	63.5	9.5
Type of <i>Chaetura dubia</i> *-----	220	64	10
<i>Hirundapus celebensis</i> †-----	203	71	-----

* McGregor, Man, Philippine Birds, pt. 1, 1909, p. 359.

† Meyer and Wiglesworth, Birds Celebes, vol. 1, 1898, p. 330.

Gizzard very large and filled with the heads, wings, legs, etc., of insects, which were possibly flying ants.—H. C. R.

³ Birds of Celebes, vol. 1, 1898, p. 329.

Family CUCULIDAE.

CUCKOOS.

118. *SURNICULUS MUSSCHENBROEKI* Meyer.

One female, Likoepang, March 10, 1916.

The above specimen differs from Meyer and Wigglesworth's⁴ description of the type in having the outer tail-feather with five irregular white bars distally and two white spots along the shaft basally; the second tail-feather with four white spots along the shaft on one side of the tail and three on the other, being unsymmetrical in this respect; and the white concealed nuchal spot apparently larger. It measures: Wing, 124.5; tail, 128; culmen, 21.5.

Surniculus musschenbroeki in plumage comes nearer to *S. velutinus* of the Philippines than to *S. lugubris*, the only other known species of the genus. From *S. velutinus*, the Celebes bird differs in having the white on the nape more extensive; in the less brilliant color of the wings and tail; and in the tail being longer, the feathers broader, and of a different shape. The different shape of the tail of *S. velutinus* is more apparent than real, the two outer tail-feathers have the outer web broadened at the tip, showing a tendency to bend outwards. In the Celebes species when the tail is spread, it is seen not to be really forked but more or less truncate or slightly emarginate, with the second and third outer feather bent slightly outward.

Since writing the above Stuart Baker has published⁵ a review of the genus. In it he reduces *S. velutinus* to only a form of *S. musschenbroeki*. That they are closely related no one will deny, but the differences are such that they had better be recognized as distinct species for the present at least.

Mr. Raven in a letter says that the species is more or less nocturnal; this may account for its scarcity in collections.

119. *CACOMANTIS MERULINUS MERULINUS* (Scopoli).

One young male not long from the nest, Parigi, September 25, 1916.

120. *CACOMANTIS SEPULCRALIS VIRESCENS* (Brüggemann).

One male, Likoepang, March 5, 1916; one male, Rano Rano, December 10, 1917.

The male from Rano Rano has the breast and belly darker than the Likoepang specimen and the tips to the tail feathers buff, not white as in the latter. They measure as follows:

	Wing.	Tail.	Culmen.
	mm.	mm.	mm.
No. 251832, Rano Rano	116	135	15
No. 249144, Likoepang	107	135	16

⁴ Birds Celebes, vol. 1, 1898, p. 203.

⁵ Nov. Zool., vol. 26, 1920, pp. 291-294.

121. *LAMPROCOCYX MALAYANUS* (Raffles).

One female, Parigi, September 17, 1916, and one male, Toboli, October 25, 1916.

These belong to *Neochalcites* Mathews,⁶ but I do not see the advantage of recognizing it, though there are slight structural differences. *Lamprococcyx basalis*,⁷ when compared with *Lamprococcyx lucidus* (type of *Lamprococcyx* Cabanis and Heine), has the nostril of a different shape; more oval and nearly parallel with the tomium, *L. lucidus* has the feathers of the chin more bristly at the tips, and the bill is broader. The wing formula is practically the same. These differences are slight and hard to make out. Genera are largely matters of convenience or to emphasize lines of descent, and in the present case I can see no practical utility in recognizing *Neochalcites*.

122. *EUDYNAMIS MELANORHYNCHA* S. Müller.

A good series of adults and immature in various stages of plumage from the following localities: Soemalata, September 7, 1914; Kwandang, October 9, 1914; Likoepang, March 12, 1916; Manembo Nembo, June 23, 1916; Toemaratas, July 8, 1916; Laboea Sore, November 28, 1916; Koelawi, February 1, 1917; Rano Lindoe, March 8-19, 1917; Gimpoë, August 2-23, 1917; Pinedapa, February 5 and 21, 1918.

This series convinces me that Meyer and Wiglesworth's⁸ interpretation of the plumages of this species, except for the adult male, is erroneous. A young male, taken June 23, 1916, No. 249,652, is not long from the nest; the tail is about half grown and the bill is short and stubby, yet it is a shining blue black, above and below, only a little duller than the adult. Now, what I take to be the fully adult female, and it is so marked by the collector, is a greenish black above and on the fore neck, shading off into fuscous, with a metallic sheen on the chest, breast, and belly. From the foregoing it will be seen that the fully adult female resembles the adult male, but is duller, being a greenish black above and fuscous on the chest, breast, and belly, whereas the male plumage is a uniform bluish or purplish black, only slightly duller on the under parts. The next stage with greenish black backs and tails, dull black throats, and cinnamon-buff lower parts are immature females, approaching maturity and are marked as females by the collector, the specimens like the above but with bars below being only still younger. Birds with backs and tails barred rufous and black, with cinnamon-buff under parts barred with black, and chestnut throats are younger females, probably

⁶ Austral Av. Rec., vol. 1, 1913, p. 7.

⁷ Mathews makes his *Chrysococcyx basalis mellori* the type of *Neochalcites*, but subspecies do not differ structurally from the species.

⁸ Birds of Celebes, vol. 1, 1898, p. 205.

of the year, as some of the specimens in this stage have begun to assume the black heads and throats of the next plumage.

There is one specimen (No. 252550), Gimpoe, August 21, marked as a female, that does not fall into any of the above stages and I must confess that I do not know what to make of it. It is a bluish black on the back, tail, and fore neck; the breast and belly buffy barred with black; the old feathers of the wings (it is in molt) show a few hardly discernible rufous irregular cross bars, the new feathers are coming in bluish black. It resembles the male in the color of the back and tail, but not otherwise. If the bird is wrongly sexed and proves to be an immature male, it is still very remarkable, as I have already shown that the young male when it leaves the nest is a shining black like the adult. For a bird to acquire the adult dress and then retrograde would be rather unique. I must confess that I do not know how to interpret Meyer and Wiglesworth's description of the nestling, except that it must be a female and that the sexes differ widely in the immature plumage, even in the nestling, but approach each other in old age.

To recapitulate: The fully adult female resembles the adult male but is duller. The young male resembles the adult male from the nest up, while the young female has a distinctive immature dress and only acquires the fully adult plumage after successive molts covering a period of two or more years. The females breed in the immature plumage, that is the stage with greenish black backs, black throats, and cinnamon underparts, which is assumed in the second year, judging from the material in the collection. This would account for the rarity of fully adult plumages of the female in collections as they would be overbalanced by immature individuals and owing to the struggle for existence much fewer would ever live to assume it. There is nothing new in the above interpretations of the changes in plumage, except that the young male described above seems to me to be the key to the whole situation and to settle the matter, leaving no ground for further argument.

123. *SCYTHROPS NOVAEHOLLANDIAE* Latham.

One male and one female, Rano Lindoe, March 11, 1917; one immature unsexed, Lende, June 15, 1917.

The two adults when compared with Australian specimens have the backs less tinged with olive, and the top of the head a clearer gray. The Australian specimens are old and unsatisfactory and when new and larger series are compared the above differences might not hold.

The immature when compared with a specimen of about the same age from Cape York, Queensland, has the throat and top of head

a deeper buff; the back lacks the brownish tinge and the tips of the wing-coverts, secondaries, and primaries have the buff a deeper tint; the barring on the sides and flanks are more pronounced; the dark bars on the tail are more distinct and the buff of the notches deeper. The Australian specimen has been mounted and some of these differences may be due to exposure to light.

The series measures as follows:

Cat. No.	Sex.	Locality.	Wing.	Tail.	Bill from nostril.
71632	Male adult	Cape York, Queensland	<i>mm.</i> 361	<i>mm.</i> 286	<i>mm.</i> 58
145785	Adult	do	346	261	58
13920	do	Australia	365	270	71
250798	Male adult	Rano Lindoe, Celebes	360	273	74
250799	Female adult	do	336	251	65.5

124. *CENTROPUS BENGALENSIS SARASINORUM* Stresemann.⁹

Three males, five females, and one unsexed, from the following localities: Kwandang, October 26, 1914; Likoepong, February 20, March 2 and 9, 1916; Parigi, September 26, 1916; Toboli, October 25, 1916; Rano Lindoe, March 8 and 21, 1917; Lende, June 15, 1917.

The above series has been compared with a fair number from the Philippines, and a few specimens from Java and the Malay Peninsula. Birds from the latter three localities seem to agree in size and color, but those from Celebes are larger and do not seem to be quite so dark on the backs; the color differences are slight but that of size entitles the Celebes form to recognition.

The series at my command averages as follows:

	Wing.	Tail.	Culmen.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Three males, Celebes	151	192.7	26
Five males, Philippines	141.5	174.2	23.4
One male, Trong, lower Siam	139.5	151.5	25
One male, Banka, east Sumatra	138	149	24
Two females, Celebes	180	222.7	29
Six females, Philippines	160.7	192.1	26.6
Two females, Java	153.2	181.5	25.2
One female, west Malay Peninsula	169	198	27

125. *PYRRHOCENTOR CELEBENSIS CELEBENSIS* (Quoy and Gaimard).

Three males and three females from the following localities: Kwala Besar, July 29 and August 24, 1914; Tandjong Penjoe, February 19, 1915; Likoepong, March 9, 1916.

⁹ Nov. Zool., vol. 19, 1912, p. 338.

A female from Likoepang (No. 249137) has about half the lower mandible from the tip and the tip of the maxilla, horn color, but this is an indication that the bird is not fully adult.

Local name *Koeng Koeng*.—H. C. R.

126. *PYRRHOCENTOR CELEBENSIS RUFESCENS* Meyer and Wigglesworth.

One male, Laboea Sore, November 21, 1916; one male and one female, Koelawi, February 2 and 23, 1917; two females, Rano Lindoe, March 10 and 15, 1917; one male and one female, Gimpoe, August 12, 1917; two males, Pinedapa, January 22 and February 14, 1918.

Two specimens in the above series (Nos. 250804 and 251842) taken at Rano Lindoe, March 10, and Gimpoe, August 12, respectively, have the lower mandible wax yellow and the tip of the upper mandible horn color. A specimen taken at Koelawi, February 2, has the lower mandible darkened along the tomium and the remainder and extreme tip of the upper dusky horn color, while a specimen taken at Rano Lindoe March 15 (No. 250805) has only the tip of the lower and extreme tip of the upper mandible dusky horn color. From the above it would appear that the wholly black bill is only assumed by old birds.

Of the two birds taken at Koelawi, the female is more rufescent above, especially on the wing coverts, than any in the series, while the male is much lighter below than any other specimen of the form before me, approaching specimens of *Pyrrhocentor c. celebensis* but still not quite so light below.

Specimens taken at Laboea Sore, November 21, Koelawi, February 23, Rano Lindoe, March 15, and Pinedapa, January 22 and February 14, are molting on the head, wings, and tail, but more especially on the top of the head. The new feathers on the forehead are much darker than those they displace or after the molt is completed. One specimen (No. 251845), Pinedapa, February 14, has the primaries and tail very dark, the exposed part of the closed wings nearly the color of the back, but this seems to be due to stain as the unexposed part of the wings are of the usual color and there are signs of stain at the base of the tail.

When compared with specimens from the north end of the island the above series averages more rufescent on the underparts and sides of face; above there do not appear to be any striking constant differences.

127. *RHAMPHOCOCCYX CALORHYNCHUS CALORHYNCHUS* (Temminck).

Six males and eight females from the following localities: Kwala Besar, July 29, 1914; Paleleh River, August 8, 1914; Tandjong Penjoe, February 16–20, 1915; Likoepang, March 4, 1916; Toemaratas, July 10, 1916.

This series is fairly uniform, though some specimens are lighter than others; but judging from the color of the bill and compressed condition of the lower mandible, forming a sharp ridge on the gonys, these are birds of the year or not fully adult. One specimen (No. 248,390) from Kwala Besar is without the whitish tip to the upper mandible and in four others in the series it is reduced to such a minute point as to be practically absent.

In describing *Rhamphococcyx centralis*,¹⁰ I referred two specimens from Parigi to *Rhamphococcyx c. calorhynchus*. They are birds of the year as attested by the base of the lower mandible being blackish and one of the birds having the top of the head strongly washed with cinnamon-rufous. Comparing them with *R. c. centralis* of equal age they are darker on the throats and have smaller bills and the other measurements are decidedly smaller. They are lighter than northern specimens of *R. c. calorhynchus*, and as there are undoubted specimens of *R. c. centralis* from the same locality I now think I was in error and they had better be placed with the Middle Celebes form, on geographic grounds, especially as they are immature birds. As a matter of fact they are more or less intermediate and would seem to indicate that the two forms intergrade on the borders of their respective ranges.

128. RHAMPHOCOCCYX CALORHYNCHUS CENTRALIS Riley.¹¹

Five males and ten females from the following localities: Parigi, September 10 and 19, 1916; Laboea Sore, November 21 and December 1, 1916; Rano Lindoe, March 21, 1917; Gimpoë, August 12, 1917; Pinedapa, January 11–February 15, 1918.

This race differs from *Rhamphococcyx c. calorhynchus* as follows: In larger and more arched bill; longer wing; the top of the head lighter; in the lighter color of the throat, chest, and mantle; and in less purplish wings and tail.

It might be that I have only redescribed *Rhamphococcyx calorhynchus meridionalis* Meyer and Wigglesworth but they say¹² that the only difference between their bird and the one from the north is the lighter color of the top of the head. Hartert,¹³ however, in commenting on birds from Indrulaman says: "differ considerably from the bird from northern Celebes in having a much paler crown and a decidedly paler throat and it seems that also the tail as about half an inch longer." He says nothing about the larger and more arched bill, or longer wing, so the only course left to me for the

¹⁰ Proc. Biol. Soc. Wash., vol. 31, 1918, p. 156.

¹¹ *Rhamphococcyx centralis* Riley, Proc. Biol. Soc. Wash., vol. 31, 1918, p. 156 (Rano Lindoe, Celebes).

¹² Birds of Celebes, vol. 1, 1898, p. 227.

¹³ Nov. Zool., vol. 3, 1896, p. 160.

present is to list my birds under the above name until we know more about the distribution and relationship of these large cuckoos.

In the original description of the above form I identified two immature specimens from Parigi as belonging to *Rhamphococcyx c. calorhynchus*. This I am now convinced was an error and that they are really more or less intermediate between the two forms; accordingly, I have reduced my supposed species to a race.

A female taken at Pinedapa, Jan. 11, 1918, contained eggs with soft shells. Feet and tarsus black; skin about eyes black; tip of upper mandible with no color pigment for 5 mm., then black for 10 mm., then chrome yellow, which extends about 100 mm., gradually becoming sulphurous yellow; space near nostril and lower mandible, red.—H. C. R.

Family PICIDAE.

WOODPECKERS.

129. YUNGIPICUS TEMMINCKI (Malherbe).

A male and female, Likoepang, March 9, 1916; two males and one female, Toewo Mountain, Besoa, October 28–November 3, 1917; two males and one female, Rano Rano, December 12–22, 1917.

130. LICHTENSTEINIPICUS FULVUS FULVUS (Quoy and Gaimard).

A good species from: Paleleh River, August 17, 1914; Kwandang, October 8, 1914; Paleleh, November 10–13, 1914; Toli Toli, November 25–December 3, 1914; Tandjong Penjoe, February 17–20, 1915; Likoepang, January 18, and March 2–12, 1916; Koeala Prang, June 3–15; Manembo Nembo, June 24, 1916; Toemaratas, July 3, 1916.

A specimen (No. 249656) marked as a female, from Toemaratas, July 3, has a band of scarlet tipped feathers on the forehead; it is apparently an adult bird as it shows no indication of immaturity, indeed the plumage is somewhat worn below. It seems to indicate that very old females develop a few red feathers on the forehead.

A few specimens of either sex develop light spots to the tips of the feathers of the chest which apparently are soon worn off and some even have small light spots on the mantle; the latter variation being rarer than the first.

131. LICHTENSTEINIPICUS FULVUS INTERMEDIUS (Meyer).¹⁴

A good series from the following localities: Parigi, September 20, 1916; Toboli, October 21, 1916; Laboea Sore, November 28, 1916; Rano Lindoe, March 14–16, 1917; Tamboe, June 13, 1917; Gimpoe, August 4–27, 1917; Toewo Mountain, Besoa, November 1, 1917; Rano Rano, December 8–19, 1917; Pinedapa, February 6, 1918.

¹⁴ *Microstictus intermedius* Meyer, Notes Leyden Museum, vol. 23, 1901, p. 186 (Gimpu).

The males of this series differ from *L. f. fulvus* in the greater extension of the red of the head on to the nape and cheeks; the females by the darker tails.

I have no specimens of *L. f. wallacci* for comparison. Two males of the above series (Nos. 251906 and 251909), from Rano Rano and Gimpoë, respectively, have the red confined to the forehead and crown, not reaching down on the sides of the face as far as the eye; they are evidently immature. The Gimpoë specimen is the younger (taken August 4) and has the breast and chest avellaneous, while in the older specimen it is like the adult.

Family PITTIDAE.

PITTAS.

132. PITTA CELEBENSIS Müller and Schlegel.

One male, Temboan, July 24, 1916; one female, Pinedapa, February 21, 1918.

In some particulars the specimen taken at Temboan does not agree with Meyer and Wigglesworth's¹⁵ description. It lacks the blue vertical stripe and neck collar; the new feathers on the crown are very dark, almost black, edged with morocco red; the nape is brazil red; the black jugular patch shows a whitish central spot, caused by the bases of the feathers showing through the black; the dark pectoral band is *not* black but taupe brown. The bird is molting but in apparently adult plumage. It measures: Wing, 104; tail, 38.5; culmen, 20; bill from nostril, 14.5. The Pinedapa specimen is apparently a much younger bird than that from Temboan, or there is a difference in the sexes. It is a much lighter red on the breast and belly; the white center to the black jugular spot is more pronounced; the crown is lighter, chestnut not blackish; the blue vertical stripe and neck band are present; the chin and cheeks lighter, light russet vinaceous, not vinaceous russet; the dark pectoral band is very narrow, almost obsolete. It measures: Wing, 102; tail, 40; culmen, 20; bill from nostril, 14.5. The Temboan specimen has had the skin badly broken on the top of the head and cleverly mended by the collector, this may account for the absence of the blue vertical stripe, but would not account for the other differences.

133. PITTA FORSTENI (Bonaparte).

One female, Temboan, August 1, 1916.

It measures: Wing, 114; tail, 46; Culmen, 25; bill from nostril 16.5.

¹⁵ Birds of Celebes, vol. 1, 1898, p. 340

Family HIRUNDINIDAE.

SWALLOWS.

134. HIRUNDO RUSTICA GUTTURALIS Scopoli.

A fair series of both sexes and immature from: Toli Toli, December 12 and 17, 1914; Parigi, September 24–October 5, 1916; Dolo, December 25 and 26, 1916; Rano Lindoe, March 10–27, 1917; Napoe, Watoetaoe, November 20, 1917.

135. HYPUROLEPIS JAVANICA FRONTALIS (Quoy and Gaimard).

A fair series from the following localities: Toli Toli, November 28, 1914; Koeala Prang, June 17 and 18, 1916; Parigi, September 28, 1916; Toboli, October 17 and 21, 1916; Manilili, December 16, 1916.

This series averages darker on the forehead and throat than Javan birds, but the breast and belly appear lighter; there is little or no difference in size. Birds from the Philippines, Borneo, the coast of the Malay Peninsula, the Anambas, and the Mergui Archipelago appear to be much like those from Celebes in color, allowing for individual variation, but have a longer wing, and belong to the form named by Oberholser¹⁶ *Hypurolepis javanica abbotti*, with the range expanded. It is true the type of the latter has the throat a little darker and of a somewhat different shade than any in the series from the Philippines or elsewhere but the difference is slight and besides it is in freshly acquired plumage, before fading has set in; a specimen from Borneo (No. 178118) closely approaches it. I have no specimens from the type locality of *H. j. frontalis* for comparison but as the Celebes bird apparently does not belong to the Javan race or the one to the north there is nothing left to do but follow precedent¹⁷ in the matter and refer it to the southern race for the present. Of *Hypurolepis javanica domicola* of peninsular India, I am not able to speak, having no specimens.

	Wing.	Tail.	Culmen.
	mm.	mm.	mm.
One male, Java.....	105.5	47.5	9.5
Nine males, Celebes.....	104.3	45.9	9.3
Four males, Philippines.....	108.4	47.6	9.1
Two males, Borneo.....	107.2	42	9
Two males, Anambas.....	109	45.7	8.7
One male, east coast Malay Peninsula.....	110	46.5	9
Three males, Mergui Archipelago.....	109.7	46.3	9
One female, Java.....	102	42.5	8.5
Six females, Celebes.....	104.6	45	8.9
Five females, Philippines.....	106.4	47.5	9.1
One female, Borneo.....	107	47	9
Three females, west coast Malay Peninsula.....	106.7	43.3	8.8
Two females, Mergui Archipelago.....	108.2	46	9

¹⁶ Bull. U. S. Nat. Mus. No. 98, 1917, p. 32.

¹⁷ See Oberholser, Bull. U. S. Nat. Mus. No. 98, 1917, p. 33.

Family MUSCICAPIDAE.

FLYCATCHERS.

136. *CYORNIS BANYUMAS OMISSA* (Hartert).

A small series of adults and young of both sexes from: Koelawi, February 23, 1917; Rano Lindoe, March 6-23, 1917; Toewo Mountain, Besoa, October 31-November 4, 1917.

I have been able to compare the above series with an adult male and female from Java and the birds from the two islands are quite distinct. In the male of the Javan form (*Cyornis banyumas banyumas*) the line on the forehead and over the lores is very light blue, while in the Celebes bird it is much deeper. The black on the chin is narrower, the lores deeper, and the ear coverts darker in the Javan form. The belly is whitish in the Javan male while in none of the Celebes specimens is it so; the lower parts are also deeper in the latter. The female of *Cyornis banyumas omissa* in the color of the back, wings, and tail, is only a lighter duller blue, than the male, while in the female of the Javan race the back is deep olive, the wings edged with buffy brown, the tail and upper tail-coverts cinnamon-brown. There are other differences, but the above is sufficient to show that the two races are very distinct and it is doubtful if they should only be recognized as forms instead of distinct species. However, out of deference to Hartert's¹⁸ opinion, such an arrangement will show their relationship better and is retained.

An immature in the spotted plumage of about the same size as the adult was taken November 4, and two additional immatures that have begun to assume the adult plumage were taken March 6 and 21. Judging from the above more than one brood must be raised in a season, and the breeding period extends over a considerable part of the year.

Averages.	Wing.	Tail.	Culmen.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Six males, <i>Cyornis b. omissa</i> -----	74. 8	59. 7	13. 3
Three females, <i>Cyornis b. omissa</i> -----	72. 8	57. 5	12. 5
One male, <i>Cyornis b. banyumas</i> -----	73. 5	58. 5	13. 5
One female, <i>Cyornis b. banyumas</i> -----	70. 5	56. 5	12. 5

137. *CYORNIS HOEVELLI* (Meyer).¹⁹

A small series of adults and immature of both sexes from Goenoeng Leho, January 13-19, 1917; Toewo Mountain, Besoa, November 1, 1917; Rano Rano, December 10-27, 1917.

¹⁸ Nov. Zool., vol. 8, 1901, p. 53.

¹⁹ *Siphia hoevelli* Meyer, Notes Leyden Mus., vol. 23, 1903, p. 186 (Takala Mountains, Celebes).

As Meyer's original description of this rare and very distinct species is in Dutch, it has been thought advisable to give a description in English: Head all round, including the foreneck, dusky slate blue; across the forehead and the superciliary as far as the posterior border of the eye, a slightly brighter blue; chin, feathers covering the nostril, and lores, black; back and upper wing coverts, brownish olive with a russet wash on the rump; longer upper tail coverts and upper surface of the tail, argus brown, rectrices shading at the tip to sepia; remiges, chaetura drab, margined externally with raw umber, the tertials wholly of that color; under wing coverts, breast, abdomen, and crissum, ochraceous tawny, this color extending up each side slightly beyond the rounded border of the blue of the jugulum; remiges below, hair brown, bordered where they rest against the sides of the body with cinnamon; under surface of tail, sepia.

The female differs from the male in having the pileum deep neutral gray; the frons and lores ochraceous buff, the ear coverts and sides of neck lighter gray than the pileum and washed with ochraceous buff, middle of throat and jugulum ochraceous buff. Another female (No. 251,927) in the collection has the pileum deep payne's gray.

Young birds about the size of the parents, but in spotted plumage, were taken November 1 and December 24-27. One of these taken December 27 already has a few blue feathers appearing on the jugulum and a few feathers of the adult plumage appearing on the chest. An immature male taken at Goenoeng Lechio January 14 has nearly assumed the adult dress; the head is blue with only the chin ochraceous buff and a few tawny spots on the forehead and along the superciliary; the back still has a few tawny black-tipped feathers, and the breast and abdomen a few narrow black spots. From the above it will be seen that the males molt directly into the adult plumage and at an early date after leaving the nest.

In the quite extensive series of males in the collection there is little variation in color; in some the blue is slightly lighter than others. The principal variation seems to be in the width of the lighter blue of the forehead and superciliary; in some specimens it is quite extensive on the forehead, while in others it is much reduced.

The present species is closely related to *Cyornis hyacinthina* of Timor and *kühni* of Wetter in structure, but in coloration is unique in the genus, so far as is known at present.

The measurement of the series, exclusive of the immatures, is given below to show the variations:

Museum	Sex.	Locality.	Wing.	Tail.	Culmen.
			<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
251113	Male	Goenoeng Lehio	88	69	15.5
251115	do	do	86	70	13.5
251980	do	Besoa (Toewo Mountain)	87.5	72	13.5
251982	do	Rano Rano	89.5	70	15
251983	do	do	89	69.5	13.5
251984	do	do	87	68	14
251985	do	do	85	65	13
251989	do	do	88	73	13.5
251991	do	do	86.5	70.5	13.5
251992	do	do	85.5	65.	13
251116	Female	Goenoeng Lehio	82	65.5	13
251987	do	Rano Rano	87	64.5	14

138. POLIOMYIAS MUGIMAKI (Temminck).

Two males and one female, Rano Rano, December 11-18, 1917.

I can not find that this species has been recorded from Celebes before.

Stresemann²⁰ places the above in *Erythrosterina* Bonaparte of which *Muscicapa parva* Bechstein is the type, but I do not think he will be generally followed in so doing.

139. DENDROBIASTES RUFIGULA (Wallace).

One male, Koelawi, February 6, 1917.

This specimen measures: Wing, 63.5; tail, 46.5; culmen, 13.55 mm. It does not agree exactly with Meyer and Wiglesworth's²¹ description; the throat and breast are not bright rufous but more of an ochraceous-orange, shading off on the sides into a lighter color; the middle of the lower breast, the belly, and under tail coverts white.

140. DENDROBIASTES HYPERYTHRA JUGOSAE Riley²²

A good series from: Goenoeng Kalabat, April 9-10, 1916; Goenoeng Lehio, January 15-19, 1917; Rano Rano, December 9-28, 1917; Toewo Mountain, Besoa, November 4, 1917.

The above race is similar to *Dendrobiastes hyperythra vulcani* Robinson, of Java, but averages lighter above; the belly with more white; wing longer. Wing, 62; tail, 43; culmen, 10 mm.

The female is even more different than the male. The back is more brownish-olive; the superciliary and lower parts more of a clay color, not light brownish-buff; edgings of the remiges darker than in the Javan form.

²⁰ Nov. Zool., vol. 19, 1912, p. 325.

²¹ Birds of Celebes, vol. 1, 1898, p. 372.

²² Proc. Biol. Soc. Wash., vol. 34, 1921, p. 561 (Goenoeng Lehio, Celebes).

In all the forms of this species examined by me the males are similar, but judging from the females of the only two forms in which I have been able to examine this sex the differences are quite noticeable. The female of the Javan form has the pectoral band very pronounced with the throat and superciliaries much lighter, while in that from Celebes the superciliaries are of about the same color as the throat which is scarcely or not lighter than the chest. A single male from Kina Balu, Borneo, is lighter above and much lighter below than any specimen of the several forms before me and probably represents a distinct form.

Three young in the spotted plumage, not long from the nest, with stumpy tails, were taken at Rano Rano, December 13-18; a young bird, considerably older, taken at Goenoeng Kalabat, April 9, though marked female is undoubtedly a male and is assuming the plumage of the adult. Some dark-blue feathers are appearing amongst the sooty ones of the back; the superciliary is only indicated by buffy bases to some of the feathers; the throat and fore-neck light pinkish cinnamon, the dark mentum barely indicated; the chest much deeper than the throat, the feathers margined with sooty, giving a mottled appearance; the rest of the plumage is much as in the adult, except that the feathers of the sides are narrowly edged with dusky. The chief interest of this specimen is that it shows that the adult plumage is assumed soon after leaving the nest.

The series before me average as follows:

	Wing.	Tail.	Culmen.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Ten males, <i>D. h. jugosae</i>	61. 8	41. 8	9. 8
Four males, <i>D. h. vulcani</i>	57. 7	41	9. 7
Two males, <i>D. h. annamensis</i>	62. 7	45	10
One male, Kina Balu, Borneo.....	56. 5	39. 5	10
Nine females, <i>D. h. jugosae</i>	58. 8	39. 3	9. 3
Four females, <i>D. h. vulcani</i>	56. 9	40	9. 2

141. MUSCICAPULA MELANOLEUCA WESTERMANNI Sharpe.

One male, Goenoeng Kalabat, April 10, 1916.

It measures: Wing, 58; tail, 41; culmen, 9 mm.

142. GERYGONE FLAVEOLA Cabanis.

One female, Kwandang, September 15, 1914; one male, Toli Toli, December 6, 1914; three females, Koelawi, January 27-February 10, 1917; one male, Rano Lindoe, March 29, 1917; one female, Rano Rano, December 29, 1917.

Meyer and Wiglesworth²³ in their description do not refer to the dark subterminal tail-band, but it is mentioned by Sharpe²⁴ and well

²³ Birds of Celebes, vol. 1, 1898, p. 388.

²⁴ Cat. Birds Brit. Mus., vol. 4, 1879, p. 214, pl. 5, fig. 2.

shown in his plate. It may be that the birds from the north and central part of the island are different from those of the south, but I have none of the latter for comparison. Hitherto the species has only been found in the south and central part of the island. The series measures as follows:

Cat. No.	Sex.	Locality.	Wing.	Tail.	Culmen.
248706	Male	Toli Toli	54	38	10.5
251137	do	Rano Lindoe	52	35	10
248705	Female	Kwandang	52.5	35	10
251134	do	Koelawi	50	34.5	10.5
251135	do	do	55	36	10
251136	do	do	51.5	35	10
252000	do	Rano Rano	55	40	9

143. HYPOTHYMIS PUELLA PUELLA (Wallace).

A fine series of both sexes and immature from: Paleleh River, August 17, 1914; Kwandang, September 15-19, 1914; Kapas Bay, November 19, 1914; Toli Toli, December 3-19, 1914; Tandjong Penjoe, February 19, 1915; Teteamoet, February 3, 1916; Likoe pang, March 4-12, 1916; Ayermadidi, April 1-4, 1916; Pulo Lembeh, June 13, 1916; Manembo Nembo, June 22, 1916; Rano Lindoe, March 7-21, 1917; Gimpoe, August 3-24, 1917; Pinedapa, February 2-4, 1918.

This series shows quite a little variation, some specimens being a much deeper blue than others, but this condition does not seem to be geographic as both styles occur at the same locality. An immature taken at Gimpoe, August 11, has the back fuscous; a narrow dusky drab band across the chest; breast and abdomen whitish; the pileum, cheeks, and throat, slate blue; wings chaetura drab, the lesser wing-coverts bluish; tail chaetura drab with a bluish tinge.

The type of *Myiagra puella* Wallace²⁵ came from Celebes, as stated by the describer, not from the Sula Islands as stated by Meyer and Wigglesworth²⁶; the bird of the latter group has been separated by Hartert²⁷ as *Hypothymis puella blasii*.

144. RHIPIDURA TEYSMANNI Büttikofer.

A small series of both sexes and young from: Toemaratas, July 9, 1916; Goenoeng Lebio, January 20, 1917; Koelawi, February 23, 1917; Lindoe Trail, February 25-27, 1917; Rano Lindoe, March 23, 1917; Toewo Mountain, Besoa, October 27-November 4, 1917; Rano Rano, December 12-23, 1917.

²⁵ Proc. Zool. Soc., 1862, p. 340.

²⁶ Birds of Celebes, vol. 1, 1898, p. 378.

²⁷ Nov. Zool., vol. 5, 1898, p. 131.

The birds of this series do not agree with the original description²⁸ or that of Meyer and Wigglesworth.²⁹ The forehead and flanks are much lighter than the rump and base of tail, which is described as cinnamon-red; the white of the throat is continued back beneath the auriculars in a narrow line; the black on the jugulum is a rather large blotch, not a narrow bar, and the feathers on the lower border of this black blotch are tipped with white, forming a rather large spot. It may well be that this is not true *R. teysmanni*, which has only been found in south Celebes, until quite recently, while the above series is from the north and north-central part of the island. Meyer³⁰ has reported it from central Celebes without definite locality.

A young female not long from the nest, with a short stumpy tail, taken at Toewo Mountain, October 28, resembles the adult, except the colors are lighter and the black jugular spot is lacking, its place being taken by a mouse gray band, washed with buffy.

The black jugular blotch first appears as a narrow band below the white of the throat and gradually increases in size as the bird ages, the white tips only appearing when it becomes fully adult. The unspotted condition of the young in this genus would seem to indicate that it is wrongly placed in the family Muscicapidae, or that the spotted condition of the young is not a family character.

Nine adult males measure as follows: wing 70–76 (73.5); tail, 77–84 (81.6); culmen, 9.5–11.5 (10.7); and four adult females: wing, 66.5–69 (67.4); tail, 76–80 (78); culmen, 9.5–10 (9.9).

From the above the female appears to be smaller and is slightly duller in color.

145. *CULICICAPA HELIANTHEA HELIANTHEA* (Wallace).

A good series of both sexes: Paleleh River, August 10, 1914; Ayermadidi, April 4, 1916; Goenoeng Kalabat, April 6 and 10, 1916; Toemaratas, July 6–8, 1916; Goenoeng Leho, January 19, 1917; Koelawi, February 23, 1917; Lindoe Trail, February 25, 1917; Rano Lindoe, March 9–14, 1917; Toewo Mountain, Besoa, October 26–November 4, 1917; Rano Rano, December 17, 1917.

The birds from the north in the above series when compared with a series from the Philippines show the latter to represent a recognizable race; the Celebes birds are more yellowish and the Philippine specimens have more of a greenish cast to the upper surface; below there seems to be little if any difference. The Celebes series averages a little larger. The name for the Philippine form is, apparently, *Culicicapa helianthea panayensis* (Sharpe).³¹

²⁸ Notes Leyden Mus., vol. 15, 1893, p. 80.

²⁹ Birds of Celebes, vol. 1, 1898, p. 380.

³⁰ Notes Leyden Mus., vol. 23, 1903, p. 189.

³¹ *Xantholestes panayensis* Sharpe, Trans. Linn. Soc. Lond., ser. 2. Zool., vol. 1, 1877, p. 327.

The birds from central Celebes when compared with the northern birds are duller, more greenish above, especially on the pileum. It may be there is more than one form of this species in Celebes, or the differences may be seasonal; for the present I prefer to adopt the latter supposition.

Averages.	Wing.	Tail.	Culmen.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Four males, north Celebes.....	62	50.7	11.2
Six males, central Celebes.....	59.1	48.7	10.4
Six males, Philippines.....	56.8	47.2	9.3
Five females, north Celebes.....	57.3	46.8	10
Five females, central Celebes.....	56.5	46.8	9.5
Two females, Philippines.....	56.5	42.5	9

146. *EUMYIAS SEPTENTRIONALIS SEPTENTRIONALIS* (Büttikofer).

Two males and one female, Toemaratas, July 5-9, 1916; one female, Goenoeng Lehiu, January 17, 1917; one male, Toewo Mountain, Besoa, November 3, 1917; one male, Rano Rano, December 19, 1917.

The two males from central Celebes appear to be slightly darker with smaller bills than the two northern males. The series is too small to arrive at any definite conclusions, and for the present I prefer to keep them under one name.

Stresemann³² makes the Philippine (*E. panayensis*, *E. nigrimentalis* and *E. nigriloris*), Celebes (*E. septentrionalis* and *E. meridionalis*), the Ceram (*E. harterti*), and Obi (*E. obiensis*) species, races of *E. panayensis*, an arrangement which in my judgment is not correct. Of *E. panayensis* I have seen no specimens, but of the other two Philippine species I have good series and they are so different from the Celebes forms that it is doubtful if they are more closely related than being derived from the same stock. True, the Celebes forms probably reached the island from the Philippines, but this has been at so remote a period of time and the differences are so great that their subspecific relationship is purely speculative. Judging from descriptions (no specimens of *E. meridionalis* have been examined) the two Celebes birds are only forms of one another and should be treated as such. *E. panayensis obiensis* (Hartert) and *E. panayensis harterti* (van Oort), are made races of the Philippine species by the describers, but this, speaking geographically, can not well be so, if we recognize the Celebes forms as specifically distinct. They are, judging from descriptions alone, closely related to the Celebes forms of which they are probably only races.

³² Nov. Zool., vol. 21, 1914, p. 127.

Oberholser³³ argues that *Stoporala* Blyth, 1845 (type *Muscicapa melanops* Vigors) is not preoccupied by *Stoparola* Blyth, 1836 (type *Stoparola luctuosa*=*Muscicapa atricapilla* Linnæus), but as it seems that the one-letter rule has not been universally adopted or consistently used even by those who have evoked it to make some change, it would be better to continue to use a name of certain application, in this case *Eumyias* Cabanis.

The above series measures as follows:

Cat. No.	Sex.	Locality.	Wing.	Tail.	Culmen.
			<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
249858	Male	Toemaratas	73	54	10
249856	do	do	72.5	53	10
251998	do	Besoa	71.5	52.5	9.5
251999	do	Rano Rano	71	51.5	9
249857	Female	Toemaratas	68.5	52	10
251112	do	Goenoeng Leho	70	54	9

Family CAMPEPHAGIDÆ.

CUCKOO-SHRIKES.

147. *GRAUCALUS BICOLOR* (Temminck).

One male, Kwandang, October 7, 1914; one male, Likoe pang, February 28, 1916; one female, Tamboe, June 13, 1917; one male and one female, Pinedapa, February 7 and 21, 1918.

The male taken at Pinedapa, February 21, differs from the Likoe pang male in having the feathers of the chest narrowly edged with black, forming a poorly defined band; it appears to be adult.

Aside from the larger size and presence of white at the extreme base of the tail-feathers, the bills in the above species are bluish-slate, lighter at the tip as a rule, especially in the female, as contrasted with the dull black (in the skin) bills in both sexes of *Graucalus leucopygius*. The specimen from Tamboe has the whole culmen horn color.

Bill slaty-blue, lighter at the tip and along the edges of the mandibles—
H. C. R.

148. *GRAUCALUS LEUCOPYGIUS* Bonaparte.

A good series of both sexes from: Paleleh, August 1, 1914; Soemalata, September 4 and 8, 1914; Kwandang, September 16–October 9, 1914; Kapas Bay, November 22, 1914; Toli Toli, December 4, 1914; Tandjong Penjoe, February 20–26, 1915; Likoe pang, January 16–March 12, 1916; Koeala Prang, June 4–14, 1916; Parigi, September 25, 1916; Toboli, October 25, 1916; Manilili, December 16, 1916; Rano Lindoe, March 8, 1917; Tamboe, June 13, 1917; Gimpoë, August 12, 1917.

³³ Proc. Biol. Soc. Wash., vol. 32, 1919, p. 47.

149. *GRAUCALUS TEMMINCKI TEMMINCKI* (S. Müller).

One male, Paleleh River, August 16, 1914.

Of a much deeper blue than the form listed below, with the bill of a different color; dusky horn-color at the tip for about half its length. The bill is also smaller. It measures, wing, 151.5; tail, 145.5; culmen, 23. The different color of the bill is due, evidently, to immaturity.

150. *GRAUCALUS TEMMINCKI TONKEANUS* (Meyer).⁸⁴

A good series of both sexes from: Lindoe Trail, February 26, 1917; Rano Lindoe, March 9, 1917; Toewo Mountain Besoa, October 27–November 3, 1917; Rano Rano, December 11–26, 1917.

The above series is uniformly of a much lighter blue and have larger bills than the single specimen of *Graucalus temmincki temmincki*. The immature has the tips of the tail feathers and inner remiges edged with white, and the tip of the bill horn color. Judging from this, the Paleleh specimen (*G. t. temmincki*) is not fully adult. The above series may not belong to *G. t. tonkeanus*, as no specimens from the type locality are available to me for comparison, but they agree with the description.

Five males measure: Wing, 161–171 (165.2); tail, 143–161 (152.7); culmen, 25–27 (26), and 12 females: Wing, 155.5–168.5 (162.3); tail, 143.5–164 (153.7); culmen, 24–26.5 (25.4).

151. *EDOLISOMA MORIO MORIO* (S. Müller).

A small series of both sexes from: Kwandang, September 16, 1914; Likoe pang, February 24–March 12, 1916; Ayermadidi, May 4, 1916; Laboea Sore, November 24, 1916; Rano Lindoe, March 14–21, 1917; Gimpoë, August 4–10, 1917; Toewo Mountain, Besoa, October 29, 1917.

I can detect no differences between the females from the extreme northern end of the island and those from the region in the vicinity of Lake Lindoe.

Males with the whole throat and chest blackish, apparently acquire this plumage at the first breeding season as two males from Likoe pang still show signs of immaturity, though the throats and chests are blackish, in fact one (No. 249274) is the most highly developed in this respect of any bird in the series, yet the under wing coverts are cinnamon; the other (No. 249273) has in addition to the cinnamon under wing coverts some buff and black-barred feathers on the breast, yet the throat and chest are blackish. A male from Rano Lindoe, March 21 (No. 251043), has only the chin, lores, and auriculars black, the remainder of the lower parts

⁸⁴ Notes Leyden Mus., vol. 23, 1903, p. 187 (Tonkean).

being only a little darker than the back, except the throat which shades off into dark slate; it is the grayest specimen in the series, but is approached by another male from Gimpoë. Perhaps they are intermediates. This seems very probable, as a specimen from Tobea Island, Buton Strait, resembles a specimen of the gray-breasted type from Gimpoë, but is not as gray as the specimen from Rano Lindoe mentioned above. Two other males from Gimpoë are as dark as the extreme northern birds, however. It would appear as if the gray-breasted birds are the old males.

Van Oort³⁵ has shown that the type locality of *Ceblepyris morio* S. Müller is northern Celebes (Tondano and Gorontalo) and names the southern form *Edoliisoma morio wiglesworthi*.

Genus CELEBESIA Riley.³⁶

The original description was as follows:

Similar to *Malindangia* Mearns but bill proportionally narrower (width just forward of the nostril equal to the depth instead of broader); fifth primary (counting from the outside shorter than the third instead of longer; rectrices more rounded; plumage not so soft in texture; and color pattern different.

To the above original diagnosis I would like to state that in *Malindangia* the tail about equals the wing in length, while in the above genus it is quite a little shorter.

Type and only known species the following:

152. CELEBESIA ABBOTTI Riley.³⁷

Seven males and four females, Rano Rano, December 9-27, 1917. The original description is as follows:

Upper parts, including the lesser wing coverts, slate gray; lores, superciliary, auriculars and throat, deep shining black; remaining under parts, white; wings (except the lesser coverts) black, the feathers edged outwardly with the color of the back; bend of wing blackish; under wing coverts, white; middle tail feathers slightly darker than the back with an irregular line along the shaft towards the tip and shaft black; remaining tail feathers blackish, the three outer with a subterminal band of deep neutral gray, widest on the outer and almost disappearing on the third, all the tail feathers narrowly bordered at the tip with white, this almost obsolete as the middle feathers are approached; thighs black. Wing, 114; tail, 87; culmen, 20; tarsus, 25.5; middle toe, 17.5 mm.

The females only differ from the males in having the face and throat slate gray instead of shining black.

There is some slight variation in the series of males. The black shaft line on the middle tail feathers is much narrowed or confined to the shaft; the dark gray subterminal tip on the three outer tail feathers and the narrow white terminal edging are much reduced or

³⁵Notes Leyden Mus., vol. 29, 1907, p. 77.

³⁶Proc. Biol. Soc. Wash., vol. 31, 1918, p. 158.

³⁷Idem, p. 158.

nearly obsolete; the tail feathers next to the central pair with the outer webs bordered with and having a subterminal border of slate gray; and the gray edging to the remiges is more developed in some specimens than others.

In some lights the top of the head and mantle appear to be darker than the rump, in other positions this difference is scarcely noticeable. This effect seems to be produced by a sheen seen in certain lights; it is hardly what is usually called iridescent.

When I described this genus it was compared with *Malindangia* Mearns, but I neglected to compare it carefully with *Edolisoma*, as the color pattern was so different. Comparing it with the latter, the rectrices are more pointed; the bill longer and proportionally more slender; and the texture of the throat more silky. In fact, in structural details, *Celebesia* seems to be nearly intermediate between *Malindangia* and *Edolisoma* with leanings perhaps towards the latter. Nevertheless, *Celebesia* evidently represents *Malindangia* in the highlands of Celebes.

Most of the specimens of *Celebesia abbotti* before me have the primaries more or less in process of molt, and it is rather difficult to determine the true wing formula.

In the original description only the measurement of the type was given and the length of tail inadvertently given incorrectly. Below the extremes and averages of the above series are given: The (seven) males—wing, 105.5–114.5 (109.6); tail, 87–103 (94.4); culmen, 18–20 (19). The (four) females—wing, 103.5–107.5 (105); tail, 87–97 (92); culmen, 18–18.5 (18.4).

153. LALAGE LEUCOPYGIALIS Walden.

One adult male, one adult female, and one immature female, Likiepang, March 9, 1916.

Family TIMALIIDAE.

BABBLING THRUSHES.

154. CATAPONERA ABDITIVA Riley.³⁸

One adult female, Rano Rano, December 21, 1917 (the type).

The original description of this distinct species is as follows:

Above mummy brown, shading into dresden brown on the forehead and crown; below dresden brown, shading into buckthorn brown on the belly; a rather broad superciliary line extending back over the ear coverts and widening posteriorly and a spot on the lower eyelid, black; upper tail coverts, tail, remiges, and the longer under tail coverts, mars brown; bill (in dried skin), ochraceous orange. Wing, 129; tail, 109; culmen, 25; tarsus, 39; middle toe, 26 mm.

³⁸ Proc. Biol. Soc. Wash., vol. 31, 1918, p. 158.

Remarks.—This species is so very different from the description and plate of *Cataponera turdoides* Hartert given in Meyer and Wiglesworth³⁹ that it scarcely needs comparison. Hartert's species came from the south, while the present comes from the central mountainous part of the island.

In this class of birds the sexes are alike, so the differences can not be explained upon that score.

Collected at dusk and seen to hop along branches in the same way as *Malia*. Bill reddish-orange; eyelid and feet chrome yellow.—H. C. R.

155. *ANDROPHILUS CASTANEUS* (Büttikofer).

One male, Goenoeng Lehió, January 17, 1917; one male, Toewo Mountain, November 4, 1917; two males, Rano Rano, December 10 and 13, 1917.

The tails in the above specimens are somewhat defective.

The genus *Androphilus* strongly resembles *Pseudotharrhaleus* of the Philippines, both in color and structure, and the only striking difference is in the longer, stiffer, and more pointed tail feathers of the latter. The wing formula is practically the same and somewhat peculiar, there being little difference in size after the third (from the outside) in the length of the primaries, making a very blunt wing. *Androphilus* is said to have 10 rectrices, while *Pseudotharrhaleus* has 12; the two genera are very closely allied and evidently represent each other in their respective habitats. Since Meyer and Wiglesworth wrote on the birds of Celebes, *Androphilus* has been discovered on the high mountains of Buru and Ceram, and Rothschild and Hartert⁴⁰ have described a species from central Dutch New Guinea; from the description of the latter and the remarks accompanying it this is a very doubtful member of the genus, however.

These are often heard but hard to see because of their habit of running along and under fallen tree trunks and dense dark underbrush, though most of the time they sit absolutely motionless watching for food.—H. C. R.

The four males measure as follows:

No.	Locality	Wing.	Culmen.	Tarsus.	Middle toe.
		<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
251049	Goenoeng Lehió.....	61. 5	12. 5	26	18
251963	Toewo Mountain, Besoa.....	59. 5	13	27	17
251964	Rano Rano.....	59	13	26. 5	17
251965	-----do.....	62. 5	13. 5	27	16. 5

156. *MALIA GRATA GRATA* Schlegel.

A fair series of both sexes and immature from: Goenoeng Lehió, January 14–20, 1917; Rano Rano, December 8–27, 1917.

³⁹ Birds of Celebes, vol. 2, 1898, p. 503, pl. 29.

⁴⁰ Bull. Brit. Orn. Club, vol. 34, 1911, p. 33.

There are no specimens available for comparison from either the north or the south, but I am provisionally referring the above series to the southern form, as the relationship of other species from the region seem to point in that direction and the specimens before me do not agree with Meyer and Wigglesworth's description or plate (Birds Celebes, 2, 1898, 500, pl. 33) of *Malia grata recondita*. Their plate shows a bird with the greater and middle wing coverts, tertials, and inner secondaries warbler green like the back, while in the specimens before me only the lesser wing coverts are warbler green, the rest of the closed wing being mars brown like the tail; the flanks on my birds are also more extensively warbler green.

The immature is much like the adult, except it is duller, the chest and belly pyrite yellow, duskiest on the flanks, with the feathers of the lower parts obscurely edged with dusky, giving these parts a slightly mottled effect in certain lights. Even the wings and tail are only slightly duller than in the adult. They gradually brighten with age as the adult condition is approached.

Acts much like a starling in the way it climbs about on moss-covered tree trunks and branches; flight starlinglike.—H. C. R.

157. AETHOSTOMA CELEBENSIS (Strickland).

A good series of both sexes from: Paleleh River, August 10, 1914; Tandjong Tango, August 28, 1914; Kapas Bay, November 19, 1914; Toli Toli, December 1-4, 1914; Likoepong, March 2-9, 1916; Toemaratas, July 3, 1916; Laboea Sore, November 28, 1916; Goenoeng Lebio, January 18, 1917; Koelawi, February 2-23, 1917; Rano Lindoe, March 21-25, 1917; Pinedapa, January 18-February 15, 1918.

This series shows quite a little individual variation. An apparently adult female (No. 249880) from Toemaratas, has the throat light buff and is approached in this respect by a male from Pinedapa. Some specimens have the flanks strongly buffy brown and this color even extends across the chest in an indistinct band, while in other specimens the flanks are much less strongly marked with buffy brown and the chest is smoky gray; in a few specimens the lower parts are almost entirely white, with the exception of the grayish wash on the sides and buffy under tail-coverts. Judging from an immature male taken at Koelawi, February 2, not long from the nest, having the chest with obscure dusky spots, the specimens with the indistinct chest bands are probably birds of the year and the birds with the underparts almost entirely white very old adults. The majority of the series have a dark rictal stripe, more or less distinct, but this is practically absent in a number of specimens. The series from central Celebes when compared with northern birds average a little more brownish on the sides and flanks, yet individual specimens from

either series can be picked out that are almost identical. There is little or no difference in size.

The type of *Aethostoma* Sharpe is *Trichostoma rostratum* Blyth, and a comparison of *celebensis* with it shows them to be not structurally quite the same and it is doubtful if they should be placed in the same genus. *Trichostoma celebense* Strickland has the tarsus less than one half the length of the tail, while in *rostratum* it is more than half. In *T. celebense* the tarsus equals about one and a third the length of the middle toe without claw while in *T. rostratum* the proportion is about one and a half.

Nasal region very soft. Iris light brown.—H. C. R.

Family TURDIDAE.

THRUSHES.

158. SAXICOLA CAPRATA ALBONOTATA (Stresemann).

One adult male, Dolo, December 30, 1916; two adult males, Rano Lindoe, March 10 and 23, 1917; one male in mixed plumage, Doda, Besoa, October 24, 1917; one male in mixed plumage, Napoe, Watoetae, December 4, 1917.

The above series when compared with Luzon birds (*S. c. caprata*) shows the Celebes form to be larger, with more white on the wing and rump and the black deeper as pointed out by the describer.⁴¹ A male of *Saxicola caprata fruticola* from Java in the United States National Museum is larger with less white on the wing coverts than Celebes birds.

The five males measure as follows:

No.	Locality.	Wing.	Tail.	Culmen.
251138	Dolo	<i>mm.</i> 67	<i>mm.</i> 51	<i>mm.</i> 12
251139	Rano Lindoe	70	52	12.5
251140	.....do	69	-----	11.5
252058	Besoa	70.5	54.5	12
252059	Napoe, Watoetae	71	54	12

Seen many times in fields and open plains near Parigi, Toboli, and Laboea Sore, but very shy and difficult to approach.—H. C. R.

Family SYLVIIDAE.

WARBLERS.

159. CISTICOLA EXILIS GRAYI (Walden).

A good series: Rano Lindoe, March 7-24, 1917, and Doda, Besoa, October 23, 1917.

⁴¹ Nov. Zool., vol. 19, 1912, p. 321.

Three or four specimens taken in March have a very slight tinge of yellow on the chest and flanks, remains of the immature plumage. The fall birds are whiter below.

The above series when compared with Philippine specimens taken at the same season are lighter, both above and below, and average smaller. Ogilvie-Grant⁴² has expressed a doubt whether the Philippine bird is the same as that from Australia, and is of the belief that it is the same as *Cisticola erythrocephala*. I have no examples of the latter for comparison. Cabanis⁴³ named the Luzon bird *Cisticola semirufa*, and as it is the only name certainly applicable, it seems to me the only safe course is to call the Philippine race *Cisticola exilis semirufa*. Mathews⁴⁴ divides the birds of this species occurring in Australia into numerous forms. This leaves the name of the Celebes bird in doubt and as I have shown above that it is not exactly the same as the Philippine race, the only safe course is to use the oldest name founded upon a Celebes specimen, which happens to be *Cisticola grayi* Walden.⁴⁵ The only specimen from Australia examined by me is without definite locality or date; it seems to be darker and more heavily streaked than Philippine birds. A male in the United States National Museum (No. 234123) from Bouro Island, December 10, in breeding plumage is hardly distinguishable from Philippine examples; it is only slightly darker on the back.

A male from Java (No. 219579) in breeding plumage, only differs from Philippine specimens in having the top of head lighter and this may be due to bleaching; two females from the same source are like Celebes birds in color and measurements. From the above it would appear that this species needs revision, but the material at my command is not sufficient to undertake it.

Hartert⁴⁶ says that all the birds of this species from Letti, Moa, and Roma examined by him are without white tips to the tail-feathers. Philippine winter specimens usually have white tips but breeding birds seem to lack it. Most of the Celebes examples are without white tips to the outer tail feathers, but a few have them, so it would appear that the presence or absence of the white tips has something to do with the condition of the plumage.

Below the measurements of various series are given, exclusive of breeding males:

⁴² Ibis, 1896, p. 117.

⁴³ Journ. f. Orn., 1866, p. 10 (nomen nudum), and 1872, p. 316 (descr.).

⁴⁴ Nov. Zool., vol. 18, 1912, p. 343, and List Birds Australia, 1913, p. 210.

⁴⁵ Ann. Mag. Nat. Hist., ser. 4, vol. 9, 1872, p. 400.

⁴⁶ Nov. Zool., vol. 11, 1904, p. 210.

	Wing.	Tail.	Culmen.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Eighteen males, Celebes.....	46.7	37.3	9.5
Seven males, Philippines.....	49.6	39	9.6
Eleven females, Celebes.....	44.2	34.7	9.4
Five females, Philippines.....	47.5	40.5	9.3
Two females, Java.....	45	33.3	9.7
One unsexed, Australia.....	46	27	10

160. MEGALURUS CELEBENSIS Riley.⁴⁷

A male and female, Doda, Besoa, October 23, 1917.

The original description is as follows:

Similar to *Megalurus amboinensis* but larger, with the back more heavily streaked with blackish, the cinnamon edges of the tertials broader, the nape obscurely streaked with dusky, the blackish streaks on the wing coverts broader, lower back, rump, and upper tail coverts streaked with brownish black, and the buffy chest band more pronounced. Wing, 67; tail, 113.5; culmen, 12 mm.

The female is smaller than the male with the streaks on the head extending onto the forehead and the black streaking on the back narrower. A male specimen of *Megalurus amboinensis*, with which the above species has been compared, has no streaks on the nape whatever, the top of the head is a deeper sayal brown, and the lower back and rump are without streaks, only the upper tail coverts having narrow dark shaft streaks. It measures: Wing, 61; culmen, 12 mm.

These are apparently the first birds of this genus taken in Celebes and Mr. Raven informs me that while not rare at the type locality they skulked in the reeds and he found them very difficult to collect.

In the original description I only mentioned Besoa, because that was the only locality given on the label. Besoa turns out to be a district and the exact locality is as above.

161. ACANTHOPNEUSTE BOREALIS BOREALIS (H. Blasius).

One male, Ayermadidi, April 4, 1916.

162. CRYPTOLOPHA NESOPHILA Riley.⁴⁸

A good series from the following localities: Goenoeng Lechio, January 14-19, 1917; Lindoe Trail, February 25, 1917; Rano Rano, December 10-29, 1917.

The original description is as follows:

Above citrine, deepening on top of head and nape into medal bronze; superciliary stripe barium yellow; loreal streak dusky; post ocular streak color of the head; below, including cheeks and ear coverts, citron yellow, streaked with

⁴⁷ Proc. Biol. Soc. Wash., vol. 32, 1919, p. 94.

⁴⁸ Idem, vol. 31, 1918, p. 159 (Goenoeng Lechio, Celebes).

whitish and spotted on the chest with obscure spots of buffy citrine; under tail coverts citron yellow; flanks yellowish citrine; wings chaetura drab, the feathers edged externally with the color of the back, the tips of the greater coverts a little paler, but not forming a bar; bend of wing edged with citron yellow; under wing coverts whitish; remiges below hair brown, the feathers where they rest against the body bordered with whitish or internally pale buff; tail above olive with a citrine wash, the outer edges of the feathers brighter basally. Wing, 58; tail, 40; culmen, 11; tarsus, 20.5; middle toe, 9.5 mm.

The nearest ally of this species is evidently *Cryptolopha sarasinorum* Meyer and Wigglesworth, from which it differs in lacking the crown stripe and the white on the two outer rectrices.

To the above original account I would like to make one correction: The two outer rectrices on each side are very narrowly edged on the inner margin with yellowish white, almost obsolete and sometimes absent, being easily overlooked. This is nothing like the condition in *Cryptolopha sarasinorum*, but is an approach and shows their relationship.

The above series is fairly uniform. Some specimens are more whitish below; in fact, the whitish predominates over the yellow streaks, while in others the reverse is the case. The whitish is more pronounced on the abdomen and throat as a rule. The buffy citrine spots on the chest form a bar in one specimen (No. 252075), while in others they are almost absent. Above there is not much variation; some specimens have the top of the head hardly different in color from the back, but as a rule it is deeper and darker. The sexes are alike.

In the original description only the measurement of the type was given. The series measures as follows:

Fifteen males measure: Wing, 55-62 (58.7); tail, 40-44.5 (42.2); culmen, 10-11 (10.3); and 12 females: Wing, 52.5-59.5 (55.8); tail, 36-44.5 (40); culmen, 9.5-10.5 (10.1).

Since writing the above, Mr. J. H. Fleming has kindly loaned the National Museum two topotypes of *Cryptolopha sarasinorum*. They only emphasize the differences pointed out above, the lack of a central crown-stripe and restriction or absence of white on the outer rectrix in *Cryptolopha nesophila*.

In the absence of the crown-stripe and the very narrow whitish edging on the inner web of the outer rectrices, *C. nesophila* approaches *C. nigrorum* of the Philippines, but is darker above, with only streaks of yellow below, and there are other minor differences. *C. nesophila* probably had a Philippine origin, while *C. sarasinorum* was derived from the islands farther south.

Cryptolopha as at present constituted is not a homogeneous group and needs revision. Indeed, Stresemann⁴⁰ has removed *Cryptolopha*

⁴⁰ Nov. Zool., vol. 20, 1913, p. 354.

trivirgatus (Strickland) to *Phylloscopus*. *Acanthopneuste everetti* Hartert, *Cryptolopha everetti waterstradti* Hartert, and *Cryptolopha ceramensis* Grant, Stresemann⁵⁰ makes races of *Gerygone giulianetti* Salvadori, which he also places in *Phylloscopus*. Of the latter I can not speak, not having specimens, but this disposition of *Cryptolopha trivirgatus* is not a happy one. Bianchi⁵¹ has reviewed the genus, but there have been quite a number of forms described since that time.

163. PHYLLERGATES CUCULLATUS RIEDELI Meyer and Wigglesworth.

Two males, Goenoeng Kalabat, 6,600 feet, April 7 and 9, 1916; two males, Goenoeng Lebio, January 15 and 19, 1917; two males, Rano Rano, December 11 and 12, 1917.

The two males from Goenoeng Kalabat have much more yellow on the flanks, under tail coverts and cheeks, with a much less rusty wash, than the four males from central Celebes; the latter are in more worn plumage, but that would hardly account for the increased rusty wash on the cheeks. It may well be that the differences are geographic and that there is more than one form found in Celebes.

The two Kalabat specimens differ from each other in the color of the top of the head. One (No. 249879) has this region inclining toward cinnamon rufous, shading off into a deeper color on the nape, while in the other it is an ochraceous-orange. This is without doubt due to fading in the latter, as it is in worn plumage, while the other is in fresh plumage.

The series measures as follows:

No.	Locality.	Wing.	Tail.	Culmen.
		<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
249878	Goenoeng Kalabat-----	46	45.5	13.5
249879	do-----	48	46	14
251058	Goenoeng Lebio-----	49	46.5	13.5
251059	do-----	48.5	46	14
252088	Rano Rano-----	49.5	49.5	13.5
252089	do-----	51.5	50	13.5

Several specimens seen amongst the dense reeds on the summit of Kalabat.—H. C. R.

Family ARTAMIDAE.

WOOD SWALLOWS.

164. ARTAMUS LEUCORHYNCHUS CELEBENSIS Brüggemann.

A good series of adults and immatures from: Toli Toli, December 13–17, 1914; Likoepong, March 2, 10, 1916; Koeala Prang, June 7,

⁵⁰ Nov. Zool., vol. 21, 1914, p. 135.

⁵¹ Bull. Acad. Imp. Sci. St. Petersburg, ser. 5, vol. 23, 1905, pp. 49–65.

1916; Parigi, September 14–27, 1916; Toboli, October 17, 20, 1916; Manilili, December 16; 1916; Dolo, December 26, 29, 1916; Koelawi, February 7 and July 25, 1917; Rano Lindoe, March 5–21, 1917; Gimpoe, August 9, 21, 1917; Doda, Besoa, October 23, 1917; Toewo Mountain, Besoa, November 1, 1917; Napoe, Watoetaoe, December 4, 1917; Pinedapa, February 4 and 13, 1918.

The most striking difference between Philippine and Celebes birds is the longer and much heavier bill of the latter; if there were no other differences this alone would be sufficient to differentiate the two forms, but *celebensis* has a longer wing and when laid out in series appears paler on the throat and upper surface.

Interior of the mouth with the tongue, black in the adult and yellow in the young, later becoming streaked with black.—H. C. R.

165. *ARTAMUS MONACHUS* Bonaparte.

Five males, Likoepang, January 16–February 25, 1916; one male, Temboan, July 17, 1916; one male and one female, Toewo Mountain, Besoa, November 4, 1917.

Family FALCUNCULIDAE.

THICKHEADS.

166. *MUSCITREA SULFURIVENTRA* (Walden).

A good series of both sexes from: Goenoeng Kalabat, April 9, 10, 1916; Toemaratas, July 4–7, 1916; Koelawi, February 23, 1917; Goenoeng Leho, January 12–20, 1917; Rano Lindoe, March 14, 1917; Toewo Mountain, Besoa, October 26–November 4, 1917; Rano Rano, December 9–31, 1917.

In the above series only two males and three females are from the extreme northern end of the island, the remainder are from the north-central part. As a rule the birds from middle Celebes seem to be paler, but right in the same locality with the paler specimens others occur that can not be told from northern examples, so the differences must be due more or less to individual variation and not to locality; there seems to be no difference in size. Meyer,⁵² however, has recorded *Muscitrea meridionalis* (Büttikofer) from central Celebes, but gives no definite locality.

An immature female, not long from the nest, taken at Rano Rano, December 21, differs from the adult in having the head, back, flanks, and a band across the chest strongly washed with mikado brown, and only the under tail-coverts are yellow.

The female differs from the male in being browner above, especially noticeable on the frons, lores, ear coverts, and edges of the remiges, and has a slightly shorter wing.

⁵² Notes Leyden Mus., vol. 23, 1903, p. 189.

A series of 10 males measure: Wing, 81–86.5 (82.5); tail, 58.5–64 (61.4); culmen, 13–15 (14.2); and 10 females: Wing, 77.5–83 (79.6); tail, 57.5–68.5 (61.6); culmen, 13–15 (14.1).

As Meyer and Wiglesworth⁵³ state this seems to be a mountain species; and the above series having all been taken in the highlands.

The present species of *Muscitrea*⁵⁴ recalls birds of the genus *Cyclarhis* which Pycraft⁵⁵ has made the type of a family Cyclarhidae. In external structure the two genera are almost identical, except *Cyclarhis* has stronger feet and the frontal and rictal bristles are less developed. The unspotted condition of the young described above would seem to exclude *Muscitrea* from the *Muscicapidae* and *Laniidae*, but in this character it is almost identical with the *Cyclarhidae*. The latter is so far as known Neotropical, so the only alternative at present is to recognize the birds of this type as Falcunculidae.

167. *PACHYCEPHALA PLUVIOSA* Riley.⁵⁶

A good series of both sexes and one immature, Rano Rano, December 11–27, 1917.

As the original description may not be accessible to all, it is repeated here:

Pileum and auriculars medal bronze, shading into buffy brown on the forehead; across upper back a band of deep neutral gray; rest of back warbler green, becoming more yellowish on the rump; breast neutral gray, becoming much lighter on the abdomen; under tail-coverts cinnamon; flanks pyrite yellow; wings fuscous-black, the feathers edged outwardly with the color of the back, this edging on the outer primaries very narrow and grayish toward the tips; under wing-coverts and the inner margins of the remiges where they rest against the body, cinnamon; tail above deep neutral gray, the outer feathers fuscous-black on the inner web. Wing, 81.5; tail, 67; culmen, 13; tarsus, 21; middle toe, 13.5 mm.

The female resembles the male, except the pileum is saccardo's olive with a yellowish wash and the chin and throat cinnamon-buff, streaked with deep neutral gray.

It is evidently similar to *Pachycephala bonthaina* of south Celebes, but the pileum and throat are brown, not greenish yellow-olive. *Pachycephala bonensis* of north Celebes was described from an immature specimen. The immature specimen of *Pachycephala pluviosa* when compared with the plate of *Pachycephala bonensis* in Meyer and Wiglesworth⁵⁷ presents a number of differences; the former has the pileum saccardo's olive, the auriculars are like the pileum, there are no cinnamon edgings to the outer primaries, the breast is without a buffy-cinnamon band down the center, and there are other differences.

In the original description only the measurement of the type was given, the series measures as follows: Twelve males, wing; 80–83.5

⁵³ Birds of Celebes, vol. 2, 1898, p. 395.

⁵⁴ Matthews, Aus. Av. Record, vol. 2, 1913, p. 57, has shown that *Muscitrea* Blyth is the proper name to employ for this genus.

⁵⁵ Proc. Zool. Soc., 1907, pp. 377, 378.

⁵⁶ Proc. Biol. Soc. Wash., vol. 32, 1919, p. 95.

⁵⁷ Birds of Celebes, vol. 2, 1898, pl. 18.

(82); tail, 64–69.5 (67.2); culmen, 12.5–14 (13.3), and seven females wing, 78.5–85 (81.4); tail 61–69.5 (65.7); culmen 13–14 (13.4).

It is possible that the above is only *Pachycephala bonensis* re-described, but I do not think so, as they both seem to be mountain species and their ranges are separated by a considerable stretch of country. Generally speaking the birds of central Celebes, with a few exceptions, are racially different and more closely related to those of the south. Then as far as can be told from the plate of *Pachycephala bonensis*, the immature of the two species are different, as mentioned above. This is not conclusive, however, as they might not be of the same age. The only way to settle the matter is to secure adults of the latter and carefully compare them with *Pachycephala pluviosa*.

Strictly, however, none of the Celebes species usually placed in *Pachycephala* Vigors and Horsfield (type *Muscicapa pectoralis* Latham) really belong there, but until the genus has been thoroughly revised, I do not know where else to place the above species.

Genus CORACORNIS Riley.⁵⁸

The original description is as follows:

Apparently related to *Pachycephala* Vigors and Horsfield but the rictal bristles longer; the outer primary proportionally longer and broader; rectrices broader, bluntly pointed instead of obliquely rounded), and the webs at the end semidecomposed, giving a softer texture to the feathers; nostril oval and parallel with the tomia (instead of short ovate and oblique); tail rounded; and color pattern entirely different.

Type and only known species the following:

168. CORACORNIS RAVENI Riley.⁵⁹

One female, Goenoeng Lechio, January 14, 1917; one adult male (type), one immature male, and one female, Rano Rano, December 9–28, 1917.

The original description of this species is as follows:

Chin, upper throat, sides of face, top of head, and hind neck sooty-black with a slight olive tinge on the hind neck; lesser wing-coverts, mantle, and rump, mahogany red; middle and greater wing-coverts, remiges, rectrices, and longer upper tail-coverts, black; lower throat, jugulum, and breast dark olive gray with a light yellowish olive wash; belly and crissum lighter than the breast and with a much heavier wash of light yellowish olive, hiding the under color; under wing-coverts like the breast; remiges below fuscous, the inner primaries and secondaries bordered slightly on the inner web with tilleul-buff. Wing, 82.5; tail, 67.5; culmen, 14; tarsus, 23; middle toe, 13.5 mm.

The female quite different, may be described as follows: Above, raw umber, lighter and with a grayish cast on top of head; tail sepia, the feathers edged

⁵⁸ Proc. Biol. Soc. Wash., vol. 31, 1918, p. 157.

⁵⁹ Idem, p. 157.

on the outer web with argus brown, but this color not quite reaching the tip; upper tail-coverts, argus brown; below buffy brown, lighter on the chin and with a pronounced lemon yellow wash on middle of belly; under tail-coverts ochraceous-tawny; wings prout's brown, the inner webs of the primaries and outer secondaries fuscous; under wing-coverts grayish olive with a slight yellowish tinge along the margin of the wing; the remiges where they rest against the body narrowly bordered with light ochraceous buff.

The wing and tail in the type specimen are in partial molt. The only female that has an apparently perfect tail has it slightly rounded.

The two females measure: Wing, 77.5–81; tail, 66.5–69; culmen, 12–13.5 mm.

The two females are much alike above, one is only slightly washed with brussels brown on the back; below the Rano Rano specimen is much lighter with a much more pronounced wash of yellow on the abdomen and the under tail-coverts are lighter.

The immature male is light below like the Rano Rano female but with the yellow wash on the abdomen very pale and only slightly indicated; above it is more of an olive brown. A few dark feathers are appearing on the pileum and sides of face and a few mahogany red feathers over each shoulder on the back.

Family ZOSTEROPIDAE.

SILVER-EYES.

169. ZOSTEROPS SARASINORUM Meyer and Wigglesworth.

Nine males and four females, Goenoeng Kalabat, 1,830 meters, April 7–11, 1916; one male, Toemaratas, July 9, 1916; two males and two females, Toewo Mountain, Besoa, October 26–27, 1917; one female, Rano Rano, December 9, 1917.

In the above series an occasional specimen shows an incipient yellow streak down the center of the breast.

Birds from the central mountains (Besoa-Rano) do not seem to differ from those from the type locality (Kalabat).

170. ZOSTEROPS INTERMEDIA Wallace.

A fair series from Koelawi, February 4–23, 1917; and Rano Lindoe, March 4–24, 1917.

Specimens from south Celebes (the type locality of the species is Macassar) are not available for comparison. The adults from central Celebes do not exactly fit the descriptions consulted, as for instance there is a dusky loreal streak in all the specimens examined by me. Two specimens in the United States National Museum from Dodepo Island, Gulf of Tomini, are much lighter above and below with the loreal streak less well defined and have larger bills than the series taken by Raven. It may well be that there is more than one form of the species in Celebes.

There are several sub-adult specimens from Koelawi and a young bird not long from the nest from Rano Lindoe, March 4. The young resembles the adult but is duller above and much lighter yellow below.

As this species has not been reported from north-central Celebes before, the measurements of the series in the United States National Museum are given below:

Museum No.	Sex.	Locality.	Wing.	Tail.	Culmen.
			<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
251163	Male	Koelawi	52	36.5	10.5
251165	do	do	53.5	40	10
251166	do	Rano Lindoe	53	40	10.5
251169	do	do	53.5	39	10.5
251168	do	do	54	39.5	10
251171	do	do	53	40	10.5
251174	do	do	53	39	10
251176	do	do	54	40	10.5
251177	do	do	53	39	10
251180	do	do	53	38.5	10
251178	do	do	51.5	39	10.5
251179	do	do	51.5	38.5	10
251182	do	do	51.5	39.5	10
234132	do	Dodepo Island	54	42	12.5
234131	do	do	55	38.5	12
251164	Female	Koelawi	52	39	10
251170	do	Rano Lindoe	53	38.5	10.5
251172	do	do	52	38	10
251175	do	do	52	38.5	10
251181	do	do	52.5	40.5	10.5
251183	do	do	53	41	10
251184	do	do	53.5	39	10

171. ZOSTEROPS ATRIFRONS ATRIFRONS Wallace.

A fine series from the following localities: Paleh River, August 18, 1914; Toli Toli, December 4-19, 1914; Kampa, February 14, 1915; Ayermadidi, April 1-2, 1916; Manembo Nembo, June 22, 1916; Toemaratas, July 3-9, 1916.

The birds from Toemaratas are whiter on the breast and the yellow of the throats are deeper than the rest of the series, but this is probably due to the different season of the year in which they were collected. Specimens from the mountainous central part of the island are larger and duller than even winter specimens from the north and these I have separated below.

172. ZOSTEROPS ATRIFRONS SURDA Riley.⁶⁰

A good series from the following localities: Koelawi, February 23, 1917; Rano Lindoe, March 5-24, 1917; Doda, Besoa, October 27, 1917; Toewo Mountain, Besoa, October 28-November 4, 1917.

⁶⁰ Proc. Biol. Soc. Wash., vol. 32, 1919, p. 95 (Rano Lindoe, Celebes).

This series when compared with a large series from north Celebes (the type of *Zosterops atrifrons* came from Menado) has the throat duller yellow, the chest grayer, the white eye-ring narrower, the back more greenish, the black suborbital streak more diffused, and the size larger.

Zosterops subatrifrons, from Peling Island, is described by Meyer and Wiglesworth⁶¹ as having the throat clearer yellow and the breast whiter than in *Zosterops atrifrons atrifrons*, while in the present race the reverse is the case, so it is unlikely they are the same. Finsch⁶² places *Zosterops subatrifrons* in the synonymy of *Zosterops atrifrons*, but whether he was justified in so doing, I am unable to say without an examination of specimens from Peling Island.

The measurements of the two series are as follows:

	Wing.	Tail.	Culmen.
	mm.	mm.	mm.
Ten males, <i>Zosterops a. atrifrons</i>	52.8	37.2	10.2
Eight males, <i>Zosterops a. surda</i>	57.2	40.9	11.1
Ten females, <i>Zosterops a. atrifrons</i>	52.5	37.7	10.2
Ten females, <i>Zosterops a. surda</i>	54.9	39.8	11.1

173. PSEUDOZOSTEROPS STRIATICEPS (Riley).⁶³

In addition to the type from Goenoeng Lechio, January 13, 1917, the collection contains a good series from Toewo Mountain, Besoa, November 1-3, 1917, and Rano Rano, December 10-27, 1917.

The following is the original description:

Above warbler green, the upper back with a few fine light yellowish shaft streaks; the top of head dark neutral gray with fine white shaft stripes; frons and lores buffy white; ear-coverts and cheeks lighter gray than top of head, the white shaft streaks a little coarser; throat and jugulum buffy white; rest of underparts lemon yellow; flanks pyrite yellow; wings the color of the back, the primaries and outer secondaries chaetura drab, except on the outer margin; bend of the wing margined with light yellow; under wing coverts white with a yellowish wash; primaries and secondaries where they rest against the sides of the body strongly margined on the inner web and basally with yellowish white; tail chaetura drab washed and margined with the color of the back. Wing, 63; tail, 45; tarsus, 16.5; middle toe, 10 mm.

Remarks.—The type, from Goenoeng Lechio, is brighter, more yellowish above and brighter below than the Rano-Besoa series. Judging from the description and plate in Meyer and Wiglesworth⁶⁴ the above is closely related to *Lophozosterops squamiceps*, from which it differs in lacking the terminal edges of silvery gray to the feathers of the top of the head; the throat buffy-white; the back of a different shade of green; the lower parts brighter yellow; and there are other slight differences.

⁶¹ Birds of Celebes, vol. 2, 1898, p. 490.

⁶² Das Tierreich, 15 Lief. 1901, p. 34.

⁶³ *Lophozosterops striaticeps* Riley, Proc. Biol. Soc. Wash., vol. 31, 1918, p. 157.

⁶⁴ Birds of Celebes, vol. 2, 1898, p. 485, pl. 29.

In the original description only the measurements of the type were given, the averages of the series are as follows: Ten males, wing, 62-67 (64.3); tail, 43.5-47 (45.2); culmen, 12.5-14 (13.4); and five females, wing, 60-64.5 (62.7); tail, 42.5-45.5 (43.9); culmen, 12.5-13.5 (13.1).

Since the above was written, J. H. Fleming has loaned the museum a small series of cotypes of *Pseudozosterops squamiceps* (Hartert) and upon comparison with the above species they are found to be even more distinct than first supposed. *Pseudozosterops squamiceps* appears to be slightly larger with a heavier bill; the feathers of the occiput broader and more rounded. The color differences are best given in parallel columns, as follows:

P. squamiceps.

Above darker warbler green.

Top of head chaetura drab, with a whitish shaft streak and silvery edges to the feathers.

Frons hardly lighter than the crown.

Ear coverts much darker with the light shaft streaks almost obsolete.

Throat light olive-gray, the feathers edged with dusky, making it appear still darker.

Breast oil yellow.

P. striaticeps.

Above lighter warbler green.

Top of head dark neutral gray with more conspicuous shaft stripes, but no silvery edges to the feathers.

Frons buffy white.

Ear coverts lighter with the light shaft streaks broad and pronounced.

Throat buffy white; no dusky margins to the feathers.

Breast lemon yellow.

When I named the above species, the United States National Museum did not contain a specimen of *Lophozosterops* or *Pseudozosterops* and I then thought they would prove synonymous. The museum has recently acquired a specimen of *Pseudozosterops mülleri* (the type of the genus) and structurally it is much like *Chlorocharis squamiceps* Hartert, especially in the rounded tip to the crown feathers. *Lophozosterops dohertyi* Hartert⁶⁵ (type of the genus), judging from figures and plate, in style of coloration comes very close to the Celebes species and *Lophozosterops subcristatus* Hartert is said to be very similar to *L. dohertyi*. *Pseudozosterops striaticeps* has the crown feathers less rounded than in *squamiceps* and approaches *Zosterops goodfellowi* of Mindanao, an aberrant member of the genus *Zosterops*, in structure. The latter has the crown unstreaked and the feathers of this part of the head of a looser texture, but otherwise the style of coloration is similar and it was probably derived from the same stock as the Celebes species, which undoubtedly were derived from the south. If all the above species were

⁶⁵ Nov. Zool., vol. 3, 1896, p. 568.

united generically, then *Lophozosterops* Hartert⁶⁶ would be the name to use, but out of deference to Finsch⁶⁷ and from a lack of proper material, the two Celebes species had better remain in *Pseudozosterops* for the present.

Family DICAUIDAE.

FLOWER-PECKERS.

174. DICAUM CELEBICUM S. Müller.

A good series of both sexes and immature from: Paleleh, August 1, 1914; Paleleh River, August 10, 1914; Soemalata, September 3-7, 1914; Kapas Bay, November 22, 1914; Toli Toli, December 2-8, 1914; Kampa, February 14, 1915; Tandjong Penjoe, February 25-26, 1915; Likoepong, January 16, 1916; Manembo Nembo, June 23, 1916; Langowan, July 12, 1916; Parigi, September 28, 1916; Kasimbar, December 13, 1916; Laboea Sore, November 24, 1916; Gimpoe, August 2-September 1, 1917; Toare, Bada, September 20, 1917; Koelawi, February 4 and 23, 1917; Rano Lindoe, March 7-23, 1917; Pinedapa, January 12, and February 13, 1918.

Birds from the north when compared with a series from the north-central mountainous section have deeper purplish backs and the dark central pectoral patch is more pronounced. The series from the north-central country is more worn and the differences may be due to fading, however. There is little difference in size between the two series.

The majority of the adult males have the throat and jugulum scarlet-red, but one male (No. 248,743) from Tandjong Penjoe, February 26, has these parts geranium-red. It is peculiar in other particulars, also; the back is darker, less purplish, and the black pectoral spot extends clear across the chest, but in this latter character it is approached by a specimen from Toli Toli (No. 248,738), and others. The white chin spot varies from hardly any at all to the condition in which the whole throat is white and the scarlet-red reduced to a jugular patch, as in a specimen taken at Gimpoe, August 3 (No. 252,389). This later seems to be fully adult and is unique in the series.

Two young males, Gimpoe, August 21 and 28, have a few red feathers appearing on the throat and a few dark purplish feathers on the top of the head. Another young male taken at the same place, August 2, is much further advanced toward the adult plumage.

⁶⁶ Nov. Zool., 3, 1896, 568.

⁶⁷ Das Tier., 15 Lief., 1901, p. 46.

175. *DIACEUM NEHRKORNI* W. Blasius.

Two males, Toemaratas, July 4, 8, 1916; one male, Rano Lindoe, March 8, 1917; two males, Toewo Mountain, Besoa, October 29, and November 3, 1917.

All the above males have a median sooty black line within the area of white of the abdomen, a feature not mentioned by Meyer and Wigglesworth⁶⁸ in their description, but as it is shown on the plate the omission must be an inadvertence.

The above series when compared with four males from Indrulan, south Celebes, kindly loaned me by J. H. Fleming, appear to be lighter on the throats and foreneck; in size they are about the same. The differences are too slight for separation by name, however.

176. *ACMONORHYNCHUS AUREOLIMBATUS* (Wallace).

A good series of both sexes and immature from: Paleleh River, August 17-18, 1914; Kwala Besar, August 23-24, 1914; Soemalata, September 4-7, 1914; Toli Toli, December 4-14, 1914; Tandjong Penjoe, February 25-26, 1915; Likoepang, January 21, 1916; Goe-noeng Lebio, January 18, 1917; Rano Lindoe, March 5-23, 1917; Gimpoe, August 3-September 1, 1917; Pinedapa, January 23, 1918.

The birds from the north-central mountain country are duller above and the yellow of the flanks is not so bright as in birds from the north end of the island, but it is not advisable to separate them at present.

Family NECTARINIIDAE.

SUN BIRDS.

177. *AETHOPYGA FLAVOSTRIATA* (Wallace).

Two adult males and three adult females, Toli Toli, December 2-9, 1914; one adult male, Tandjong Penjoe, February 26, 1915; one adult male, Lindoe Trail, February 28, 1917; one adult male, Rano Lindoe, March 25, 1917; one immature and two adult males and one adult female, Gimpoe, August 2-24, 1917.

The males from the central part of the island seem to have the metallic crown more restricted, and the red of the back brighter than northern specimens, but the series from the two localities are too small to reach any definite conclusions.

The young male taken at Gimpoe, August 11, is similar to the adult female, but has more red on the back, the jugulum is tinged with red, there is a small tuft of new red feathers in the center of the chest, and it has acquired a single central tail-feather of the adult plumage.

⁶⁸ Birds of Celebes, vol. 2, 1898, p. 447, pl. 25.

The measurements of the series are as follows :

Museum No.	Sex.	Locality.	Wing.	Tail.	Culmen.
251198	Male	Lindoe Trail	<i>mm.</i> 55	<i>mm.</i> 44. 5	<i>mm.</i> 18
251199	do	Rano Lindoe	53. 5	41	17
252433	do	Gimpoe	53	46	17. 5
252434	do	do	56. 5	43	18
248792	do	Toli Toli	54	42. 5	18
248791	do	do	54. 5	41. 5	18. 5
248793	do	Tandjong Penjoe	52. 5	41. 5	18. 5
252436	Female	Gimpoe	47	33. 5	17
248789	do	Toli Toli	48	32	18
248788	do	do	47. 5	33	17
248790	do	do	48	35	17. 5

178. HERMOTIMIA GRAYI (Wallace).

A good series of both sexes and immature from: Kapas Bay, July 22, 1914; Kwandang, October 7, 1914; Toli Toli, December 2-19, 1914; Kampa, February 14, 1915; Tandjong Penjoe, February 18-26, 1915; Likoe pang, January 14-18, 1916; Ayermadidi, April 2-4, 1916; Kasimbar, December 13, 1916.

An apparently adult male (No. 248808) taken at Tandjong Penjoe, February 18, 1915, has the chest and upper back pyrite yellow with a reddish wash and is unique in the series of males, though a male (No. 248798) from Toli Toli, December 3, shows a slight yellowish tinge to the maroon of the chest. A perfectly normal male was taken on the same day as the unique Penjoe specimen.

The above series of males shows apparently two phases in the color of the crown; in one it is a beautiful shining golden green, while in the other it is more coppery. This is due to wear, I believe, as the phase without the golden sheen or little of it, shows more wear when examined under a lens. That it is not geographic is certain, as both phases were taken at the same locality.

179. HERMOTIMIA PORPHYROLAEMA PORPHYROLAEMA (Wallace).

Five adult males, one immature male, and three females, Gimpoe, August 2-September 3, 1917; two adult males and one female, Pineclapa, February 2-4, 1918.

No specimens of this species are available for comparison from the south, but the above birds do not fit the description of *Hermotimia porphyrolaema scapuluta* Meyer and Wigglesworth, which Doctor Sharpe finding preoccupied has renamed [*Hermotimia porphyrolaema*] *meyeri*,⁶⁹ so there is nothing left to do but refer them to the typical form for the present.

⁶⁹ Hand-list Birds, vol. 5, 1909, p. 43.

The immature male taken September 1 resembles the adult female very closely. The top of the head and throat are a little darker and the metallic rictal streak is making its appearance.

As specimens of the species seem to be rather scarce in collections the measurements of the series is appended:

Museum No.	Sex.	Locality.	Wing.	Tail.	Culmen.
252458	Male	Gimpoe	<i>mm.</i> 57.5	<i>mm.</i> 37	<i>mm.</i> 16
252459	do	do	60	38	15
252461	do	do	58	39	17
252462	do	do	58.5	38	16.5
252463	do	do	58	37.5	16
252467	do	Pinedapa	59	38	14
252468	do	do	59.5	37.5	16
252460	Female	Gimpoe	50	30	15
252464	do	do	51	32	14.5
252466	do	do	50.5	31.5	14.5
252469	do	Pinedapa	49	30.5	16.5

180. *CYRTOSTOMUS FRENATUS MEYERI*, Hartert.⁷⁰

A fine series of adults of both sexes and immature from: Kapas Bay, July 22 and November 18-23, 1914; Soemalata, September 3-7, 1914; Kwandang, September 15, 1914; Toli Toli, November 29-December 19, 1914; Kampa, February 14, 1915; Tandjong Penjoe, February 17-26, 1915; Likoepang, January 16 and 21-March 3 and 4, 1916; Ayermadidi, April 2, 1916; Koelala Prang, June 18, 1916; Manembo Nembo, June 22-24, 1916.

This series differs from typical *C. f. frenatus* in being darker and more greenish above, with larger bills.

181. *CYRTOSTOMUS FRENATUS PLATENI* (W. Blasius).

A good series of both sexes from: Parigi, September 19 and 28, 1916; Toboli, October 18-22, 1916; Manilili, December 16, 1916; Gimpoe, August 2-27, 1917; Koelawi, January 30-February 14, 1917; Toewo Mountain, Besoa, October 28 and November 2, 1917.

Specimens from Gimpoe, Koelawi, and Besoa seem to be a little lighter yellow on the breast, the backs dusker, and slightly smaller than specimens from the north (*C. f. meyeri*). The difficulty comes in assigning specimens from Parigi, Toboli, and Manilili, as they are intermediate, but they seem to be nearer the southern form and I have placed them here for the present. It is uncertain whether the central mountain race belongs to the southern form or to *Cyrtostomus frenatus dissentiens* of Bonthain Peak, adults of which are not available for comparison, but until more is known of the

⁷⁰ Nov. Zool., vol. 4, 1897, p. 156.

distribution of the forms inhabiting Celebes it is referred to the southern form.

A series of males from the north and central mountain region average as follows:

	Wing.	Tail.	Culmen.
	mm.	mm.	mm.
Ten males, <i>C. f. meyeri</i>	53.3	35	18.6
Ten males, <i>C. f. plateni</i>	51.5	32.6	17.7

A male taken at Gimpoe, August 11, (No. 252443) has the breast strongly washed with cadmium yellow, and there is a tendency in several other specimens from the mountains to have the chest a little deeper yellow than usual.

A young female not long from the nest was taken at Besoa, October 28, so the breeding season is probably in the autumn, or irregular.

182. ANTHREPTES MALACENSIS CELEBENSIS Shelley.

A large series of both sexes and immature: Kapas Bay, July 22 and November 18 and 23, 1914; Kwala Besar, August 23, 1914; Soemalata, September 3-8, 1914; Toli Toli, November 28-December 14, 1914; Kampa, February 14, 1915; Tandjong Penjoe, February 18-27, 1915; Likoepong, January 13-18, and March 9, 1916; Koerala Prang, June 14 and 18, 1916; Manembo Nembo, June 22-24, 1916; Toboli, October 18-23, 1916; Kasimbar, December 13, 1916; Tinomboe, December 15, 1916; Manilili, December 16, 1916; Gimpoe, August 2-29, 1917; Rano Lindoe, March 25, 1917.

Birds from Gimpoe are paler below but as they are August specimens this is probably due to bleaching as the Rano Lindoe birds taken in March are like northern skins of the same season. I have only one skin from the south of the island (near Macassar, December 18) and it has the breast a more greenish yellow and the throat duller than northern birds, but these may be only individual differences.

A. m. celebensis stands out from all its related forms in having the yellow of the breast in the male more greenish. The female is still more distinct from the related forms than the male. She has the lower parts grayish with only the breast and belly washed with a light shade of yellow, while in all other forms of the species the breast and belly are quite yellow and even the throat is washed with yellow or even concolor with the breast.

The immature *A. m. celebensis* has the throat washed with yellow and the remaining under parts are much deeper; in this condition they approach the adult female of *Anthreptes malaccensis wigles-*

worthi of the southern Philippines, which is undoubtedly the nearest relative.

A male in the United States National Museum from Great Sangi, in rather poor condition, has the breast a brighter yellow, the throat duller, and the cheeks without the reddish wash of *Anthreptes malacensis wigglesworthi* and it is extremely doubtful if they are the same.

This species has been revised by Doctor Hartert⁷¹ but a number of races have been described since. He recognized six races, but included, *Anthreptes griseigularis*, which is a good species, more distinct from typical *Anthreptes malacensis* than is *Anthreptes rhodolaema*, that is recognized as such. The latter has the greenish breast and pronounced yellow pectoral tufts of *A. m. celebensis*, *A. m. chlorigaster*, *A. m. wigglesworthi*, and *A. m. cagayanensis*, and it may be that they have been derived from a separate stock. The Palawan bird *Anthreptes malacensis paraguac*⁷² is derived from the same stock as *Anthreptes m. barnensis* of north Borneo and these have nothing to do with *Anthreptes rhodolaema*, which occurs at sea-level in north Borneo with the latter. It seems plausible that the southwestern Philippine forms were derived from the same stock as *Anthreptes rhodolaema* and that the Celebes bird came to the islands from the southern Philippines. The form from the Lesser Sunda Islands that resembles *Anthreptes m. wigglesworthi*, but is unnamed, that Doctor Hartert is at a loss to place, would be thus explained. The yellow-breasted forms derived from *Anthreptes malacensis* coming east along the Greater Sunda Islands, while the greenish-breasted birds derived from the same stock as *Anthreptes rhodolaema* have come also from the mainland by the way of Borneo, the southeastern Philippines, and Celebes into the Lesser Sunda Islands. This is mere speculation, however, and as the female of *Anthreptes rhodolaema* shows greater differences than the males (being much darker and greener than the same sex of *A. malacensis*) it had better be kept as a distinct species; our present nomenclature not being suitable to show lines of descent. On the other hand, the female of *A. m. celebensis* is just as distinct, so this objection would not hold. If the greenish-breasted forms are derived from the same stock as *A. rhodolaema*, then we would have *Anthreptes chlorigaster chlorigaster*, *A. c. wigglesworthi*, *A. c. cagayanensis*, *A. c. rhodolaema*, and *A. c. celebensis*. It is probable that *A. griseigularis* is also derived from the same stock as the southern forms, it being a greenish-breasted bird, that moved north early and through long isolation has developed into a distinct species, the other related forms coming into the islands at a later date.

⁷¹ Nov. Zool., vol. 9, 1902, p. 209; vol. 24, 1917, p. 323.

⁷² Proc. Biol. Soc. Wash., vol. 33, 1920, p. 55.

Family MELIPHAGIDAE.

HONEYEATERS.

183. MYZOMELA CHLOROPTERA CHLOROPTERA Walden.

A fine series, mostly males, from Goenoeng Kalabat, April 12, 1916; and Toemaratas, July 4-9, 1916.

The series of adult males is very uniform. The breast and belly rather strongly washed with sulphur yellow; the scapulars, wings, and tail distinctly black; the remiges edged with warbler green. A series of five males from south Celebes and Saleyer Island, kindly loaned by J. H. Fleming and from which he permitted the United States National Museum to retain a pair in exchange, almost entirely lacks the sulphur wash from the breast and belly; the scapulars, wings, and tail are distinctly brown, not black; the reds are duller, and they average slightly larger, but this supposed character might disappear upon the measurement of a larger series. The color differences are very striking upon comparison, and I have named the southern form *Myzomela chloroptera juga*.⁷³

An adult male from Saleyer Island, in the collection of J. H. Fleming, has the reds much paler than the southern form, but whether this difference would hold I am not prepared to say until a larger series has been examined.

An immature male (No. 249975) taken July 9, resembles the adult female but is acquiring red-tipped feathers on the top of the head, back, and rump, and three or four on the chest; the scapulars and lesser wing coverts are coming in sooty black. This shows that the adult plumage is assumed the first year after a postjuvinal molt.

A selected series of males of the northern form compares with the other series as follows:

	Wing.	Tail.	Culmen.
	mm.	mm.	mm.
Ten males, north Celebes.....	55.4	36.7	14.8
Four males, south Celebes.....	57.5	37.5	15.5
One male, Saleyer Island.....	56	35	16

184. ORODYTES CELEBENSIS CELEBENSIS (Meyer and Wiglesworth).

One male and one female, Goenoeng Lebio, January 18 and 20, 1917; one male, Lindoe Trail, February 25, 1917; six males and two females, Rano Rano, December 9-31, 1917.

The above series is from the mountains of north-central Celebes and I have been able to compare them with topotypes of *Orodytes*

⁷³ Proc. Biol. Soc. Wash., vol. 34, 1921, p. 56.

celebensis meridionalis (Meyer and Wigglesworth) through the kindness of J. H. Fleming. They are more distinct than one would be led to believe from descriptions alone. The southern form is much darker above, with less of a yellowish wash; below it is much darker, with the lighter edges of the feathers much reduced. *Orodytes c. celebensis* has the feathers of the lower parts strongly edged with dark olive buff while in *O. c. meridionalis* the edges on the feathers to the lower parts are narrow and more of a citrine, which makes the darker centers of the feathers more conspicuous. If these two forms occurred on different islands there is not much question but that they would be ranked as distinct species. It may well be that the series from north-central Celebes does not belong to the northern form at all but to an intermediate race. Meyer⁷⁴ reports the southern form from central Celebes; this I can not well understand, unless the ranges of the two forms end rather abruptly.

The two series average as follows:

	Wing.	Tail.	Culmen.
	mm.	mm.	mm.
Eight males, north-central Celebes.....	85.7	73.4	29.7
Three males, south Celebes.....	83.7	69.7	27.7
Three females, north-central Celebes.....	75	66.2	26.3

From the above measurements it will be seen that the females are considerably smaller than the males; this seems to be the only sexual difference.

As previous authors have had difficulty in placing this species in the currently accepted genera, I have erected *Orodytes*⁷⁵ for it as a solution of the difficulty.

Since writing the foregoing the United States National Museum has acquired a specimen of *Melilestes megarhynchus* (type of the genus) and the differences between it and *Orodytes* are given below in parallel columns:

Melilestes.

Bill proportionately longer and heavier; depth at base about equal to the width; culmen about equal to tarsus and middle-toe with claw; ridge of culmen rounded and expanded at base; serrations on the cutting edge of upper mandible at the tip more pronounced; operculum to nostril proportionately weaker; a distinct line or stria

Orodytes.

Bill proportionately shorter, weaker, and more compressed; depth at base greater than the width; culmen less than tarsus and middle-toe with claw; ridge of culmen not expanded at base but compressed; serrations on the cutting edge of upper mandible of the tip less pronounced; operculum to nostril proportionately greater; no dis-

⁷⁴ Notes Leyden Mus., vol. 23, 1903, p. 189.

⁷⁵ Proc. Biol. Soc. Wash., vol. 34, 1921, p. 52.

running from forward border of nostril toward tip of bill.

Ramus to symphysis with gonys nearly equal to the latter.

Lores more or less naked, except for the eye-ring.

Frontal antiae poorly defined and sparsely feathered and not extending far forward on the bill.

Bare superciliary and post-ocular space small.

Outer primary greater than half the second, broader.

Feet proportionally heavier and longer; middle-toe and claw equal to four-fifths tarsus; outer-toe without claw extending to about the middle of the ultimate joint of middle-toe.

Tail-feathers narrower and rounded at the tip; the two outer on each side only very slightly shorter than the others.

tinct line or stria from the forward border of the nostril toward tip of bill.

Ramus to symphysis with gonys less than one-half the latter.

Lores feathered.

Frontal antiae well defined and well feathered, extending well forward on the bill.

Bare superciliary and post-ocular space proportionally greater.

Outer primary equal to about one-half the second, narrower.

Feet proportionally weaker and shorter; middle-toe and claw equal to three-fourths tarsus; outer-toe without claw extending beyond the middle of the ultimate joint of middle-toe.

Tail-feathers broader and obliquely rounded at the tips; the two outer on each side appreciably shorter than the others.

Some of the above differences are only relative and probably specific, yet there are so many structural differences remaining between the two genera that to think of uniting them would be unreasonable. Judging from what specimens I have seen and the literature, *Melilestes* is monotypic, so far as known at present, which agrees with Stresemann's⁷⁶ conclusions. The genera *Arachnothera* and *Arachnorhaphis* superficially resemble some of the Meliphagidae and have the commissure serrated at the tip, but so do some of the other genera of the Nectariniidae. If *Tovorhamphus* Stresemann (type *Cinnyris novaeguineae* Lesson) is allowed to remain in the Meliphagidae, then it would appear as if *Arachnothera* and *Arachnorhaphis* should be placed near it in the same family. Hartert⁷⁷ in discussing *Melilestes fergussonis* has already questioned the right of *Arachnothera* as a member of the Nectariniidae.

Family MOTACILLIDAE.

PIPITS, WAGTAILS.

185. MOTACILLA CINEREA CASPICA (S. G. Gmelin).⁷⁸

A small series of both sexes from Goenoeng Lechio, January 15, 1917; Koelawi, January 30–February 10, 1917; Rano Lindoe, March 9, 1917; Toewo Mountain, Besoa, November 1, 1917.

⁷⁶ Nov. Zool., vol. 21, 1914, p. 394.

⁷⁷ Idem, vol. 3, 1896, p. 237.

⁷⁸ For the use of this name in place of *Motacilla cinera melanope* Pallas, see Stresemann, Orn. Monats., vol. 30, 1922, p. 89.

Some of the specimens in the above series have dark tarsi, but in the majority they are light colored; the birds with dark tarsi seem to be older, and this character may be due to age.

186. *BUDYTES FLAVUS SIMILLIMA* (Hartert).

A good series of both sexes in various stages of plumage from: Dolo, December 25-26, 1916; Koelawi, January 30-February 10, 1917; Rano Lindoe, March 3-25, 1917; Doda, Besoa, October 23-26, 1917; Toewo Mountain, Besoa, October 29-November 2, 1917; Napoe, Watoetaoe, November 20, 1917.

The few birds in the above extensive series in nearly adult plumage, I have compared with *B. f. plexus* and *B. f. simillima*. From the former, the Celebes birds differ in having the pileum, lores, and auriculars much lighter, but from Kamchatkan skins of the latter the differences are slight and may be due to the different seasons at which the two series were collected, the Kamchatkan specimens having been taken in the breeding season. Hartert⁷⁹ did not designate a type in the original description of *Motacilla flava simillima*, but later⁸⁰ stated that the type came from Sulu Island. Specimens from Luzon and Celebes agree in size, but the latter appear to average a little lighter on the top of the head. This may be seasonal, the Luzon birds being taken later in the season; at any rate the differences are very slight.

All the specimens taken in Celebes from the latter part of December to the latter part of March are in molt and in none is it completed. There seems to be a complete spring molt with the exception of the wings and tail.

187. *ANTHUS GUSTAVI* Swinhoe.

One adult female, Tandjong Penjoe, February 20, 1915.

Family PLOCEIDAE.

WEAVER BIRDS.

188. *MUNIA ATRICAPILLA BRUNNEICEPS* (Walden).

A good series of both sexes, adult and immature from: Likoe-pang, March 2-9, 1916; Dolo, December 25, 1916; Rano Lindoe, March 3-23, 1917; Doda and Toewo Mountain, Besoa, October 23-31, 1917; Napoe, Watoetaoe, November 20-December 4, 1917.

The nearest relative of the Celebes bird is *Munia atricapilla jagori* from the Philippine Islands (except northern Luzon), and when compared with it very little difference can be detected. *Munia*

⁷⁹ Vögel paläarkt. Fauna, vol. 1, Heft 3, 1905, p. 289 (Kamchatka to Maluscas, etc.).

⁸⁰ Nov. Zool., vol. 26, 1919, p. 167.

atricapilla brunneicaps when laid out in series alongside *Munia atricapilla jagori* seems to have the black breast patch more restricted, the head probably averages a little browner black, and there is more of a tendency for the edges of the tail feathers to become yellowish above; there appears to be no difference in size. Individuals can be picked out of either series that almost match in coloration and size. Specimens from northern Luzon have the black of the head shade off into smoky brown on the nape, and these have been assigned to the Formosan form *Munia atricapilla formosana*. That both the above are only subspecies of *Munia atricapilla*, there can be little doubt. Stresemann⁸¹ has called attention to the fact that *Fringilla minuta* Meyen⁸² is the young of *Munia atricapilla jagori* Martens,⁸³ and has advocated the adoption of Meyen's name on the ground of priority, but he has overlooked the fact that *Fringilla minuta* Temminck,⁸⁴ which appears to be a synonym of *Fringilla flavirostris* Linnaeus. (*Acanthis flavirostris* Authors), would preclude such action.

There are fully grown young without any sign of molting into the adult plumage taken as late as December 25, and others that have begun to molt into the adult dress as early as October 23. As a matter of fact, the breeding period is probably a long one, and the young doubtless molt into the adult plumage the first season. The only spring bird showing any trace of the immature plumage is a female taken March 11. This specimen is in worn plumage and has not as yet fully acquired the black breast of the adult.

Mathews⁸⁵ unites *Munia* Hodgson⁸⁶ with *Lonchura* Sykes,⁸⁷ for which Cabanis⁸⁸ substituted *Uroloncha*, *Lonchura* being preoccupied and designated as its type, *Loxia molucca* Linnaeus. If *Munia* and *Uroloncha* are united, and I think they should be, then *Munia* is the name to use.

189. MUNIA PUNCTULATA PARTICEPS Riley.⁸⁹

One immature and four adult males, and one immature female, Rano Lindoe, March 15-25, 1917; two immature males and one immature female, Gimpoe, August 6-20, 1917; one adult female, Toewo Mountain, Besoa, November 2, 1917; two adult females, Napoe, Watoetaoe, November 20, and December 4, 1917.

⁸¹ Orn. Monats., vol. 30, 1922, p. 88.

⁸² Verh. Carol.-Leopold. Akad. d. Natur., vol. 16, suppl., prim., 1834, p. 86, pl 12, fig. 2.

⁸³ Journ. f. Orn., 1866, p. 14.

⁸⁴ Cat. Sys. Cab. Orn., 1807, errata to p. 112.

⁸⁵ List Birds Australia, 1913, p. 300.

⁸⁶ Asiatic Research., vol. 19, 1836, p. 153.

⁸⁷ Proc. Zool. Soc. Lond., 1832, p. 94.

⁸⁸ Mus. Hein., vol. 1, 1851, p. 173.

⁸⁹ Proc. Biol. Soc. Wash., vol. 33, 1920, p. 57 (Rano Lindoe).

The original description is as follows:

Similar to *Munia punctulata cabanisi* of the Philippines, but darker above, the closed wing outwardly deeper more rusty brown, the throat and cheeks deeper brown, especially on sides of face and lores, the barring on the breast and flanks much coarser and darker brown. Wing, 50.5; tail, 40; culmen, 11 mm.

The type is an adult male from Rano Lindoe, March 15, 1917 (U. S. National Museum, No. 251332).

This is the bird described as *Munia punctulata nisoria* by Meyer and Wiglesworth,⁹⁰ but they could hardly have compared specimens from Celebes with those from Java, or they certainly would have seen how different they are. The Javan bird has the rump barred with white and the tail gray above, while the Celebes form has the rump unbarred and the tail buffy citrine; the latter race is also darker above and on the throat, with the white of the belly more restricted, and is smaller.

Walden⁹¹ had noticed the difference between the color of the tails of the Java race and that of the only specimen he had from Celebes. Stresemann⁹² has indicated the Celebes bird as probably a distinct form, but did not name it, probably because his series was inadequate. As a matter of fact, in size and in the color of back and tail, the Celebes bird approaches the Philippine form, but in the coarser markings of the breast and flanks it more closely resembles Javan specimens. It is perfectly distinct from either and well merits recognition.

Two female specimens (Nos. 252529 and 252530) from Napoe have slight grayish bars on the rump but nothing like the coarse white bars of *Munia punctulata nisoria*.

In the original description only the measurement of the type was given. The four adult males measure as follows: Wing, 50-51 (50.5); tail, 36.5-40 (38.7); culmen, 11-11.5 (11.1); and the three adult females: Wing, 48-52 (50); tail, 36.5-39 (37.8); culmen, 10.5-11 (10.7).

The immature is buffy brown above and a light wood brown to cinnamon-buff below. A young male (Rano Lindoe, March 24, No. 251336), just beginning to molt into the adult plumage, has a few new feathers appearing on the mantle and on the throat and chest. An immature female (Gimpoe, Aug. 20, No. 252531) has almost assumed the adult plumage, except for the crown and some of the feathers on the throat, so it would appear that the adult plumage is assumed the first year and that the breeding season is irregular.

190. MUNIA MOLUCCA MOLUCCA (Linnaeus).

A good series of both sexes and immatures from: Kapas Bay, November 23, 1914; Toli Toli, December 9-18, 1914; Tandjong Pen-

⁹⁰ Birds of Celebes, vol. 2, 1898, p. 548.

⁹¹ Tr. Zool. Soc. Lond., vol. 8, 1872, p. 73.

⁹² Nov. Zool., vol. 19, 1912, p. 317.

joe, February 17, 1915; Likoe pang, March 2-6, 1916; Koeala Prang, June 17, 1916; Temboan, July 25-30, 1916; Koelawi, February 2-9, 1917; Gimpoë, August 2-27, 1917; Toewo Mountain, Besoa, October 29, 1917.

I have no specimens of typical *Munia molucca*, but am referring the above series to the typical form on geographic grounds.

Family EULABETIDAE.

GLOSSY STARLINGS.

191. BASILEORNIS CELEBENSIS G. R. Gray.

One male, Soemalata, September 9, 1914; one male, Kwandang, October 9, 1914; one male and one female, Temboan, July 30, 1916; two males, Rano Lindoe, March 16 and 21, 1917; one male, Gimpoë, August 21, 1917.

192. LAMPROCORAX PANAYENSIS NEGLECTUS (Walden).

A large series of adults of both sexes and immature from: Kwala Besar, August 23-24, 1914; Soemalata, September 8-9, November 3, 1914; Kapas Bay, November 23, 1914; Tandjong Penjoe, February 23-26, 1915; Koeala Prang, June 4-18, 1916; Parigi, September 12-24, 1916; Toboli, October 24-25, 1916; Tinomboë, December 15, 1916.

Adults of the above series when compared with Philippine specimens of typical *L. p. panayensis* are duller and darker, not so glossy, and with a tendency to have a bluish cast on the back; the upper surface of the tail and wings is also darker. There seems to be little or no difference in size, as the following will show:

	Wing.	Tail.	Culmen.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Ten males from Celebes.....	109. 2	74	20. 5
Ten males from the Philippines.....	110. 2	75	20. 6
Ten females from Celebes.....	104. 5	68. 5	19. 3
Ten females from the Philippines.....	105. 9	69. 3	19. 1

Eggs fully developed (Parigi, Sept. 23, 1916).—H. C. R.

193. LAMPROCORAX MONTOSA Riley.⁹³

A good series of both adults and immature from Rano Lindoe, March 4-16, 1917.

The following is the original description:

Similar to *Lamprocorax minor*, but feathers of the throat, jugulum, and sides of neck almost plain shining green, only a slight purplish sheen seen

⁹³ Proc. Biol. Soc. Wash., vol. 34, 1921, p. 57.

In certain lights; averaging slightly smaller. Wing, 99; tail, 59.5; culmen, 16; tarsus, 21; middle-toe, 17.5 mm.

Remarks.—The above species is founded upon 11 males, 8 females, and 3 immatures, all taken at the type locality, March 4-16, 1917. For comparison I only have three females of *Lamprocorax minor* from Pendek and Toba Islands, Buton Strait. There appears to be little difference in the sexes the female only being smaller and duller than the males. The series of *Lamprocorax montosa* is quite uniform, the purplish sheen on the throat and jugulum being faint and only seen in a favorable light and absent or nearly so from the sides of the neck.

In *Lamprocorax minor* the purplish sheen is much more pronounced on the throat and jugulum and even extends to the side of the neck; it is also apparently larger. The type of *Lamprocorax todayensis* (a female) from Mount Apo, Mindanao, resembles *Lamprocorax montosa* very much, but the feathers of the throat and jugulum are more lanceolate and the purple sheen is still fainter, almost lacking; the wings are duller. I attach no importance to the latter, as the series of *L. montosa* shows that as the plumage fades the iridescent green of the wings disappears and they become brownish and the backs steely. *Lamprocorax todayensis* and *montosa* are both mountain forms derived from the same stock, probably *Lamprocorax minor*, but as the latter appears to be even a later immigrant from the south into Celebes, it is better to treat them all as species for the present until more is known of their distribution and relationship.

Since writing the above the United States National Museum has acquired a specimen of *Lamprocorax minor* from Sumba Island. This has the purplish sheen on the throat and jugulum even more extensive than in the specimens from south Celebes; in fact it extends clear around the hind-neck, forming a collar.

The various series average as follows:

	Wing.	Tail.	Culmen.	Tarsus.	Middle toe.
	mm.	mm.	mm.	mm.	mm.
Ten male, <i>L. montosa</i> -----	98.7	60.3	15.3	20.2	16.4
Eight females, <i>L. montosa</i> -----	91.2	54.3	14.2	19.5	16.
Three females, <i>L. minor</i> , from S. Celebes-----	95.8	59.8	15.2	20	16.7
One female, <i>L. minor</i> , from Sumba---	95.5	53	14.5	19.5	15.5
One female, <i>L. todayensis</i> , the type--	95.5	56	14	20	16.5

191. STREPTOCITTA TORQUATA (Temminck).

A good series of adults and immature from: Paleleh, August 19 and November 13, 1914; Soemalata, September 4 and 7, 1914; Kwandang, September 16, 1914; Kapas Bay, November 20-21, 1914; Toli Toli, November 28, 1914; Kampa, February 14, 1915; Tandjong Penjoe, February 17-20, 1915; Likoepang, February 24-March 12, 1916; Manembo Nembo, June 23, 1916; Toemaratas, July 4, 1916; Temboan, July 17-30, 1916; Parigi, September 16-17, 1916; Laboea

Sore, November 19, 1916; Koelawi, January 27–28, 1917; Rano Lindoe, March 5–19, 1917; Tamboe, June 13, 1917; Gimpoe, August 3–23, 1917; Toare, September 20–23, 1917; Pinedapa, January 13 and February 8, 1918.

There appears to be no constant differences in birds from the north and the north-central mountainous country.

Two immature specimens, male and female, from Manembo Nembo, June 23 (249789–790), in worn abraded plumage, with short crests, have the scapulars, lesser wingcoverts, tips of the remiges, occiput, ear-coverts, and a central band down the rump cinnamon-brown; the backs have begun to acquire the shining bluish black of the adults; the chin blackish; the crest has begun to develop slightly; the male has the chest spotted with brownish, the female not; the breasts have a brownish cast; the tails are much as in the adults, except the feathers are tipped with brownish. Another stage of the immature is much like the adult, except only the chin is black, there is a band of black spots across the chest, and the white on the hind neck is less developed. Still another stage of immature has no black on the chin whatever and no chain of black spots across the chest and evidently represents an older stage than the above, as they were taken later in the year (Gimpoe, August 10, 252556–252257).

195. *ENODES ERYTHROPHRYS ERYTHROPHRYS* (Temminck).

A good series of both sexes from Goenoeng Kalabat, 1,700 meters, April 6–9, 1916, and Toemaratas, July 4 and 9, 1916.

196. *ENODES ERYTHROPHRYS CENTRALIS* Riley.⁶⁴

One male, the type, Goenoeng Lebio, January 13, 1917; one male, Winatoe, January 21, 1917; one male and two females, Lindoe Trail, February 28, 1917; three males and two females, Toewo Mountain, Besoa, October 29–November 3, 1917; one male, Rano Rano, December 28, 1917.

All the specimens from the northern part of the island have the peculiar superciliary feathers flame scarlet, while the above series from the north central region has them orange chrome; this is the most striking difference and seems to be constant, although there are other minor and inconstant characters that are only average. For the above reason I have ventured to separate the north-central bird, with the following description:

Similar to *Enodes erythrophrys erythrophrys*, but superciliaries orange chrome, not flame scarlet; rump and crissum lighter yellow; outer margin of wing feathers and upper surface of tail more greenish; and wing and tail shorter. Wing, 109; tail, 106.5; culmen, 19; tarsus, 26.5; middle toe, 21.5 mm.

⁶⁴ Proc. Biol. Soc. Wash., vol. 33, 1920, p. 56 (Goenoeng Lebio).

The two series average as follows:

	Wing.	Tail.	Culmen.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Seven males, north Celebes.....	115	113. 2	17. 8
Six males, north-central Celebes.....	111. 2	104. 6	18
Eight females, north Celebes.....	107. 2	104. 1	17. 7
Four females, north-central Celebes.....	104. 6	98. 3	16. 6

A bird of the year that seems to be fully grown, taken at Besoa, November 2, is lighter above and below than the adult and the supercilaries are light cadmium instead of orange chrome.

197. *SCISSIROSTRUM DUBIUM* (Latham).

A good series of both sexes of nearly all ages from: Soemalata, September 8-9, 1914; Likoe pang, February 23-March 10, 1916; Ayermadidi, May 6, 1916; Rano Lindoe, March 4-15, 1917; Gimpoë, August 5-24, 1917; Pinedapa, February 7, 1918.

After comparing a series from the north with another from the north-central mountainous area there appear to be no constant differences in size or color.

The majority of the specimens taken at Rano Lindoe in March are molting from a brownish-gray plumage to a slaty one; quite a number are undoubtedly immature as the red tips to the rump feathers are duller, but the brownish plumage must be due to fading, for a young bird just from the nest does not differ materially from the adult, except the lores are lighter and the red tips to the rump feathers are duller. The adult specimens taken at Gimpoë in August have the dark color of the lores and chin much reduced and are lighter than freshly molted March birds; this is probably due to fading, but some of the Gimpoë specimens are also molting. This would tend to show that they have two molts a year, or that individual birds may be found molting at any time.

Young, apparently taken from the nest and others barely able to fly, with short stumpy tails, were collected at Gimpoë August 24. The younger stage, with feathers only just appearing on the feather tracts, shows the red tips to the rump feathers where the tips are breaking through the sheath. A young female, about half grown, was taken at Rano Lindoe March 6; this seems to indicate that the breeding season must be irregular.

Judging from the series taken, this must be an extremely abundant bird on the island.

Family ORIOLIDAE.

ORIOLES.

198. *ORIOLUS CELEBENSIS CELEBENSIS* (Walden).

A good series of both sexes from: Kapas Bay, July 22 and November 22, 1914; Kwala Besar, August 23, 1914; Soemalata, September 4-8, 1914; Kwandang, September 17-October 26, 1914; Paleleh, November 9, 1914; Toli Toli, December 6, 1914; Tandjong Penjoe, February 17-26, 1915; Likoe pang, January 14-March 12, 1916; Ayermadidi, May 5, 1916; Koeala Prang, June 5 and 15, 1916; Batoe Hangoes Baroe, June 11, 1916; Temboan, July 17, 1916; Toboli, October 21-25, 1916; Laboea Sore, November 26, 1916; Lindoe Trail, February 25, 1917; Rano Lindoe, March 7-21, 1917; Gimpoë, August 3-25, 1917; Toare, September 23, 1917; Parigi, September 16-20, 1917; Pinedapa, February 9 and 21, 1918.

The majority of the specimens with the black occipital band interrupted or entirely absent are designated as females by the collector; some of the females possessing the black occipital band have this character less developed than in the fully adult males. Specimens indicated as males, with the occipital band interrupted behind, are probably younger males that have not acquired the fully adult plumage. In other words, the specimens before me seem to bear out Meyer and Wiglesworth's⁹⁵ belief that the interrupted occipital band is more or less sexual, it being united in the males and to a less extent in the old females. The variation in the tail pattern is more or less of a variable character, birds with the outer tail feather nearly solidly yellow, or with the base black outwardly, not being confined to either sex or age, except that the tails of the males average a greater amount of black. One female (No. 248581), taken at Tandjong Penjoe, February 17, has scarcely any black in the tail whatever, it being lemon chrome and pyrite yellow in the usual pattern, only slightly blackish next the yellow tip on the three pairs of feathers next the central pair. No other specimen approaches it.

A male in apparently adult plumage taken at Soemalata, September 8 (No. 248570), and another male taken at Parigi, September 20 (No. 250264) have the bills black, but that this is an immature character still retained is shown by an undoubted immature shot at Rano Lindoe, March 15 (No. 251032); all three have the black occipital band indicated.

No specimens from south Celebes are available for comparison but there are apparently no constant differences in color or size between

⁹⁵ Birds of Celebes, vol. 2, 1898, p. 587.

birds from the extreme north and the north-central mountainous country. The majority of northern birds are said to have the occipital black band interrupted, but in the extensive series before me this does not prove to be the case and as mentioned above there are grounds to suspect that this character is one of age, or to a certain extent sexual.

In any event *Oriolus celebensis meridionalis* Hartert⁹⁶ is preoccupied by *Oriolus meridionalis* Brehm.⁹⁷

Family DICRURIDAE.

DRONGOS.

199. DICRUROPSIS LEUCOPS (Wallace).

A good series of both sexes and nearly all ages from the following localities: Kwala Besar, July 29–31, 1914; Paleleh, August 1–19, 1914; Soemalata, September 6–8, 1914; Kwandang, September 16–October 8, 1914; Toli Toli, December 1, 1914; Tandjong Penjoe, February 17, 27, 1915; Likoepang, January 16–March 12, 1916; Teteamoet, February 3, 1916; Ayermadidi, April 1, 1916; Manembo Nembo, June 22, 23, 1916; Toemaratas, July 8, 1916; Toboli, October 26, 1916; Laboea Sore, November 21, 1916; Kasimbar, December 13, 1916; Rano Lindoe, March 7, 1917; Gimpoie, August 4–25, 1917; Pinedapa, January 14–February 20, 1918.

There are two young, with short stumpy tails, apparently just from the nest, taken at Teteamoet, February 3, and Pinedapa, February 20. Judging from this, the breeding season must be very early in the year.

Birds from the central and northern parts of Celebes do not appear to differ in size or color and a female in the United States National Museum from near Macassar is not essentially different.

The various series average as follows:

	Wing.	Tail.	Culmen.	Tarsus.	Middle toe.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Ten males, North Celebes.....	162. 4	140. 2	33. 5	24. 5	18. 4
Ten males, Central Celebes.....	163. 3	142. 7	32. 9	25. 6	18. 2
Ten females, North Celebes.....	159. 5	138. 9	32. 6	24. 7	18
Ten females, Central Celebes.....	161. 5	143. 3	32. 3	25	18. 6
One female, South Celebes.....	159	136	32	23	18. 5

200. DICRUROPSIS MONTANA Riley.⁹⁸

One female, Goenoeng Lechio, January 20, 1917; one male (type) and one female, Toewo Mountain, Besoa, October 28–29, 1917; one female, Rano Rano, December 22, 1917.

⁹⁶ Nov. Zool., 1896, p. 155.

⁹⁷ Isis, 1845, p. 332.

⁹⁸ Proc. Biol. Soc. Wash., vol. 32, 1919, p. 94 (Besoa, Celebes).

The original description is as follows:

Similar to *Dicruopsis leucops* but much smaller, especially the bill and feet; the metallic colors duller, more bronzy, and spots on the chest reduced in size; the tail more forked, the feathers narrower, and the outer pair less flared outwardly. Wing, 131; tail, 138; culmen, 24; tarsus, 19; middle toe, 14 mm.

In this genus there is practically no difference in color between the sexes and very little difference in size; females average slightly smaller. The three females of *Dicruopsis montana* measure as follows: Wing, 133.5–140 (137.5); tail, 133–152.5 (142.2); culmen, 24–24.5 (24.3); tarsus, 19.5–20 (19.7); middle toe, 14–14.5 (14.2). Nine females of *Dicruopsis leucops* measure: Wing, 154–167 (159.4); tail, 131–150 (138.6); culmen, 29–35.5 (32.6); tarsus, 24–26 (24.8); middle toe, 17–19 (18.2). From the above it will be seen how greatly the two above species differ in size; differences that can not be explained in any other way than that the smaller bird is specifically distinct.

To the original description there is one correction to be made, the locality given on the label, Besoa, proves to be a district; in Mr. Raven's field catalogue the precise locality is given as Toewo Mountain.

All the above localities are in the mountains, in the general region of Lake Lindoe.

This is one of Raven's most interesting discoveries and I am not really sure that it belongs in the same genus with *Dicruopsis leucops*, as the rictal bristles are longer, the bill and feet weaker, and the tail structurally different, but there seems no other place for it and it has been clearly derived from the lowland species.

Family CORVIDAE.

CROWS.

201. NESOCORAX TYPICA (Bonaparte).

A pair from Toewo Mountain, Besoa, October 26 and 30, 1917; and another pair from Pinedapa, January 14, 1918.

The above specimens were taken considerably north of any hitherto reported locality. They measure as follows:

No.	Sex.	Locality.	Wing.	Tail.	Culmen.
			<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
252239	Male	Besoa	218.5	115.5	48.5
252238	do	Pinedapa	232	123.5	50
252240	Female	Besoa	229	121.5	48
252237	do	Pinedapa	229	122	48

These birds are all similar and differ somewhat from Meyer and Wigglesworth's⁹⁹ description. The black of the throat is not sharply

⁹⁹ Birds of Celebes, vol. 2, 1838, p. 584.

defined but encroaches upon the white of the lower parts where it becomes fuscous-black; the white collar is bordered narrowly posteriorly with fuscous; there is a tuft of elongate white feathers, tipped with fuscous, on the flanks; the thighs are black like the back; and there are other slight discrepancies.

Seen only about patches of isolated woods or along the edge of heavy forest. Its call is very much like that of a jay, not at all like *Corvus*. Nest a structure somewhat like that of a crow, placed high in a tall tree at the border of a clearing, and composed of twigs, etc. Eyes hazel brown. Locally known as *koki* (Pinedapa).—H. C. R.

As Walden¹ has clearly shown that *Gazzola* Bonaparte can not be used for this genus and as no one has apparently proposed a substitute, I have reluctantly renamed it *Nesocorax*.²

202. CORVUS ENCA Horsfield, subspecies?

A good series of both sexes and young from: Tandjong Tango, August 28, 1914; Soemalata, September 3-7, and November 3, 1914; Kwandang, September 20, 1914; Paleleh, November 9, 1914; Boesak, November 16, 1914; Kapas Bay, November 18-22, 1914; Toli Toli, November 25-December 20, 1914; Tandjong Penjoe, February 17-27, 1915; Likoepang, January 16-March 11, 1916; Ayermadidi, April 4-May 16, 1916; Batoe Hangoes Baroe, June 11, 1916; Manembo Nembo, June 22, 1916; Temboan, July 20, 1916; Parigi, September 9-10, 1916; Toboli, October 12-27, 1916; Tinomboe, December 15, 1916; Koelawi, January 6-7, 1917; Winatoe, January 10, 1917; Rano Lindoe, March 9, 1917; Gimpoë, August 5, 1917; Toeare, Bada, October 3, 1917; Pinedapa, February 14, 1918.

The above large series of crows shows quite a little individual variation in size. I have been able to compare them with only two Javan specimens (a male and female), and while the latter seem to have the bill proportionately slenderer and less arched, the series is too unequal to form any definite opinion, except that I believe with Meyer and Wigglesworth³ that they are hardly the same. Even if they should prove to be racially separable, the proper name could only be determined by an examination of Brüggemann's types of the several species described by him from Celebes.

Birds from the north end of Celebes average slightly larger than those from the north-central part, but the differences are not great enough to warrant recognition by name.

Generally common; it seems to prefer coconut groves.—H. C. R.

¹ Trans. Zool. Soc., vol. 8, 1872, p. 74.

² Auk, vol. 38, 1921, p. 458.

³ Birds of Celebes, vol. 2, 1898, p. 581.

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NEW NORTH AMERICAN PARASITIC COPEPODS, NEW HOSTS, AND NOTES ON COPEPOD NOMENCLATURE.

By CHARLES BRANCH WILSON,

Department of Biology, State Normal School, Westfield, Massachusetts.

INTRODUCTION.

This is the seventeenth paper in the series dealing with the parasitic copepods in the collection of the United States National Museum.¹ It is chiefly concerned with two collections recently received by the author. One of these was from Dr. H. M. Smith, former Commissioner of Fisheries, and included specimens collected by him at Woods Hole during the summer of 1922. The other was from Dr. Edwin Linton, the able parasitologist, and was made up of specimens collected at Woods Hole during the past 15 years. To both of these investigators sincere thanks are returned for the material thus placed at the author's disposal.

To these collections have been added specimens sent for identification, and a few others belonging to the original lot sent from the United States National Museum. Together these constitute an important addition to the valuable Museum series, in which they appear under the numbers here recorded. They include a new genus, several new species, and many new hosts.

¹ The sixteen preceding papers, all of which were published in the Proceedings of the United States National Museum, are: 1. The Argulidae, vol. 25, pp. 635-742, pls. 8-27. 2. Descriptions of Argulidae, vol. 27, pp. 627-655, 38 text figures. 3. The Caliginae, vol. 28, pp. 479-672, pls. 5-29. 4. The Trebinae and Euryphorinae, vol. 31, pp. 669-720, pls. 15-20. 5. Additional Notes on the Argulidae, vol. 32, pp. 411-424, pls. 29-32. 6. The Pandarinae and Cecropinae, vol. 33, pp. 323-490, pls. 17-43. 7. New Species of Calliginae, vol. 33, pp. 593-627, pls. 49-56. 8. Parasitic Copepods from Pacific Coast, vol. 35, pp. 431-481, pls. 66-83. 9. Development of *Achtheres ambloplitis* Kellicott, vol. 39, pp. 189-226, pls. 29-36. 10. The Ergasilidae, vol. 39, pp. 263-400, pls. 41-60. 11. Descriptions of new genera and species, vol. 39, pp. 625-634, pls. 65-68. 12. Descriptions of new species, vol. 42, pp. 233-243, pls. 30-34. 13. The Lernaeopodidae, vol. 47, pp. 565-729, pls. 25-56. 14. The Lernaeidae, vol. 53, pp. 1-150, pls. 1-21. 15. The Sphyridae, vol. 55, pp. 549-604, pls. 50-59. 16. The Dichelesthidae, vol. 60, Art. 5, pp. 1-100, pls 1-13.

NEW SPECIES AND A NEW GENUS.

ARGULUS NOBILIS, Thiele.

Plate 1, figs. 6-9.

Argulus nobilis THIELE, Mittheilungen aus dem Zoologischen Museum zu Berlin, vol. 2, Heft 4, p. 28, pl. 7, figs. 64-66; pl. 8, figs. 67-76, 1904.

Argulus ingens WILSON, Proceedings U. S. National Museum, vol. 42, 1912, p. 233, pl. 30, figs. 1-6; pl. 31, fig. 7.

Host and record of specimens.—The New York aquarium secured from Lake Calcasieu, Louisiana, about two years ago a colony of alligator gars, *Lepisosteus tristoechus*, and kept them on exhibition for a long time. They became so badly infested with the above species of *Argulus* that it was necessary to take the fish out of their aquarium and remove the parasites. The latter were preserved and sent to the author for identification; they included adults of both sexes and various developmental stages. The amount of material was sufficient to make possible the identity of the two species indicated above.

Thiele had but seven specimens, including a single male, when the species was originally described, while the present author had one male and two females upon which to found the species *ingens*. Between the species as described and figured there were substantial differences. But the large number of specimens in the present material, and especially the developmental stages, forms a series that passes into *nobilis* on the one hand, and into *ingens* on the other. We are forced to conclude therefore that the two forms are simple variations of one and the same species, and if so, Thiele's name takes precedence. Such a conclusion was suggested by the present author in 1916,² but at that time there was no basis of actual proof. The two descriptions with their accompanying figures may be accepted as published, each for its own variety. The one presented by Thiele may then be known as *Argulus nobilis*, variety *nobilis*, and the one by the present author as *Argulus nobilis*, variety *ingens*.

In the present paper developmental stages are described and figured for the first time.

Color.—Thiele stated that his specimens were faintly tinged with brown, but when alive were probably transparent. The color of *ingens* (preserved material) was given as a uniform yellowish-brown. The present material shows a few specimens that are almost transparent, others that are yellowish-brown, and still others that are dark cinnamon-brown. The general impression of a hundred specimens spread out dorsal side uppermost is a dark shade of brown.

² Bulletin, Bureau of Fisheries, vol. 34, p. 354.

Young male.—The dorsal view of a male about 4 mm. long is shown in Figure 6 and attention is called to many differences between this form and the adult. The carapace is fully a fourth longer than wide, and it only reaches the anterior margin of the third legs instead of overlapping the abdomen: the posterior sinus is short and fully as wide as long. The arrangement of the chitin ribs on the dorsal surface of the head is more distinct than in mature specimens, and is different from that shown in any of the published figures. The chitin ribs are strongly curved between the lateral eyes, and each is forked just behind the median eye, posterior to which the two are nearly parallel. The inner branch of the fork curves backward and inward and meets its fellow from the other side on the midline, forming a reentrant notch. The outer branch curves backward and outward and nearly or quite meets the lateral groove.

Behind the posterior end of this lateral groove, and extending forward a short distance on either side, is a narrow fold of skin. From either end of this skin fold a groove extends backwards and inwards to the corresponding corner of the base of the posterior sinus.

The abdomen is nearly one-third of the entire length, and is also one-half longer than wide. It is widest at the center instead of at the anterior end and shows but the faintest indication of the finger-like processes that later appear at the anterior corners. The testes are half in front and half behind the longitudinal center, whereas later they are wholly in front of the center. The posterior sinus is less than a fourth of the abdomen's length; the anal laminae are lateral, but much nearer the distal than the proximal end of the sinus; the posterior lobes are broad and bluntly rounded.

The swimming legs are like those of the adult except that they are relatively longer and more slender. The boot-like lobes at the base of the posterior pair are also longer and narrower. Such great differences are suggestive of another species, but the appendages and mouth-parts are exactly like those of the adult, and all the intermediate stages are present to show just how the transformation progresses.

Young female.—The young female differs from the adult in much the same particulars as the male. The abdomen of one only 4 mm. in length is seen in Figure 7, and it may be noted that it corresponds exactly with that of the young male. Two or three details stand out much more clearly than in the adult. The first of these is the peculiar form of the basal plate of the maxillipeds shown in Figure 8. Neither Thiele's figure (pl. 8, fig. 68) nor that of the present author³ show the sharp bend in this plate just above the raised area.

³ Proc. U. S. Nat. Mus., vol. 42, 1912, pl. 30, fig. 3.

The two outer teeth of this plate are so close together and so far removed from the inner one that it seems as if there must have been originally a single tooth at each corner of the plate, and that the outer one subsequently divided.

The second feature is easily overlooked in the adult and has not been noted hitherto. On the endopods of the third and fourth legs in both sexes, at the distal end of the basal joint and on the anterior margin is a finger process extending obliquely outwards. These processes in the male are larger than in the female, and in both sexes those on the fourth legs are longer than those on the third legs.

A third feature is the boot-shaped lamella at the base of the fourth legs in the female. These are larger than those of the male and have a pronounced heel (fig. 9).

Remarks.—It is well that these two very large argulids should be thus identified, but the very fact that an exceptional abundance of material has led to this result suggests that other closely related species might share the same fate if they could be bred in sufficient numbers. The larger the species the better it seems to thrive when breeding upon fish in captivity. *Argulus mississippiensis* and *A. lepidostei* breed in large numbers upon the gars used in experiment work at Fairport, Iowa. The present author, assisted by Mr. H. W. Clark, picked over 1,200 specimens of these two species of parasites from three rather small gars at Fairport, September 3, 1920.

ARGULUS PAULENSIS, new species.

Plate 1, figs. 1-5.

Host and record of specimens.—Two females and a male of this new species were taken from the outside surface of a fresh-water fish called by the natives "Talrirana" at Itatiba, Sao Paulo, Brazil. Both females contained eggs nearly ready for laying, and the larger one was evidently fully matured. The three have been given Cat. No. 54111, U.S.N.M., and the larger female is made the type of the new species.

Specific characters of the female.—Carapace orbicular, a little wider than long and three-fourths of the entire length, but not covering the bases of the third and fourth legs. Posterior sinus wide and shallow, one-fifth the length of the carapace, its lateral margins widely divergent; posterior lobes broadly rounded. Free thorax narrowing rapidly posteriorly; abdomen elliptical, one-fourth longer than wide; anal sinus wide and about one-quarter the length of the abdomen (28 per cent); anal laminae subbasal, long and narrow.

First antennae long and moderately stout, no hook or spine on the anterior margin; lateral hook as long as the terminal portion and strongly curved. Second antennae short and rather stout. Eyes

small, placed far forward, well separated, and very weakly pigmented. Sucking disks large, and placed well forward, each one-fifth as wide as the carapace. The ribs which support their free margins are slender, straight, tapering, and about 12-jointed. The maxillipeds are stout, the basal joint armed with three bluntly truncated laminae on its posterior margin; the ventral surface of the second and third joints is covered with small corrugations which do not quite touch one another. The first and second legs are well covered by the carapace, the third and fourth pairs are entirely visible in dorsal view. The lobes on the basal joints of the fourth pair are narrow-conical and about half the length of the second joint. The first two pairs are furnished with large flagella, but there are none on the last two pairs; these are specially prominent on the older female.

Color.—(Preserved material) a plain grayish white, the eggs showing through as a distinct orange-yellow; eyes almost invisible but with a faint wash of reddish-brown.

Total length 6 mm. Carapace 4.50 mm. long, 4.80 mm. wide. Abdomen 1 mm. long, 0.80 mm. wide. The larger female measures 8.50 mm. in total length and the carapace is 7.50 mm. wide.

(*paulensis*, from Sao Paulo, Brazil.)

Specific characters of the male.—The male is smaller than the female but otherwise quite similar. Carapace wider than long and not reaching the anterior margins of the third legs. Abdomen relatively larger than in the female and nearly as wide as long. Eyes larger, farther forward, and closer together than in the female. Of the supplementary sexual characters the peg on the second joint of the fourth legs is large and long and extends diagonally outward. There is a small protuberance on the posterior margin of the basal joint of the third legs, and a wide flap or lamina on the posterior margin of the second joint. The second legs have a long and narrow flattened projection on the posterior margin of the second joint.

Color.—Similar to that of the female.

Total length 5.50 mm. Carapace 3.85 mm. long, 4 mm. wide. Abdomen 1.08 mm. long, 1 mm. wide.

Remarks.—This is another of the fresh-water argulids of South America, and may be distinguished from Krøyer's *salminei* as follows:

Krøyer said of his species, "Color a pleasing liver-brown, with a narrow dark margin anteriorly on the upper surface of the carapace and a small dark spot at the base of the incision of the tail (genital segment). The grooves which separate the cephalic from the lateral areas are darker and more yellow in color than the rest of the dorsal integument. Eyes black * * *. In the male the dark border of the carapace and the small black spot at the base of the anal sinus

are lacking."⁴ He was describing preserved material from the Copenhagen Museum and hence his statements may safely be compared with those made above for the present species. Here the color is plain white, the only pigment visible is the orange-yellow of the matured eggs, the eyes are not black but very pale reddish-brown. In *salminei* the carapace is longer than wide; Krøyer gave the proportion as 20 to 19; here it is wider than long, as 19 to 18. In *salminei* the abdomen of the female is one-eighth of the total length and is wider than long; here the abdomen is one-sixth of the total length and is a fourth longer than wide.

Krøyer's specimen of the male was a little more than a third of the length of the female, its carapace lobes overlapped the abdomen, and both carapace and abdomen were considerably longer than wide. In the present species the male is relatively much larger, its carapace lobes do not reach even the third legs and the carapace is decidedly wider than long while the abdomen has a length and breadth which are about equal. In *salminei* the sucking disks are each a third of the width of the carapace and so close together that they nearly touch; here they are less than a fifth of the width of the carapace and are well separated. In *salminei* the posterior sinus of the carapace is one-fourth of the length of the carapace with nearly parallel sides; here it is much shorter and the sides are widely divergent.

The male described by Thiele⁵ and referred to Krøyer's *salminei* apparently does not belong to that species. It does, however, correspond almost exactly with the present species and may well belong here.

ANCHISTROTOS OCCIDENTALIS, new species.

Plate 2, figs. 10-18.

Host and record of specimens.—Six females with egg strings were taken from the gills of the orange file fish, *Alutera schoepfii* at Woods Hole, July 13, 1911, by V. N. Edwards. They become the types of the species and have been given Cat. No. 54138, U.S.N.M.

Specific characters of the female.—Cephalothorax strongly arched dorsally, flattened and reentrant ventrally and much larger than any of the free thorax segments. The latter diminish regularly in size and the fifth segment is distinctly separated from and considerably wider than the genital segment, its greatest width being through the bases of the fifth legs. The genital segment is much wider than long; the abdomen is four-jointed, the joints about the same length but diminishing slightly in width. The anal laminae are small, widely separated, and divergent, each armed with two unequal setae at the tip and several smaller ones on the dorsal surface. The egg

⁴ Bidrag til Kundskab om Snyltekrebsene, 1863, p. 16.

⁵ Mittheilungen aus dem Zoologischen Museum zu Berlin, vol. 2, pt. 4, p. 26.

strings reach to about the center of the long anal setae, eggs in seven or eight rows, about 15 in each row.

First antennae cylindrical, slightly widened and flattened at the base, indistinctly six-jointed, and armed with rather small setae. Second antennae small, the terminal joint tipped with two long, curved claws, with three setae on the inner margin and a corrugated area similar to that in *Bomolochus* on the outer margin. Maxillipeds with a stout and well developed basal joint and a slender terminal claw, the latter bent into the shape of a sickle. First swimming legs with each ramus composed of a single joint and armed with broad and flattened setae; second, third, and fourth legs with toothed spines on their outer margins, five on the second and third legs and three on the fourth legs. In addition to the teeth along its outer margin each spine has a terminal filament attached to its inner margin near the tip (fig. 18).

Color.—(Preserved material) a uniform light yellowish-brown.

Total length, including anal setae, 2 mm. Cephalothorax 0.50 mm. long, and the same width. Free thorax 0.80 mm. long; second segment 0.35 mm. wide.

(*occidentalis*, western, American, in allusion to the fact that all the preceding species of the genus have been obtained from the Mediterranean.)

Remarks.—This genus was established by Brian in 1906 to include some tiny parasites found upon fish in the Bay of Naples. Two other species, also from the Mediterranean, were transferred to this genus by the present author in 1911. The species here described is the first to be found outside of the Mediterranean and this fact has been emphasized in the specific name.

PARAPANDARUS, new genus.

Generic characters of female.—Body elongate-obovate; cephalothorax narrowed anteriorly, cephalic area clearly differentiated, no posterior lobes. Second, third, and fourth thoracic segments each with a pair of dorso-lateral plates; fourth legs visible dorsally on either side of the genital segment behind the third pair of plates. Genital segment not hardened on dorsal surface; sixth segment in the form of a rounded lamina fitting into the posterior sinus of the genital segment as in *Pandarus*. Abdomen one-jointed, with modified anal lamina. Egg strings attached to genital segment between sixth segment lamina and abdomen. First three pairs of legs with two-jointed rami; rami of fourth pair one-jointed. Second antennae much enlarged, prehensile; maxilliped with terminal claw and not a pad.

Generic characters of male.—Carapace broad; posterior lobes straight and bluntly rounded; no secondary lobes; lateral grooves

similar to those in *Pandarus* male; frontal plates prominent, separated by a deep central sinus. Free segments without dorsal plates, all of the same width which is equal to that of the genital segment. Second segment with a pair of postero-lateral lobes, extending diagonally outward and backward; fourth segment with a lateral knob on either side, nearer the anterior margin. Genital segment with knob-like processes at anterior corners and wide rounded lobes at the posterior corners. Abdomen two-jointed, joints equal. Swimming legs all biramose, rami two-jointed. Maxillipeds with stout terminal claw, shutting against two corrugated knobs on basal joint.

PARAPANDARUS NODOSUS, new species.

Plate 2, figs. 19-24; plate 3.

Host and record of specimens.—Twenty females and ten males of this new genus and species were taken from the gills of a large hammerhead shark, *Sphyrna zygaena*, at Woods Hole, July 5, 1911. All were full grown and the females each bore egg strings. Both sexes were securely fastened to the gill arches by their powerful second antennae and maxillipeds. This will be noted as one important difference between the present genus and *Pandarus*, the latter being always an external parasite on the fins or skin.

A single female has been selected as the type of the new species and has been given Cat. No. 54139, U.S.N.M. The remaining specimens become paratypes with Cat. No. 54140, U.S.N.M.

Specific characters of female.—To the generic characters already given the following may be added. The width of the carapace across its posterior margin is to its length as 8 to 5; the posterior corners are bluntly rounded and point straight outward; the posterior margin is nearly straight and has no trace of teeth, so common in *Pandarus*. On either lateral margin, a short distance in front of the posterior corner is a notch representing the division between the head and the first thoracic segment. If a line be drawn from this notch diagonally inward and backward to the center of the posterior margin, the triangular corner of the carapace outside of and behind the line will represent one dorsal plate of the first thoracic segment. In specimens which have become swollen by the preservative this first plate is often inclined upward at an angle with the rest of the carapace, and is thus still further differentiated. The dorsal plates of the second, third, and fourth thoracic segments are attached to the dorsal surface of their respective segments diagonally, and project outward and backward in broadly rounded curves. The combined width of the two plates forming each pair is about equal to that of the carapace. The first pair do not quite touch each other on the midline and a triangular portion of the second segment comes to an

invaginated point between them.* The bases of the other pairs do touch and the plates themselves overlap slightly. Posteriorly the third plates slightly overlap the genital segment. Behind these plates on either side is seen another similar lamina, which appears at first sight like one of another pair of plates, but is really the enlarged basal joint of the fourth swimming leg.

The genital segment is a little longer than wide with rounded corners and a wide sinus at the center of the posterior margin on the dorsal surface. On the ventral surface is the base of the abdomen, on either side of which a stout spine extends backward and is visible in dorsal view behind the genital segment and outside of the sixth segment.

The abdomen is one-jointed and is covered ventrally by a rounded plate, slightly invaginate on its posterior margin and extending considerably beyond the sixth segment lamina in width and length. Near its base this plate bears a pair of modified anal laminae similar to those on *Pandarus*. There are no adhesion pads anywhere on the ventral surface; the exceptionally developed second antennae are abundantly capable of holding the parasite securely in position. Moreover its mode of attachment is entirely different from that of *Pandarus*. The latter fastens itself to the flat surface of the fins or skin where an adhesion pad can and does function. The present genus fastens to the gill arch and its body hangs free so that adhesion pads would be of no service. The egg strings are attached to the posterior end of the genital segment between the sixth segment lamina and the abdomen and are from one and a half to two times the length of the whole body.

The first antennae are like those of *Pandarus*; the second pair are greatly enlarged and are bent into the shape of a sickle. They project in front of the carapace and are visible in dorsal view. The mouth tube is narrow and conical, three times as long as it is wide at the base and sharply pointed. The first maxillae are short and consist of a moderately stout basal joint and a comparatively small terminal claw; they are situated at the base of the mouth tube and point inward toward each other. The second maxillae have a stout basal joint with a projecting knob on its outer margin near the tip, while the terminal claw is bifid for half its length. The basal joint of the maxillipeds is triangular and the stout terminal claw is attached to the outer corner of its distal margin. At the inner corner is a cup-shaped hollow into which the tip of the claw fits when it is closed.

The rami of the first three pairs of swimming legs are two-jointed, those of the fourth pair are one-jointed. The basal joint of the exopod of the first legs is armed with a single spine, while the ter-

minal joint has a row of seven spines around its margin, but no hairs or setae. The basal joint of the endopod is unarmed, while the terminal joint has a single spine and a fringe of short hairs. The basal joints of the other legs have a fringe of hairs along their outer margin, and the rami are armed with both hairs and spines but no setae.

Color.—(Preserved material) a uniform yellowish white without pigment anywhere. But the specimens were evidently preserved in picric acid so that their present color counts for very little.

Total length 13 mm. Carapace 3.85 mm. long, 6.40 mm. across its posterior margin. Genital segment 4.20 mm. long, 3.60 mm. wide. Egg strings 15 to 20 mm. long and very slender.

(*nodosus*, covered with knobs, alluding to the sides of the fourth segment and the anterior corners of the genital segment in the male.)

Specific characters of male.—Carapace orbicular, as wide as long; posterior lobes one-third the length of the carapace and broadly rounded; posterior margin straight and unarmed; lateral grooves distinct and S-shaped. First free segment with a lateral lobe on either side extending diagonally backward; second free segment transversely elliptical, one-half wider than long. Third free segment with each lateral margin prolonged into a conical knob, pointing diagonally forward and with a bluntly rounded tip; the segment in front of the knobs is narrowed into a short neck.

The genital segment is oblong, nearly a half longer than wide; the anterior corners are prolonged into knobs similar to those on the sides of the fourth segment, while the posterior corners extend backward in wide, bluntly rounded lobes, which are curved slightly inward. On the sides of the segment just in front of the posterior lobes the rudimentary fifth legs are visible in ventral view.

The abdomen is two-jointed and shaped somewhat like an hour glass, being narrower across the groove that separates the two joints, and wider across the anterior and posterior ends. The anal laminae are huge affairs, each of them wider and longer than the entire abdomen, overlapping at the center and tipped with four large nonplumose setae.

Of the appendages the second antennae are smaller than those of the female but still larger than the average for these *Nogaus* forms. The maxillipeds have a triangular basal joint but their attachment is near the center of one of the sides instead of at one of the apices. The terminal claw, instead of shutting down into a pocket, shuts against two corrugated knobs on the basal joint. The swimming legs are armed with stout plumose setae and spines arranged as follows, the setae appearing first; first endopod, 0—0, 4—0; first exopod, 0—1, 3—4; second endopod, 1—0, 8—0; second

exopod, 0—1, 6—3; third endopod, 1—0, 6—0; third exopod, 0—0, 5—4; fourth endopod, 1—0, 5—0; fourth exopod, 1—1, 4—4.

Remarks.—This new genus is closely related to *Pandarus* as has been indicated in its name. It differs, however, in the size, shape, and arrangement of the dorsal plates on the free thorax, in the greater development of the second antennae, in the entire absence of adhesion pads, and in the relative size of the sixth segment and abdomen in the female. The male differs in the knobs on the lateral margins of the fourth segment and at the anterior corners of the genital segment, and in the great enlargement of the anal laminae. The body, the plates, and the appendages are softer than those of *Pandarus* and easily become inflated in the preservative.

NEW HOSTS AND NEW LOCALITIES.

ARGULUS ALOSÆ Gould. Four lots of this species were taken from tomcod, *Microgadus tomcod*, in Bass River, Nova Scotia July 27, 1921. After identification they were returned to the Commissioner of Dominion Fisheries at Ottawa, Canada.

ARGULUS LATICAUDA Smith. Twelve specimens, including both sexes, were taken from the toadfish, *Opsanus tau*, at Woods Hole August 4, 1908. They have received Cat. No. 54104, U.S.N.M.

ARGULUS PUGETTENSIS Dana. Four females were taken by the Fisheries steamer "Albatross" from the viviparous perch, *Cymatogaster aggregatus*, off the coast of California in the summer of 1915, and have received Cat. No. 53496, U.S.N.M. Two lots, including both sexes, were obtained from the wall-eyed surfhish, *Hyperprosopon argenteus*, on the Pacific coast by J. R. Beck. They have been given Cat. Nos. 53532 and 53533 U.S.N.M. respectively.

ARGULUS STIZOSTETHII Kellicott. Twelve females and two males were taken from the Muscalunge, *Esox nobilior*, in Squirrel Lake, Vilas County, Wis., July 20, 1907. One female and one male have been deposited in the National Museum with Cat. No. 49797, U.S.N.M.

CALIGUS RAPAX Milne Edwards. A single female was found in the mouth of a striped sea robin, *Prinotus striatus* by V. N. Edwards at Woods Hole May 14, 1913, and has been given Cat. No. 54105, U.S.N.M.

CALIGUS THYMNI Dana. Two females were taken from the gills of a swordfish, *Xyphias gladius*, at Woods Hole, July 14, 1911, by Dr. Edwin Linton. They have received Cat. No. 54103, U.S.N.M.

LEPEOPHTHEIRUS EDWARDSI Wilson. Two males were taken from the gills of the goosefish, *Lophius piscatorius* at Woods Hole, May 25, 1914, by V. N. Edwards, and have been given Cat. No. 54106, U.S.N.M.

LEPEOPHTHEIRUS PARVIVENTRIS Wilson. Two females were taken from a kelpfish, *Iridio semicinctus*, on the coast of southern California and have received Cat. No. 53492, U.S.N.M. Three females were taken from a sting ray, *Urolophus halleri*, by Prof. A. B. Ulrey in an aquarium at the marine station of the University of Southern California, at Venice, California, July, 1919, and have received Cat. No. 53553, U.S.N.M.

ALEBION GRACILIS Wilson. A single female was taken from the skin of Milbert's shark, *Carcharhinus milberti*, at Woods Hole, August 5, 1922, by Dr. H. M. Smith. It has received Cat. No. 54141, U.S.N.M., and is the first specimen of this species to be recorded from this host.

- PANDARUS CRANCHII** Leach. A dozen females were taken from the skin of the same Milbert's shark, and have been given Cat. No. 54150, U.S.N.M.
- ECHTHROGALEUS COLEOPTRATUS** Guérin. A single female was taken in company with the two preceding species, Cat. No. 54149, U.S.N.M.
- ERGASILUS CAERULEUS** Wilson. Four females were found upon the gills of the common sucker, *Catostomus commersoni*, at Green Bay, Lake Michigan, by Prof. A. S. Pearse, August 3, 1920. They have received Cat. No. 54146, U.S.N.M. Another lot of twelve females was taken at the same time and place from the gills of the redeye, *Ambloplites rupestris*, and has Cat. No. 54145, U.S.N.M.
- ERGASILUS MANICATUS** Wilson. Ten females were taken from the gills of the two-spined stickleback, *Gasterosteus bispinosus*, at Woods Hole July 20, 1910, by Dr. Edwin Linton; Cat. No. 54107, U.S.N.M.
- ERGASILUS VERSICOLOR** Wilson. Twelve females were taken from the gills of the red-mouthed buffalo, *Ictiobus cyprinella* by the present author at Fairport, Iowa, July 20, 1915; Cat. No. 53497, U.S.N.M.
- ANTHOSOMA CRASSUM** (Abildgaard). Four females were taken from the gills of a man-eater shark, *Carcharodon carchariae* at Woods Hole, June 23, 1910, by V. N. Edwards; Cat. No. 54110, U.S.N.M.
- LERNANTHROPUS BREVOORTIAE** R. Rathbun. Two females were taken from the gills of the hickory shad, *Pomolobus mediocris*, at Woods Hole, August 20, 1910, by Dr. Edwin Linton; Cat. No. 54108, U.S.N.M.
- NEMESIS ATLANTICA** Wilson. Four females were found on the gills of the dusky shark, *Carcharias obscurus*, at Woods Hole, July 25, 1910, by Dr. Edwin Linton; Cat. No. 54109, U.S.N.M. A second lot of twelve females were taken from the gills of a thresher shark, *Alopias vulpes*, at Woods Hole, August 23, 1922, by Dr. H. M. Smith; Cat. No. 54147, U.S.N.M.
- KRØYERIA LINEATA** P. J. van Beneden. A single female was found on the gills of a hammerhead shark, *Sphyrna zygaena*, at Woods Hole, July 5, 1911, by V. N. Edwards; Cat. No. 54142, U.S.N.M. This species has never before been reported outside of the Mediterranean.
- LERNAEA CRUCIATA** (Le Sueur). A single female was taken by the present author from the flesh of the bluegill, *Lepomis pallidus*, at Fairport, Iowa, July 15, 1918; Cat. No. 53477, U.S.N.M. Two females were also taken from the flesh of the wide-eared sunfish, *Lepomis eurymorus* at the same time and place; Cat. No. 53479, U.S.N.M. Two females were taken from the flesh of the orange-bellied sunfish, *Lepomis miniatus*, in Bear Lake, Louisiana, by A. F. Shira, former superintendent of the biological station at Fairport; Cat. No. 53480, U.S.N.M.
- LERNAEA VARIABILIS** (Wilson). Two females were taken from the flesh of the bullhead, *Ameiurus nebulosus*, July 21, 1920, at Fairport, Iowa, by the present author; Cat. No. 53470, U.S.N.M.
- PENNELLA ORTHAGORISCI** Wright. A single female was taken from the flesh of the albacore, *Germo alalunga*, at Santa Cruz Island, California, September 24, 1919, by O. E. Sette; Cat. No. 54148, U.S.N.M.
- CLAVELLA INSOLITA** Wilson. Two females were obtained from the gills of *Notothenia sima* in the Straits of Magellan by the fisheries steamer "Albatross" in the summer of 1908; Cat. No. 53476, U.S.N.M. This species has been known hitherto only from the north temperate Atlantic.
- LERNAEENICUS AFFIXUS** Wilson. Two females were obtained by V. N. Edwards from the flesh of the common stickleback, *Gasterosteus bispinosus*, at Woods Hole, July 16, 1910; Cat. No. 53474, U.S.N.M.

LERNAEENICUS LONGIVENTRIS Wilson. Two females were taken from the flesh of the sea drum, *Pogonias cromis*, at Ocean View Station, Norfolk, Va., October 13, 1922; Cat. No. 56551, U.S.N.M.

SALMINCOLA GIBBER (Wilson). Ten females from the roof of the mouth and tongue of the char, *Salvelinus alpina alipes*, from Cairn Lake, and twelve females on the same host from Konochickalak Lake, McMillan's Baffin Land Expedition, June 28 and July 7, 1922; Cat. No. 56552 and 56553, U.S.N.M.

SALMINCOLA CARPENTERI (Packard). A dozen females were obtained by the fisheries steamer "Albatross" from the gills of the Frazer River salmon, *Oncorhynchus nerka*, in British Columbia; Cat. No. 53512, U.S.N.M.

ACHTHERES AMBLOPLITIS Kellicott. Twelve females were taken from the gills of the burbot, *Lota maculosa*, at Sturgeon Bay, Lake Michigan, July 27, 1920, by Prof. A. S. Pearse; Cat. No. 54144, U.S.N.M.

ACHTHERES COREGONI (S. I. Smith). A single female from the gills of the blackfin cisco, *Leucichthys nigrispinis*, at sturgeon Bay, Lake Michigan, July 26, 1920, by Prof. A. S. Pearse; Cat. No. 54143, U.S.N.M.

ACHTHERES CORPULENTUS Kellicott. Two females from the gills of the cisco, *Leucichthys johanna*, at the same place and date; Cat. No. 56554, U.S.N.M.

NOTES ON COPEPOD NOMENCLATURE.

During a study of parasitic copepods extending over 20 years many discrepancies have been observed, which there has been no opportunity to correct. At the very outset of the work it was realized that, while it is possible to separate the group on an ecological basis into free-swimmers, semiparasites, commensals, and parasites, these distinctions largely disappear when the copepods are considered from a morphological or systematic standpoint. Accordingly it was found necessary to include the entire group both in the bibliography and in the record of species and genera. As a result two card catalogues have been gradually accumulated, one bibliographic and the other systematic. By comparing the two with each other and with Scudder's Nomenclator Zoologicus and Sharp's Index Zoologicus it has been possible to separate a group of generic and specific names which have been preoccupied. Another small group are of such doubtful validity that they can not be accepted according to our present knowledge, or must even be discarded. A third group contains a remarkably large number of copepod genera, which were established prior to 1901, but which do not appear in either of the above lists. And finally there are numerous instances in which mistakes or omissions have been made in the record as it appears in the two lists named above.

PREOCCUPIED GENERIC NAMES.

In suggesting names to replace those already used an effort has been made to preserve as far as possible the meaning of the original word. Where this has proved to be impractical the name has been radically changed.

Genus *APLOSTOMA* Canu. New name *TRANESTOMA* (τρανής, plain and στόμα, mouth).

Aplostoma Canu, Comptes Rendus, vol. 103, 1886, p. 1025.

Type of genus, *Aplostoma brevicauda* Canu, monotypic.

Aplostoma was used by Moquin-Tandon in 1885 for a genus of mollusks.

Genus *ASPIDISCUS* Norman. New name, *SACODISCUS* (σάκος, shield; δίσκος, carapace).

Aspidiscus Norman, Report of British Association for Advancement of Science, 1868, p. 298.

Type of genus, *Aspidiscus fasciatus* Norman, monotypic.

Aspidiscus used for genus of polyps in 1825 by Kőnnechtedy. Norman's genus not accepted by Brady in 1880, but restored by Sars in 1904.

Genus *AXINE* Oken. *NAOBRANCHIA* Hesse (?), 1863.

Axine Oken, Lehrbuch der Naturgeschichte, 1816, p. 357.

Type of genus, *Axine bellones* Oken.

Oken's species has never been identified, but from his description was probably identical with Hesse's species. Whether this be true or not, the name *Axine* was used by Abildgaard in 1795 (1794 according to Sherborn) for a genus of Vermes.

Type of *Naobranchia*, *Naobranchia cygniformis* Hesse, monotypic.

Genus *BELISARIUS* Maupas. *PHYLLOGNATHOPUS* Mrázek, 1893.

Belisarius Maupas, Comptes Rendus, vol. 115, 1892, p. 135.

Type of genus, *Belisarius viguieri* Maupas, monotypic.

Scourfield in Journ. Quekett Micros. Club, Nov. 1903, made Mrázek's monotype identical with that of Maupas. But the name *Belisarius* was used for a genus of arachnids by Simpson in 1879, and hence Mrázek's genus name must be substituted for it. No other author has noted either monotype.

Genus *BRYAXIS* Sars. New name, *COMANTENNA* (*Comans*, hairy; *antenna*, feeler).

Bryaxis Sars, Crustacea of Norway; Copepoda Calanoida, 1902, p. 35.

Type of genus, *Bryaxis brevicornis* Sars, monotypic.

Sars explained that this was a manuscript name applied to the genus by Boeck, but Leach had used the same word for a genus of beetles in 1817, and Kugelann also for a genus of Coleoptera in 1794.

Genus *CALIGINA* P. J. van Beneden. *TREBIUS* Krøyer (?), 1838.

Caligina Beneden, Mémoires de l'Académie royale de Belgique, vol. 33, 1861, p. 127.

Type of genus, *Trebius caudatus* Krøyer, (1838), monotypic.

Beneden's type species was described but never figured, and from the description must have belonged to Krøyer's genus.

Genus *CAMPTONYX* Lilljeborg. New name, *CAMPELLA* (καμπή, twisting or winding).

Camptonyx Lilljeborg Öfversigt af konglige Vetenskaps Akademiens, Förhandlingar, vol. 32, 1875, p. 11.

Type of genus, *Camptonyx parentii* Lilljeborg, monotypic.

Lilljeborg's genus name had been used in 1858 by Bendsdorf for a genus of univalve mollusks and also by Heller for a very different genus of crustacea.

Genus *CEYLONIA* Thompson and Scott. New name, *CEYLONIELLA*.

Ceylonia Thompson and Scott, Ceylon Pearl Oyster Fisheries, Report, 1903, pt. 1, p. 265.

Type of genus, *Ceylonia aculeata* Thompson and Scott, monotypic.
Ceylonia was used by Buckton for a genus of insects in 1891.

Genus *CONOSTOMA* Thomson. New name, *THOOSTOMA* (θούς, pointed; στόμα, mouth.)

Conostoma Thomson, Transactions of the New Zealand Institute, vol. 15, 1883, p. 93.

Type of genus, *Conostoma ellipticum*, monotypic.

Conostoma was used by Hodges in 1842 for a genus of birds.

Genus *CORINA* Giesbrecht. New name, *VETTORIA* ("Vettor Pisani," name of vessel).

Corina Giesbrecht, Atti Accademia Lincei, Roma, ser. 4, vol. 7, 1891, p. 479.

Type of genus, *Corina granulosa* Giesbrecht, monotypic.

Corina was used in 1887 by Westerlund for a genus of mollusks.

Genus *CRYPsidOMUS* Levinsen. New name, *APHANODOMUS* (ἀφανής, hidden).

Crypsidomus Levinsen, Videnskabelige Meddelelser fra naturhistoriske Forening i Kjøbenhavn, 1877, p. 375.

Type of genus, *Crypsidomus terebellae*, monotypic.

Crypsidomus was used by Günther for a genus of reptiles in 1864.

Genus *GASTRODES* Hesse. New name, *HYPOGASTRION* (ὑπογάστριον, of the belly).

Gastrodes Hesse, Annales des sciences naturelles, ser. 5, vol. 6, 1866, p. 73.

Type of genus, *Gastrodes viridis* Hesse, monotypic.

Gastrodes was used by Westwood for a genus of Hemiptera in 1839, and also in 1888 by Korotnev for a genus of Coelenterates.

Genus *HYPNODES* Hesse. New name, *HYPNOTICUS* (ἕπρωτικός, sleepy.)

Hypnodes Hesse, Annales des sciences naturelles, ser. 5, vol. 4, 1865, p. 247.

Type of genus, *Hypnodes flavus* Hesse, monotypic.

Hypnodes was used by Reichenbach for a genus of birds in 1852.

Genus *IDYA* Philippi. *TISBE* Lilljeborg, 1853.

Idya Philippi, Archiv. für Naturgeschichte, vol. 9, 1843, p. 58.

Type of genus, *Tisbe furcata* (Baird), first species.

Idya was used by Fréminville for a genus of Acalephs in 1809, and Sars proposed to change the name to *Idyaea* in 1910. But he made Lilljeborg's genus a synonym of *Idya*, and if this be true Lilljeborg's name must be used and not the modification suggested by Sars.

Genus *JURINIA* Claus. New name, *LOURINIA*.

Jurinia Claus, Die Copepoden-Fauna von Nizza, Marburg, 1866, p. 24.

Type of genus, *Jurinia armata* Claus, monotypic.

Claus named this genus in honor of Prof. Louis Jurine, but the name *Jurinia* had been used by Desvalles for a genus of Diptera in 1830, and hence Jurine's first name is here substituted.

Genus *LEPTOTRACHELUS* Brian. New name, *AREOTRACHELUS* (ἀραιός, slender).

Silvestria Brian, Atti della societa Ligustica, vol. 13, 1902, p. 245.

Leptotrachelus Brian, Zoologischer Anzeiger, vol. 26, 1903, p. 547.

Type of genus, *Leptotrachelus truchae* Brian, monotypic.

Brian first gave his new genus the name *Silvestria*, but this had been used for a genus of myriapods in 1895. He then changed the name to *Leptotrachelus*, but this was more unfortunate, since it had been used twice, for a genus of beetles in 1829 by Latreille and for a genus of fossil fish in 1863 by Marck.

Genus *LEUCKARTIA* Claus. New name, *RUDOLFIA*.

Leuckartia Claus, Die frei-lebenden Copepoden, Leipzig, 1863, p. 182.

Type of genus, *Leuckartia flavicornis* Claus, monotypic.

Leuckartia was used by Agassiz for a genus of coelenterates in 1862, and hence Leuckart's first name is here substituted.

Genus *MONOPS* Lubbock. New name, *MONACHOPS* (*μοναχός*, single; *ὄψις*, eye).

Monops Lubbock, Annals and Magazine of Natural History, ser. 2, vol. 12, 1853, p. 122.

Type of genus, *Monops grandis* Lubbock, monotypic.

Monops was used for a genus of higher crustacea in 1820 by Billberg.

Genus *NARCODES* Hesse. New name, *NARCODINA*.

Narcodes Hesse, Annales des sciences naturelles, ser. 5, vol. 4, 1865, p. 236.

Type of genus, *Narcodes macrostoma* Hesse, monotypic.

Narcodes had been used by Agassiz for a fish genus in 1829 and by King for a genus of beetles in 1863.

Genus *PARAMEIRA* Sars. New name, *SARSAMEIRA*.

Parameira Sars, Crustacea of Norway, Copepoda Harpacticoida, vol. 5, 1907, p. 221.

Type of genus, *Parameira parva* Sars, first species.

Parameira was used by Seidlitz for a beetle genus in 1868.

Genus *PSAMATHE* Philippi. *SCUTELLIDIUM* Claus (1866).

Psamathe Philippi, Wiegmann's Archiv für Naturgeschichte, vol. 6, 1840, p. 189.

Type of genus, *Psamathe longicauda* Philippi, monotypic.

Psamathe was used by Rafinesque in 1814 for a genus of decapod crustacea, *Psamatha* was given by Schuckard to a genus of Hymenoptera in 1837, and *Psammathe* was proposed for a genus of Vermes in 1836. Most authors are agreed that *Psamathe longicauda*, Philippi's type species is identical with *Scutellidium tisboides*, the type of Claus's genus. Hence Philippi's specific name must be retained.

Genus *SETELLA* Dana. New name, *DWIGHTIA* (James Dwight Dana).

Setella Dana, U. S. Exploring Expedition under Wilkes, Crustacea, 1852, p. 1198.

Type of genus, *Setella gracilis* Dana, first species.

Setella was used by Schrank for a genus of Lepidoptera in 1802.

Genus *THAUMATOPSYLLUS* Sars. New name *THESPESIOPSYLLUS* (*θεσπείσιος*, wonderful).

Thaumatopsyllus Sars, Archiv for Mathematik og Naturvidenskab, vol. 33, 1913, p. 4.

Type of genus, *Thaumatopsyllus paradoxus* Sars, monotypic.

In 1894 T. Scott published the name *Thaumatopsyllus* as a "manuscript synonym" of the genus *Aegisthus*. This publication of the name as a synonym of another genus prohibits its use by Sars.

COPEPOD GENERA OF QUESTIONABLE VALIDITY.

Genus *CRYPTOPODUS* Hesse, Annales des sciences naturelles, ser. 5, vol. 4, 1865, p. 23.

Type of genus, *Cryptopodus flavus* Hesse, monotypic.

From Hesse's figures and text it is impossible to recognize this genus.

Genus *PEGESIMALLUS* Krøyer, Naturhistorisk Tidsskrift, ser. 3, vol. 2, 1863, p. 332.

Type of genus, *Pegesimallus spiralis* Krøyer, monotypic.

In 1869 Steenstrup claimed that Krøyer's specimen was not a copepod but an agalmid colony and recent examination of the type specimen has proved this claim to be true.

Genus *UNDINA* Dana, U. S. Exploring Expedition under Wilkes, Crustacea, 1852, p. 1092.

Type of genus, *Undina vulgaris* Dana, first species.

Giesbrecht in 1892 referred Dana's type species to the genus *Calanus*, and distributed the other species among three additional genera. There may be a question whether Dana's genus entirely disappears, but the name he chose for it was used by Gould for a genus of birds in 1836, by Munsterberg for a fish genus in 1842, and by Gistel for another fish genus in 1848.

PREOCCUPIED NAMES OF COPEPOD SPECIES.

CYCLOPS CLAUSII Heller. New name, *CYCLOPS TERES*.

In the Transactions of the Linnaean Society, vol. 24, 1863, p. 200, Lubbock described a new species, *Cyclops clausii*, which Sars afterward made a synonym of *Cyclops strenuus*. Heller in Bericht über die Medizin und Naturwissenschaft, Innsbruck, vol. 1, 1871, p. 73, described a new species to which he gave the same name. As the species are distinct Heller's specific name must be changed.

THALESTRIS ROBUSTA Brady. New name, *THALESTRIS VALIDA*.

In his "Die Frei-lebenden Copepoden," Leipzig, 1863, p. 201, Claus described a new species found in the Mediterranean, *Thalestris robusta*. Brady in the Transactions of the Natural History Society of Northumberland and Durham, new series, vol. 1, 1905, p. 218, also described a new species to which he gave the same name. These species are distinct and the specific name given by Brady is changed as above.

NAMES OF COPEPOD GENERA OMITTED FROM THE NOMENCLATOR AND THE INDEX.

Agenor.—Risso, Histoire naturelle, Paris, 1826, p. 138. Synonym of *Argulus*.

Agnathaner.—Canu, Travaux du Laboratoire de Zoologie maritime de Wimereux, vol. 6, 1892, p. 210. A valid genus.

Amymone.—Claus, Beiträge zur Kenntniss der Entomostraken, Part I, Marburg, 1860, p. 11. A synonym of *Tegastes*.

Anopherusa.—Templeton, Transactions of Entomological Society, London, vol. 1, 1836, p. 187. A valid genus.

Antheacheres.—M. Sars, Forhandlingar ved de Skandinaviske Naturforskeres, Christiania, 1856 (1857), p. 175. A valid genus.

Arnaeus.—Krøyer, Naturhistorisk Tidsskrift, ser. 3, vol. 2, 1863, p. 157. A synonym of *Elytrophora*.

Attheyella.—Brady, Monograph of Free and Semiparasitic Copepods, vol. 2, 1880, p. 58. A valid genus.

Belisarius.—Maupas, Comptes Rendus, vol. 115, 1892, p. 135. A synonym of *Phyllognathopus*.

Bonnierilla.—Canu, Bulletin scientifique de la France et de la Belgique, ser. 4, vol. 2, 1891, p. 467. Suggested in place of Kerchner's *Paryphes*.

Caligera.—P. J. van Beneden, Bulletin de l'Academie royale de Belgique, ser. 3, vol. 24, 1892, p. 258. A synonym of *Alebion*.

Caligidium.—Claus, Arbeiten des Zoologische Institute, vol. 8, 1889, p. 362. A synonym of *Cancerilla*.

Calina.—P. J. van Beneden, Bulletin de l'Academie royale de Belgique, ser. 3, vol. 24, 1892, p. 249. A valid genus.

Cancerilla.—Dalyell, "The Powers of the Creator," London, 1851, vol. 2, p. 223. A valid genus.

Cauloæcnus.—Cope, American Naturalist, vol. 6, 1872, p. 420. A valid genus.

Chelonidium.—Claus, Zeitschrift für wissenschaftliche Zoologie, vol. 25, 1875, p. 341. Suggested as a substitute for *Chelonidiformis*.

Collocheres.—Canu, Travaux du Laboratoire de Zoologie maritime de Wimereux, vol. 6, 1892, p. 200. A valid genus.

Corynuropsis.—T. Scott, Transactions of the Linnean Society of London, vol. 6, pt. 1, 1894, p. 64. Claimed by Scott as a manuscript name under date of 1892, and a synonym of *Mormonilla*.

Cribrapontius.—Giesbrecht, Fauna der Station Neapel, vol. 25, 1899, p. 107. A valid genus.

Cryptopontius.—Giesbrecht, Fauna der Station Neapel, vol. 25, 1899, p. 108. A valid genus.

Cybicola.—Bassett-Smith, Annals and Magazine of Natural History, ser. 7, vol. 2, 1898, p. 371. A valid genus.

Cyclopella.—Claus, Anzeiger Akademie der Wissenschaften, Wien, vol. 9, 1893, p. 81. A synonym of *Pterinopsyllus*.

Cymbasoma.—I. C. Thompson, Journal Linnean Society, London, vol. 20, 1888, p. 154. A synonym of *Thaumaleus*.

Daphinia.—Rafinesque, American Monthly Magazine of Critical Review, vol. 2, 1817, p. 42. A possible synonym of *Calanus*.

Doris.—Koch, Deutschlands Crustaceen, Regensburg, 1841, Heft. 35. A synonym of *Canthocamptus*.

Dystrogus.—Giesbrecht, Fauna der Station Neapel, vol. 25, 1899, p. 110. A valid genus.

Eikocalanus.—Boeck, Tidsskrift for Fisheri, Kopenhagen, vol. 1, 1867, p. 159. Possibly a printer's error, but has never been explained.

Foroculum.—Thompson, Catalogue of Museum of College of Surgeons, London, 1843, p. 270. A synonym of *Lernaenicus*.

*Gastrodelphe*s.—Graeffe, Bolletino della Società Adriatica di Scienze Naturali in Trieste, vol. 8, 1883, p. 206. A valid genus.

Goniopelte.—Claus, Zoologischer Anzeiger, vol. 14, 1891, p. 424. A synonym of *Clytemnestra*.

Guernella.—Schmeil, Bibliotheka Zoologica, vol. 21, 1898, p. 185. A new name proposed for Thomson's *Guernea*, which had been preoccupied.

Haemobaphes.—Steenstrup & Lütken, Kongelige Danske Videnskabernes Selskabs Skrifter, ser. 5, vol. 5, 1861, p. 405. A valid genus.

Hemicalanus.—Dana, U. S. Exploring Expedition under Wilkes, vol. 13, Crustacea, 1852, p. 1103. A probable synonym of *Centropages*.

Hemicyclops.—Claus, Anzeiger Akademie der Wissenschaft, Wien, vol. 9, 1893, p. 80. Preoccupied and hence changed to *Halicyclops* by Norman in 1903.

Hermannella.—Canu, Bulletin scientifique, vol. 23, 1891, p. 467. A valid genus.

Heteropsyllus.—T. Scott, Twelfth Annual Report Fishery Board of Scotland, 1894, pt. 3, p. 252. A valid genus.

Ichnograde.—Hesse, Annales des sciences naturelles, series 5, vol. 1, 1864, p. 349. A doubtful synonym of *Enteropsis*.

Luophontodes.—T. Scott, Twelfth Annual Report Fishery Board of Scotland, 1894, pt. 3, p. 249. A valid genus.

Leptopsyllus.—T. Scott, Twelfth Annual Report Fishery Board of Scotland, 1894, pt. 3, p. 254. A valid genus.

Lernaeascus.—Claus, Anzeiger Akademie er Wissenschaft, Wien, vol. 25, 1886, p. 231. A valid genus.

Lernaenicus.—LeSueur, Journal Academy of Natural Sciences, Philadelphia, vol. 3, 1824, p. 289. A valid genus.

Lestes.—Krøyer, Danmarks Fiske, Kopenhagen, 1845, vol. 2, p. 517. Name preoccupied and so changed by Krøyer to *Lestaira* in 1867.

Macrochiron.—Brady, Natural History Transactions of Northumberland and Durham, vol. 4, 1872, p. 434. A valid genus.

Megabrachinus.—Hesse, Annales des sciences naturelles, ser. 5, vol. 15, 1871, p. 2. A genus of questionable validity.

Megasaonyx.—Hesse, Annales des sciences naturelles, ser. 5, vol. 15, 1871. Title of Article no. 2. Spelled *Megasanoixus* in text. The latter a valid species.

Monstrilla.—Dana, U. S. Exploring Expedition under Wilkes, vol. 13, Crustacea, 1852, p. 1313. A valid genus.

Mychophilus.—Hesse, Annales des sciences naturelles, ser. 5, vol. 4, 1865, p. 232. A valid genus.

Myicola.—Wright, American Naturalist, vol. 19, 1885, p. 118. A valid genus.

Nuobranchia.—Hesse, Annales des sciences naturelles, ser. 4, vol. 20, 1863, p. 122. A valid genus.

Neobradia.—T. Scott, Tenth Annual Report Fishery Board of Scotland, 1892, p. 249. A valid genus.

Neopontius.—T. Scott, Sixteenth Annual Report Fishery Board of Scotland, 1898, p. 271. A valid genus.

Nereidicola.—Grube, Verhandlungen Schles. Gesellschaft für vaterländische Kultur, 1869–1872, p. 30. A synonym of *Nereicola*.

Oithonella.—Sars, Norwegian North Atlantic Expedition, part 15, Zoology, vol. 6, 1886, p. 79. A synonym of *Oithona*.

Oniscus.—Lamatière, Journal de Physique, vol. 31, 1787, p. 262. A synonym of *Cecrops*.

Otrophesia.—Risso, Histoire Naturelle, Paris, vol. 5, 1826, p. 136. A synonym of *Anthosoma*.

Panaletis.—Stebbing, Willey's Zoological Results, part 5, 1900, p. 666. A valid genus.

Papulina.—P. J. van Beneden, Bulletin de l'Academie royale de Belgique, ser. 3, vol. 24, 1892, p. 254. A synonym of *Lepeophtheirus*.

Paramesochra.—T. Scott, Tenth Annual Report Fishery Board of Scotland, 1892, p. 252. A valid genus.

Philorthragoriscus.—Horst, Notes from Leyden Museum, vol. 19, note 14, 1897, p. 137. A valid genus.

Phyllocamptus.—T. Scott, Journal Linnaean Society, London, vol. 27, 1899, p. 118. A valid genus.

Plantipode.—Hesse, Annales des sciences naturelles, ser. 5, vol. 1, 1864, p. 358. In the text (p. 349) the genus was called *Ichnograde*, but in the explanation of the plates and on the plate itself the word *Plantipode* was used.

Platycheiron.—T. Scott, Tenth Annual Report Fishery Board of Scotland, 1892, p. 153. A synonym of *Hemicyclops*.

Pontopolites.—T. Scott, Twelfth Annual Report Fishery Board of Scotland, 1894, p. 251. A valid genus.

Pseudotachidius.—T. Scott, Sixteenth Annual Report Fishery Board of Scotland, 1898, p. 267. A valid genus.

Pseudowestwoodia.—T. Scott, Twelfth Annual Report Fishery Board of Scotland, 1894, p. 257. A synonym of *Parawestwoodia*.

Pupulina.—P. J. van Beneden, Bulletin de l'Academie royale de Belgique, series 3, vol. 24, 1892, p. 254. A synonym of *Lepeophtheirus*.

Ratania.—Giesbrecht, Fauna und Flora des Golfes von Neapel, 19th monograph, Copepoda, 1892, p. 83. A valid genus.

Schizoproctus.—Aurivillius, Ur Vega Expeditionens Vetenskapliga Iakttagelser, Stockholm, 1885, vol. 4, p. 246. A synonym of *Botryllophilus*.

Scaphocalanus.—Sars, Norwegian North Atlantic Expedition, Scientific Results, vol. 5, 1900, p. 36. A synonym of *Amalophora*.

Seridium.—Giesbrecht, Mitteilungen aus der Zoologischer Station zu Neapel, vol. 12, 1897, p. 223. A valid genus.

Sestropontius.—Giesbrecht, Fauna der Station Neapel, vol. 25, 1899, p. 107. A valid genus.

Sphaerifer.—Richiardi, Atti della Società Toscana di Scienze Naturali, vol. 2, 1876, p. 99. A valid genus.

Synestius.—Steenstrup and Lütken, Kongelige Danske Videnskabernes Selskabs Skrifter, ser. 5, vol. 5, 1861, p. 364. A valid genus.

Taphrobia.—Cornalia, Atti della Società Italiana di Scienze Naturali, vol. 18, 1875, p. 197. A synonym of *Peroderma*.

Temorites.—G. O. Sars, Norwegian North Polar Expedition, Scientific Results, vol. 5, 1900, p. 100. A valid genus.

Thaumatocessa.—Hesse, Annales des sciences naturelles, ser. 5, vol. 9, 1868, p. 54. Twice preoccupied and hence changed to *Thaumatohessia* by Giard in 1900.

Thaumatohessia.—Giard, Bulletin de Société Entomologique de France, 1900, p. 395. A valid genus.

Thysanote.—Krøyer, Naturhistorisk Tidsskrift, ser. 3, vol. 2, 1863, p. 288. A valid genus.

Trophonophila.—McIntosh, Scientific Results, Challenger Expedition, vol. 12, 1885, p. 368. A valid genus.

Trypaphylum.—Richiardi, Atti della Società Toscana, Processi Verballi, vol. 1, 1878, p. XX. A valid genus.

Undinella.—G. O. Sars, Norwegian North Polar Expedition, Scientific Results, vol. 5, 1900, p. 52. A valid genus.

Undinopsis.—G. O. Sars, Schneider's Report of Invertebrates from the Kvaenangen Fjord, 1884, p. 131. A valid genus.

CORRECTIONS AND ADDITIONS TO THE LISTS OF THE NOMENCLATOR AND INDEX.

<i>Achtheres</i>	Nordmann.....	1832	Date supplied.
<i>Aenippe</i>	Philippi.....	1843	Date supplied.
<i>Aethon</i>	Krøyer.....	1837	Date supplied.
<i>Anchorella</i>	Cuvier.....	1830	Date supplied.
<i>Anthosoma</i>	Leach.....	1816	Date supplied.
<i>Anuretes</i>	Heller.....	1865	Spelled <i>Anuretus</i> in nomenclator.
<i>Aplopodus</i>	Hesse.....	1870	Spelled <i>Aplopode</i> in nomenclator.
<i>Arpacticus</i>	M. Edwards...	1840	Spelled <i>Arpactes</i> in nomenclator.

<i>Azine</i>	Oken.....	1816	Date wrong in nomenclator.
<i>Brachiella</i>	Cuvier.....	1830	Date supplied.
<i>Calanus</i>	Leach.....	1819	Date supplied.
<i>Canuella</i>	T. Scott.....	1893	Spelled <i>Canvella</i> in index.
<i>Chalimus</i>	Burmeister.....	1835	Date supplied.
<i>Chiridius</i>	Giesbrecht.....	1892	Spelled <i>Chirdius</i> in index.
<i>Chonephilus</i>	Sars.....	1861	Spelled <i>Chonephila</i> in nomenclator.
<i>Clausidium</i>	Kossmann.....	1867	Date wrong in nomenclator.
<i>Cletodes</i>	Brady.....	1872	Ascribed to Boeck in nomenclator.
<i>Delavatia</i>	Brady.....	1868	Spelled <i>Delavallia</i> in nomenclator.
<i>Dichelesthium</i>	Hermann.....	1804	Spelled <i>Dichelestium</i> in nomenclator.
<i>Dinematura</i>	Burmeister.....	1833	Date wrong in nomenclator.
<i>Diocus</i>	Krøyer.....	1861	Date wrong in nomenclator.
<i>Dyspontius</i>	Thorell.....	1857	Date wrong in nomenclator.
<i>Echthrogaleus</i>	Steenstrup & Lütken.	1861	Date wrong in nomenclator.
<i>Entomoda</i>	Lamarek.....	1818	Date supplied.
<i>Epachthes</i>	Nordmann.....	1832	Date supplied.
<i>Ergasilus</i>	Nordmann.....	1832	Date supplied.
<i>Eucalanus</i>	Dana.....	1852	Ascribed to Claus in Index.
<i>Euryphorus</i>	M. Edwards.....	1840	Date supplied.
<i>Euryte</i>	Philippi.....	1843	Date supplied.
<i>Gumentophorus</i>	Costa.....	1840	Called a sponge genus in Index.
<i>Haloptilus</i>	Giesbrecht.....	1892	Date and author wrong in Index.
<i>Hessia</i>	E. Beneden.....	1871	Date wrong in nomenclator.
<i>Huntemannia</i>	Poppe.....	1884	Spelled <i>Huntermannia</i> in index.
<i>Idomene</i>	Philippi.....	1843	Date supplied.
<i>Ismaila</i>	Bergn.....	1867	Spelled <i>Ismailia</i> in nomenclator.
<i>Laophonte</i>	Philippi.....	1840	Date supplied.
<i>Lernacanthus</i>	Blainville.....	1822	Date supplied.
<i>Lernanthropus</i>	Blainville.....	1822	Date supplied.
<i>Lernentona</i>	Blainville.....	1822	Date supplied.
<i>Linckiomolgus</i>	Stebbing.....	1900	Ascribed to Borradaile in index.
<i>Mesochra</i>	Boeck.....	1865	Spelled <i>Mesochria</i> in nomenclator.
<i>Nemesis</i>	Risso.....	1826	Ascribed to Roux in nomenclator.
<i>Nicothoe</i>	Audouin & M. Edwards.	1825	Date supplied.
<i>Nitokra</i>	Boeck.....	1864	Spelled <i>Nitokria</i> in nomenclator.
<i>Nagaus</i>	Leach.....	1819	Date supplied.
<i>Penella</i>	Dana.....	1852	Date and author wrong in nomenclator.
<i>Pontellina</i>	Dana.....	1852	Author and date wrong in nomenclator.
<i>Poppella</i>	Richard.....	1888	Spelled <i>Popella</i> in index.
<i>Potamoichetor</i>	Herrick.....	1882	Spelled <i>Potamoichetor</i> in index.
<i>Pseudocletodes</i>	T. Scott.....	1893	Spelled <i>Pseudoclitodes</i> in index.
<i>Risculus</i>	Leach.....	1819	Date supplied.
<i>Robertsonia</i>	Brady.....	1880	Spelled <i>Robertsonia</i> in index.
<i>Sabellacheres</i>	Sars.....	1861	Spelled <i>Sabellochaeres</i> in index.
<i>Salenskya</i>	Giard & Bonnier.	1895	Spelled <i>Salenskia</i> in index.
<i>Sapphirina</i>	Thompson.....	1829	Date supplied.
<i>Schisturus</i>	Oken.....	1815	Date wrong in nomenclator.
<i>Selius</i>	Krøyer.....	1837	Date supplied.
<i>Staurosoma</i>	Will.....	1844	Date supplied.

<i>Taeniacanthus</i>	Sumpf	1871	Date wrong in index.
<i>Tracheliastes</i>	Nordmann	1832	Date supplied.
<i>Trebius</i>	Krøyer	1838	Date supplied.
<i>Tucca</i>	Krøyer	1837	Date supplied.

The following was discovered while reading the page proof of the present paper:

Genus *PSEUDOCLETODES* Sars. New name. *SARSOCLETODES*.

Pseudocletodes G. O. Sars, The Crustacea of Norway, vol. 7, 1920, Copepoda Supplement, p. 89.

Type of genus, *Pseudocletodes typicus*, monotypic.

T. and A. Scott established in Annals and Magazine of Natural History (ser. 6, vol. 12, 1893, p. 237), a new genus and species, *Pseudocletodes vararensis*. The two genera are distinct and hence the genus name of Sars' species must be changed.

EXPLANATION OF PLATES.

PLATE 1.

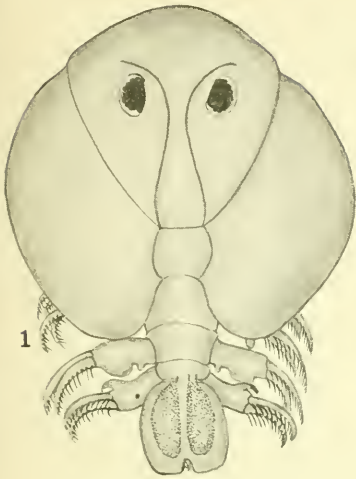
FIG. 1. Dorsal view of male *Argulus paulensis*, new species. FIG. 2. Dorsal view of female. FIG. 3. First and second antennae of male. FIG. 4. Supporting ribs of sucking disks. FIG. 5. Maxilliped of female. FIG. 6. Dorsal view of male *Argulus nobilis*, 4 mm. long. FIG. 7. Dorsal view of female, same size. FIG. 8. Basal plate on maxilliped. FIG. 9. "Boot" of fourth leg.

PLATE 2.

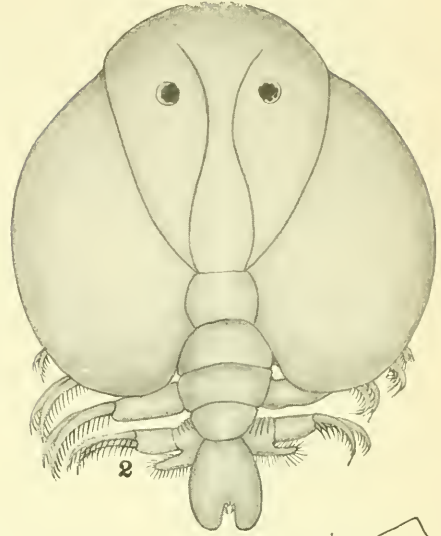
FIG. 10. Dorsal view of female *Anchistrotos occidentalis*, new species. FIG. 11. First antenna and maxillary hook. FIG. 12. Second antenna. FIG. 13. Maxilliped. FIGS. 14-17. Second, third, fourth, and fifth swimming legs. FIG. 18. One of the toothed spines, enlarged. FIG. 19. First and second antennae of female *Parapandarus nodosus*, new species. FIG. 20. Second maxilla. FIGS. 21-24. First, second, third, and fourth swimming legs of male.

PLATE 3.

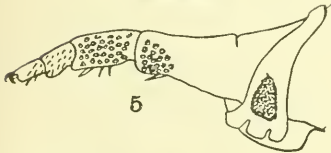
FIG. 25. Dorsal view of female *Parapandarus nodosus*, new species. FIG. 26. Dorsal view of male. FIG. 27. Mouth tube and maxillae. FIG. 28. One of the first maxillae, enlarged. FIG. 29. Maxilliped of female. FIG. 30. Maxilliped of male. FIGS. 31-34. First, second, third, and fourth swimming legs of female.



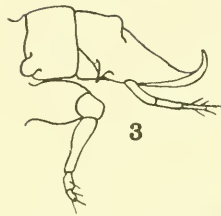
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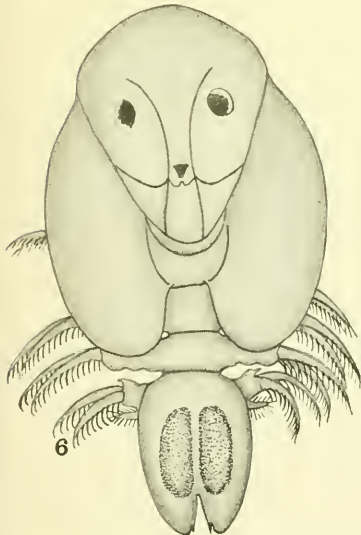
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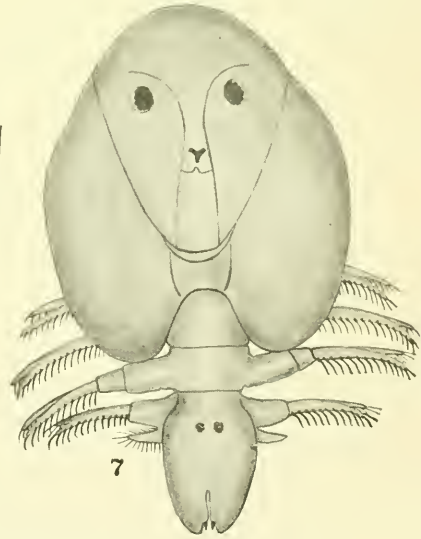


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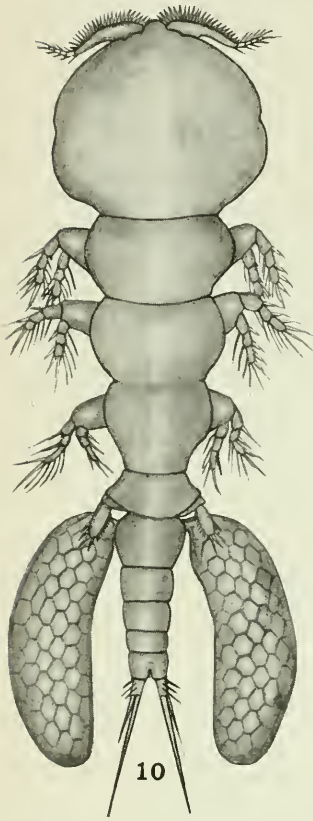
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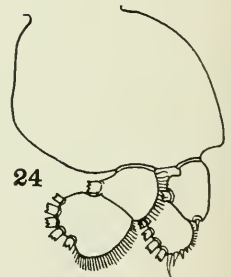
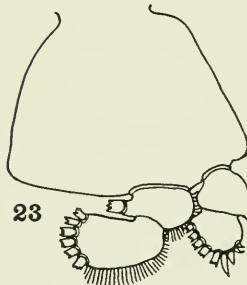
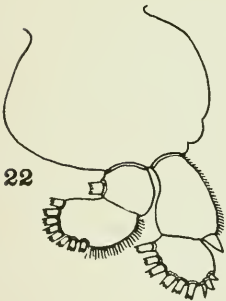
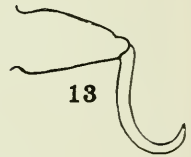
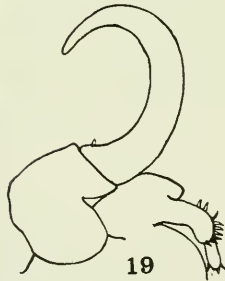
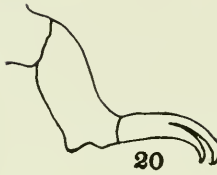
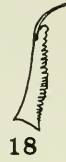
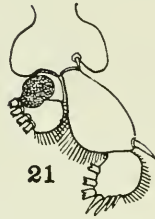
7

ARGULUS PAULENSIS AND ARGULUS NOBILIS.

FOR EXPLANATION OF PLATE SEE PAGE 22.

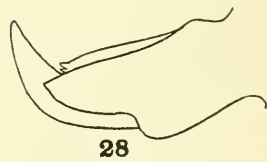
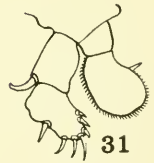
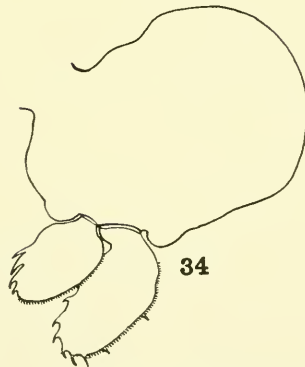
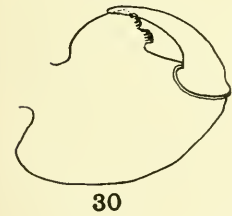
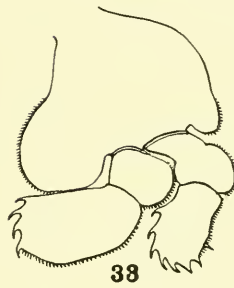
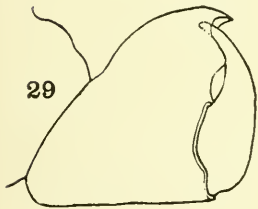
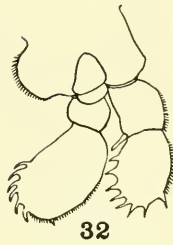
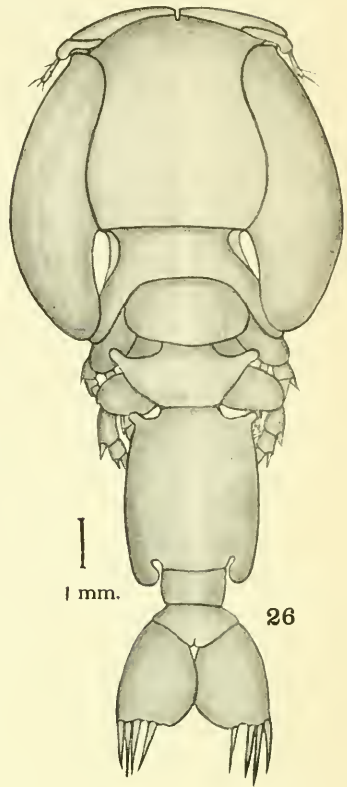
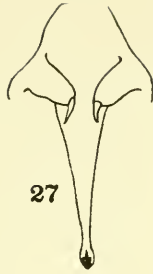
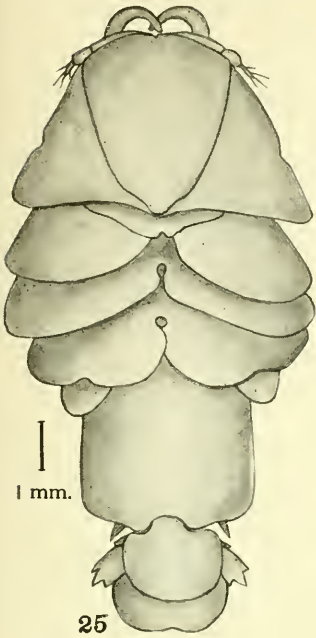


0.5 mm.



ANCHISTROTOS OCCIDENTALIS AND PARAPANDARUS NODOSUS.

FOR EXPLANATION OF PLATE SEE PAGE 22.



PARAPANDARUS NODOSUS.

FOR EXPLANATION OF PLATE SEE PAGE 22.

NOTES ON CERTAIN CATOSTOMIDS OF THE BONNEVILLE SYSTEM, INCLUDING THE TYPE OF *PANTOSTEUS VIRESCENS* COPE.

By JOHN OTTERBEIN SNYDER,
Of Stanford University, California.

For a long time the catostomid described by Cope¹ as *Pantosteus virescens* has remained a puzzle to ichthyologists². It was originally described as a native of the Arkansas River, where no member of the genus has since been found. The present paper is intended as a brief contribution toward a settlement of the matter, as the writer has rediscovered the species, abundantly represented in Weber and Bear Rivers, of the Bonneville system of Utah.³

The type of *Pantosteus virescens*, No. 16758, U. S. National Museum, is a large specimen measuring 370 millimeters in length. The body is long and slender, the caudal peduncle narrow, snout long, mouth large, the broad lips projecting laterally beyond the sides of the head. Along the lateral line the scales grow gradually larger from the head to the tail. On the throat and breast they are very minute. There are 100 scales in the lateral series, 51 between the occiput and dorsal fin, 21 between the lateral line and middle of back, and 15 between lateral line and base of anal. The cranial foramen is open.

The type specimen has been referred by some authors to *Pantosteus delphinus*, a species native to the Colorado basin.⁴ *P. delphinus*, differs from *P. virescens* in having a body of somewhat different proportions as will be seen from an examination of the tables of measurements. The scales of *P. delphinus* are smaller, there being 105 to 112 in the lateral series, 55 to 63 before the dorsal, 20 to 24 above the lateral line, and 17 to 20 below the lateral line.

¹ Wheeler's Explor. West of the 100th Merid., vol. 5, 1875 (1876), p. 675. Type No. 16758, Div. Fish, U. S. N. M. Indicating the locality, Cope's expression carries doubt with it; "One species (meaning specimen) accompanying an *Amiurus*, which is marked Arkansas River, at Pueblo, Mr. C. E. Aiken."

² Jordan and Evermann, Fishes North Amer., Bull. U. S. Nat. Mus., No. 47, pt. 1, 1896, p. 171, *P. delphinus* (Cope).

Snyder, J. O., Proc. U. S. Nat. Mus., vol. 49, 1915, p. 577.

³ Under the authority of the United States Bureau of Fisheries, the writer began an investigation of the fishes of the Bonneville system of Utah, in 1915. After some field work had been done, it was interrupted by the war, and has not been resumed. Specimens referred to were collected at the time.

⁴ The writer is indebted to Dr. Max M. Ellis for some particularly fine specimens of *P. delphinus* which were collected in the Uncompahgre and Rio Florida, tributaries of the Colorado River.

Proportional measurements and scale counts of 11 specimens of Pantosteus delphinus.

	Rio Florida-Durango.						Uncompahgre-Montrose.				
	191	200	195	173	175	185	205	175	205	220	202
Length of body (millimeters).....	191	200	195	173	175	185	205	175	205	220	202
Length of head.....	0.21	0.22	0.22	0.205	0.22	0.225	0.21	0.22	0.20	0.195	0.21
Depth of body.....	.20	.19	.20	.23	.22	.21	.20	.21	.19	.19	.22
Depth of caudal peduncle.....	.065	.07	.07	.07	.075	.075	.075	.07	.075	.07	.07
Length of caudal peduncle.....	.16	.17	.16	.17	.16	.165	.16	.16	.15	.17	.15
Length of snout.....	.125	.125	.13	.115	.125	.13	.11	.115	.11	.11	.115
Diameter of eye.....	.03	.03	.03	.035	.035	.03	.03	.03	.03	.03	.03
Interorbital width.....	.09	.095	.09	.095	.10	.095	.095	.10	.10	.095	.10
Depth of head.....	.14	.145	.14	.145	.15	.14	.14	.15	.15	.14	.14
Snout to occiput.....	.185	.195	.14	.20	.21	.205	.18	.18	.17	.17	.18
Snout to dorsal.....	.51	.515	.51	.50	.51	.51	.51	.52	.51	.49	.52
Snout to ventral.....	.57	.56	.585	.55	.58	.57	.575	.60	.58	.56	.57
Length base of dorsal.....	.16	.14	.14	.155	.145	.14	.13	.135	.135	.13	.14
Length base of anal.....	.075	.07	.08	.085	.075	.07	.075	.08	.08	.08	.08
Height of dorsal.....	.165	.17	.185	.165	.18	.185	.165	.17	.165	.17	.165
Height of anal.....	.20	.18	.20	.22	.235	.22	.18	.20	.185	.20	.19
Length of pectoral.....	.19	.18	.19	.215	.205	.20	.185	.195	.20	.20	.18
Length of ventral.....	.15	.15	.15	.17	.16	.17	.15	.155	.16	.17	.155
Length of caudal.....	.23	.215	.23	.23	.225	.24	.21	.23	.22	.22	.215
Dorsal rays.....	11	11	10	11	11	11	10	11	10	11	10
Anal rays.....	7	7	7	7	7	7	7	7	7	7	7
Scales lateral series.....	109	108	105	110	109	109	107	106	105	109	105
Scales above lateral line.....	20	21	21	21	22	23	24	23	24	24	23
Scales below lateral line.....	17	17	17	19	17	18	19	20	19	20	18
Scales before dorsal.....	57	56	55	56	55	55	61	59	63	63	57

As previously noted, *P. virescens* was found in considerable numbers in Weber and Bear Rivers. When compared directly with the type, these fishes differ in no way, many specimens from Weber River being exact counterparts, even in size and general appearance. An examination of a series of specimens resulted in the following scale counts:

Scales in lateral series.....	90	91	92	93	94	95	96	97	98	99	100
Number of specimens.....	1	1	4	4	10	10	6	6	7	2	3
Scales occiput to dorsal.....	49	50	51	52	53	54	55	56	57	58	
Number of specimens.....	1	5	9	10	8	8	7	2	3	3	
Scales above lateral line.....	18	19	20	21	22	23					
Number of specimens.....	1	3	17	15	16	2					
Scales below lateral line.....	12	13	14	15	16	17					
Number of specimens.....	5	8	19	16	3	3					

The anterior lip has 4 or 5 rows of papillae, the outer ones being very small. The posterior lip is deeply incised. It is separated from the anterior or upper, on either side, by a pronounced notch, behind which the lobe is angular and pointed. There are about 15 series of papillae which are not disposed in rows. The pectoral fins are bluntly pointed, the edge of the dorsal concave, the caudal deeply concave, or rather sharply notched in some specimens. There are 36 to 40 gillrakers on the first arch. The crania of many specimens were examined, and in no case was the fontanelle found to be closed.

In the appended table, measurements of mature examples from Weber River are given. In smaller examples, 145 to 180 millimeters in length, the body is deeper, 0.19 to 0.23 of the length; the caudal

peduncle more attenuate, 0.15 to 0.18; the eye larger, 0.03 to 0.35; and the fins, excepting the caudal considerably longer. The dorsal rays number 11, occasionally 12.

Proportional measurements of 10 specimens of Pantosteus virescens from Weber River near The Devil's Slide.

Length of body (millimeters).....	320	292	298	298	285	300	308	275	321	297
Length of head.....	0.195	0.21	0.21	0.205	0.205	0.20	0.20	0.215	0.19	0.20
Depth of body.....	.17	.195	.18	.17	.19	.18	.185	.19	.18	.17
Depth of caudal peduncle.....	.085	.082	.085	.08	.08	.08	.08	.08	.08	.08
Length of caudal peduncle.....	.145	.15	.14	.145	.15	.155	.145	.155	.15	.135
Length of snout.....	.115	.115	.11	.12	.12	.125	.112	.122	.11	.115
Diameter of eye.....	.023	.025	.025	.025	.025	.024	.025	.025	.021	.025
Interorbital width.....	.09	.098	.091	.098	.09	.095	.088	.09	.09	.086
Depth of head.....	.125	.13	.132	.132	.13	.136	.13	.14	.13	.135
Snout to occiput.....	.17	.19	.172	.18	.18	.175	.18	.18	.16	.175
Snout to dorsal.....	.47	.49	.485	.49	.48	.47	.463	.485	.47	.48
Snout to ventral.....	.56	.57	.58	.57	.56	.585	.56	.575	.576	.58
Length base of dorsal.....	.13	.15	.125	.135	.14	.15	.15	.135	.14	.135
Height of dorsal.....	.075	.07	.07	.07	.07	.07	.07	.07	.068	.075
Height of anal.....	.14	.152	.145	.15	.155	.16	.15	.16	.15	.16
Length of pectoral.....	.165	.17	.17	.172	.16	.162	.165	.19	.18	.17
Length of pectoral.....	.165	.175	.175	.172	.17	.18	.17	.195	.18	.175
Length of ventral.....	.14	.15	.145	.145	.145	.145	.145	.155	.145	.148
Length of caudal.....	.20	.22	.215	.205	.206	.215	.205	.24	.207	.212
Dorsal rays.....	11	11	11	11	11	11	11	11	11	11
Anal rays.....	7	7	7	7	7	7	6	7	7	7
Scales lateral series.....	97	94	100	94	100	98	98	98	95	93
Scales above lateral line.....	19	21	20	19	21	20	22	19	22	22
Scales below lateral line.....	16	15	15	17	17	15	16	15	15	15
Scales before dorsal.....	51	51	54	56	55	55	54	54	58	57

In this species the mountain suckers appear to reach their largest size, and they are to be found at their best in Weber River, where schools numbering thousands of individuals may at times be seen. They occur in the more mountainous parts of the basin, thriving well where the channel is broad and the water deep. They were encountered in numbers at Wanship, and again at several points between Wanship and the mouth of Echo Creek. Farther down the river, particularly in the vicinity of The Devil's Slide, they were met (July 26) in schools of large size. At a distance of 15 or 20 miles below the latter place, none was seen.

The schools move slowly up or down stream, winding about over the river bed in true sucker fashion. When feeding, small detachments occasionally separate from the main school, and moving along slowly and cautiously, the different individuals lazily roll about on the bottom, scraping food from the surface of the rocks. They are, however, very nervous and cautious fishes, fleeing at the approach of a shadow, or the jar of the gravel crunched beneath the observer's feet. Panic seizes an individual suddenly parted from a school although groups of widely separated and perfectly quiet fishes may at times be seen.

In Weber River they appear to greatly outnumber the other large fishes. *Catostomus ardens* associates with this species, and its individuals may be recognized by their more robust, greenish and bronzy bodies, and pink fins. One haul of the collecting seine took 758 fish

from a large school without visibly reducing its size. Among the *Pantosteus* were 50 examples of *Catostomus*. Other catches seemed to support this proportion. The 708 *Pantosteus* measured from 230 to 395 millimeters in length, the largest weighing $1\frac{1}{2}$ pounds, a real giant among the hard-mouthed or mountain suckers.

When in the water, *P. virescens* differs from other catostomids of the river by its dark color, the posterior part of the body usually appearing dense black in contrast with the lighter anterior region. When the side is turned toward the sun, a flash of yellow light appears, and sometimes the white bellies and the broad mouths, with their enormous lips, may be seen, the latter being so large that the edges are visible on either side of the snout.

When fresh from the water the color is a bright metallic yellow on the sides; darker above and dead white below. The top of the head is olive, lighter on the sides, brassy beneath the eyes. The lips and throat are yellowish, the horny edges of the lips white. The scale pockets on the dorsal surface have blackish borders, which are wider on the posterior parts of the body, where they impart a dark color to the entire surface. In some examples the dark borders are very narrow, giving the fish a much lighter appearance. The intensity of the color seemingly changes somewhat as the fish moves about in the water.

Two mountain suckers occur in the Bonneville system, *P. virescens* and *P. platyrhynchus*, the latter appearing to be closely related to *P. lahontan* of the Lahontan system of Nevada.⁵

P. platyrhynchus is a coarse scaled form, the lateral series numbering 78 to 89 rows. The snout is relatively short and rounded, the papillae of the lips large, the caudal peduncle deep, and the caudal fin short.

Scales lateral series.....	78	79	80	81	82	83	84	85	86	87	88	89
Number of specimens.....	1	7	5	9	19	14	12	14	7	8	3	1
Scales before dorsal.....	39	40	41	42	43	44	45	46	47	48		
Number of specimens.....	1	3	8	5	28	24	18	9	2	2		
Scales above lateral line...	15	16	17	18	19							
Number of specimens.....	7	32	51	7	3							
Scales below lateral line...	10	11	12	13	14							
Number of specimens.....	5	26	38	23	8							

⁵ It has been shown that *P. generosus* (Girard), referred by some authors to the Bonneville system, without doubt came from the Colorado. (Proc. U. S. Nat. Mus., vol. 59, 1921, p. 27.)

Minomus jarrovi Cope (Proc. Amer. Philos. Soc. Phila., 1874, p. 135) is not synonymous with either *P. virescens* or *P. platyrhynchus*. The type of *P. jarrovi* is lost, the locality is in doubt, and while the description and figures (Wheeler's Explor. West of the 100th Merid., vol. 5, 1875-76, p. 674, pl. 29, fig. 2, 2a) are sufficient to show that the species is not synonymous with either of the Bonneville forms, the writer is not able to refer them without doubt to another species. In the original description Cope refers to two specimens "obtained by Messrs. Yarrow and Henshaw at Provo," while in the later paper these specimens are ignored without explanation, and the name is applied to fishes from both the Colorado and Rio Grande Rivers. It is possible that the type came from a tributary of one of these streams.

The head of *P. platyrhynchus* is small, the snout bluntly rounded, the lips very broad and pendent, the papillae rather coarse, with about 7 series on the broadest part of the lower lip, and 3 or 4 on the upper. The lower lip is not deeply incised, nor are the incisions at the angle of the mouth especially pronounced. The horny part of the lip is very broad and conspicuous. There are 26 to 28 gill-rakers on the first arch, a distinguishing character when compared with that of *P. virescens* which has 36 to 40. The caudal peduncle is rather deep, the fin short, with rounded lobes. The anal fin is rounded and extends to the base of the caudal. The pectorals and ventrals are rounded. There are 10 dorsal rays, occasionally 9 or 11. The scales are not so crowded anteriorly as those of *P. virescens*, and they very gradually grow larger toward the tail. The fontanelle is an open slit of varying width, almost closed in an occasional individual. The largest specimens measure 180 millimeters.

The cotypes of *Minomus platyrhynchus* Cope, from Provo, Utah, are in the United States National Museum (Nos. 15763 and 12906). These have an elongate body, large lips with a horny sheath, open fontanelle, about 80 scales in the lateral line. The cotypes were compared with specimens collected in several localities in the Bonneville basin.

P. platyrhynchus appears to be more abundantly represented in the southern part of the basin than elsewhere, it being the only mountain sucker as yet found in Sevier River and its tributaries. It abounds in Provo River, it was collected in Weber River, but it was not seen in Bear River. It was not seen associated with *P. virescens*, seeming to prefer the shallow riffles and more turbulent water. It is locally known as the mud sucker, and small examples are confused with fishes belonging to the genus *Agosia*. Nothing was observed of the habits of the species. An occasional example possessed a narrow, reddish lateral stripe.

Proportional measurements of 10 specimens of Pantosteus platyrhynchus.

	Provo River near Provo.									
Length of body (millimeters)...	152	145	118	115	114	110	131	132	122	122
Length of head.....	0.21	0.23	0.225	0.215	0.22	0.22	0.22	0.22	0.215	0.22
Depth of body.....	.205	.20	.20	.20	.21	.22	.22	.20	.21	.20
Depth of caudal peduncle.....	.09	.088	.10	.09	.09	.095	.10	.10	.095	.09
Length of caudal peduncle.....	.17	.18	.175	.19	.19	.185	.18	.17	.18	.18
Length of snout.....	.115	.12	.12	.12	.112	.115	.11	.12	.12	.11
Diameter of eye.....	.035	.038	.038	.035	.04	.04	.04	.038	.042	.035
Interorbital width.....	.085	.088	.09	.08	.08	.09	.09	.085	.08	.08
Depth of head.....	.135	.145	.14	.14	.15	.15	.14	.145	.135	.14
Snout to occiput.....	.19	.205	.20	.20	.20	.20	.20	.20	.19	.20
Snout to dorsal.....	.43	.50	.50	.49	.50	.51	.50	.50	.49	.50
Snout to ventral.....	.55	.55	.57	.55	.55	.56	.55	.58	.56	.54
Length base of dorsal.....	.14	.15	.135	.14	.14	.135	.145	.135	.14	.14
Length base of anal.....	.08	.09	.08	.08	.085	.07	.08	.07	.08	.07
Height of dorsal.....	.16	.165	.18	.17	.18	.18	.17	.15	.18	.16
Height of anal.....	.195	.215	.20	.19	.22	.19	.19	.20	.20	.21
Length of pectoral.....	.19	.20	.20	.20	.20	.21	.20	.19	.21	.205
Length of ventral.....	.135	.17	.15	.16	.18	.15	.145	.15	.16	.16
Length of caudal.....	.19	.20	.21	.20	.21	.22	.205	.20	.22	.21
Dorsal rays.....	10	10	10	10	10	10	10	10	10	10
Anal rays.....	7	7	7	7	7	7	7	7	7	7
Scales lateral series.....	87	86	86	84	81	78	85	84	83	86
Scales above lateral line.....	17	16	16	16	16	15	17	17	16	16
Scales below lateral line.....	12	11	12	11	12	11	12	11	11	12
Scales before dorsal.....	44	42	43	42	46	41	46	43	44	43

MORDENITE AND ASSOCIATED MINERALS FROM NEAR CHALLIS, CUSTER COUNTY, IDAHO.

By CLARENCE S. ROSS,

Geologist, United States Geological Survey,

AND

EARL V. SHANNON,

Assistant Curator of Geology, United States National Museum.

INTRODUCTION.

In 1917 Mr. Milton A. Brown, of Challis, Idaho, sent a specimen of a very fine cottony mineral of snow white color to the United States National Museum for identification. This mineral, which was thought to be asbestos, was said to be available in considerable quantity. Upon examination in the Museum laboratory this was found to be a fibrous zeolite, and optical examinations by Wherry and Larsen showed it to have properties similar to those of the rare mineral ptilolite. Chemical examination by Koch supported this conclusion, although the mineral was so mixed with small grains of quartz that it was not suitable for analysis. A short note on the occurrence was published by Koch.¹

In 1921 a box of some 50 pounds of specimens of the zeolite and associated minerals from this locality was received at the Museum. This material has been subjected to a detailed examination, the results of which are here presented.

NOMENCLATURE.

Dr. Waldemar T. Schaller has recently critically reviewed the group of zeolites which includes mordenite, ptilolite, and flokite. In addition to the existing literature, which includes recent work by Walker and Boggild, Schaller has considered new analyses made by himself and the analytical data presented below together with numerous new optical determinations. One of the results of this admirable work was to show that the Idaho mineral here considered is not ptilolite, as at first supposed, but is, in reality, mordenite.²

¹ Louis A. Koch. A new occurrence of ptilolite. *American Mineralogist*, vol. 2, p. 143, 1917.

² Waldemar T. Schaller. Unpublished paper presented before the first meeting of the Mineralogical Society of Washington, February, 1923. See abstract in *Amer. Mineralogist*, vol. 8, p. 93, 1923.

LOCALITY.

The specimens were received from Dr. Charles L. Kirtley, a physician of Challis, who is the original discoverer of the occurrence. Some years ago Mr. Brown had found, in the low hills south of Challis, some pebbles of colored corundum of such a quality as to indicate the possible occurrence of gem material. While searching for the corundum locality, which has not been rediscovered, Doctor Kirtley found the mordenite. The writers wish to gratefully acknowledge their indebtedness to Doctor Kirtley for his generosity in supplying these interesting materials together with notes on their place and mode of occurrence.

Challis is an interior community in Salmon River Valley 58 miles by stage northwest of Mackay, the nearest railroad point and the terminus of the Lost River branch of the Oregon Short Line Railroad. The zeolites and other minerals are from a small area of amygdaloidal rock in the low hills south of Challis in the wedge formed by Salmon River and Antelope Valley and a short distance west of the Challis-Mackay road.

GEOLOGY.

As described by Doctor Kirtley, the zeolite bearing formation occupies an area 3 acres in extent, surrounded by low hills of yellowish clay underlain by soft shale, the stratification being inclined about 20°. In this area the large masses of mordenite may be seen at many places, although the specimens collected all came from a single shallow cut. The shale hills are strewn with small pebble-like masses of translucent quartz and chalcedony. A map accompanying a reconnaissance report by Umpleby³ shows this area is occupied by lacustrine sediments with included tuffs and flows of andesite and basalt of probable Miocene age. The following description is quoted from this report.

Lacustrine deposits occur in the northeastern and eastern portions of the area studied. The northern area comprises an irregular belt about 10 miles across with tongues reaching up the several valleys tributary to the basin in which Challis is situated. To the south, west, and north the lake beds give way to lava flows, but to the south they connect across a low divide at the head of Antelope Valley with similar deposits in the valley of Big Lost River. The area east of Bay Horse is of peculiar shape but seems to have an outward continuation south of Antelope Ridge.

Perhaps the best exposures of these beds are along the east bank of Salmon River below Challis. Here the bluffs are about 200 feet high and, as seen from across the river, are made up of light gray sandstones, probably tuffaceous, and dove-colored shales. Conglomeratic members are sparsely and irregularly distributed through the section. The beds vary in thickness from less than an inch to several feet. In bluffs north of Challis, tuffaceous material, generally

³ Joseph B. Umpleby. Some ore deposits in northwestern Custer County, Idaho. U. S. Geol. Survey Bull. 539, p. 27, 1913.

very fine grained and of green, gray, or white color, predominate. It is nicely bedded, in places thinly laminated.

The hurried observations afforded little idea of the thickness of the deposits, although it must unquestionably be hundreds of feet.

Fossils were not found in this area, but the topographic relations of these beds are similar to those at Salmon, which were assigned to the Miocene on floral evidence.

Julien⁴ has published petrographic descriptions of several volcanic tuffs from Challis.

It seems most probable that the bed containing the mordenite and other minerals here described is an exceedingly vesicular andesite flow interbedded with the Miocene lake sediments. The larger geodal masses of the zeolites have some inclosing rock attached, but this is friable and sandy textured and falls to pieces except where it has been silicified by processes attending the deposition of the minerals in the cavities. One specimen which was labeled "country rock" consists of very numerous small pebblelike amygdules filled with mordenite, heulandite, and diabantite or a related chlorite, in a friable greenish matrix. A thin section of this rock, which below is frequently referred to as "the amygdaloid," shows the matrix to consist of phenocrysts of augite in a glass base. Fully half of the volume of the rock is occupied by the filled vesicles, as shown in the two middle illustrations of plate 2. The forms of these small amygdules vary from spherical to irregular, but show them unquestionably to be gas cavities rather than replacement nodules in a tuffaceous rock.

MORDENITE.

Mordenite was originally described from Nova Scotia, where it has been found at several localities, but only in relatively small amount at each, as compact masses with confused fibrous structure filling small cavities in lavas. No finely fibrous or cottony material is known from Nova Scotia, although, as shown by Schaller in the paper previously cited, the flokite from Iceland, which has such structure, is identical with mordenite. The mineral seems to be present as finer specimens and in greater abundance at the Idaho locality than at any other known occurrence. In the Idaho specimens examined the mordenite occurs in a variety of forms ranging from fine cottony felted aggregates through radial-fibrous masses to dense compact porcellaneous materials. Most abundant and conspicuous are the large geodal masses of fine cottony material which reach a diameter of a foot or more. These vary from round to irregular in cross section and consist usually of a thin shell of chalcedonic material filled with the light tufted fibers of the mordenite. Although this cottony material appears entirely homogeneous to the unaided eye, it all contains gritty particles which can be felt when it is crushed, and upon

⁴ Alexis A. Julien. Volcanic tuffs from Challis, Idaho. Trans. N. Y. Acad. Sci., vol. 1, pp. 49-53, 1882.

microscopic examination these are found to be minute spherulitic or spindle-shaped grains of quartz with radial structure. Koch selected what he thought was a very pure material for analysis and estimated, after the analysis had shown an abnormal amount of silica, that the analyzed material had contained about 33 per cent of quartz. Schaller's recalculation shows that about 40 per cent would be nearer the truth. The small quartz spherulites are pinned through by the mordenite fibers and have clearly developed subsequent to the mordenite. None of the fine cottony material was found to be free from quartz, although the compact varieties are frequently free from any impurity. Practically all of the geodes of the cottony type have a very thin outer shell of heulandite which forms the first lining in the cavity. Within this there is usually a thin layer of chalcedony upon which the mordenite was deposited, filling the interior of the cavity with loosely aggregated fibers. A typical specimen of this sort, although one of the smallest received, is that shown in plate 1, upper left. Many of the cavities have a thicker crust which is found upon microscopic examination to consist of chalcedony including mordenite fibers which have the same attitude as those which occur free in the middle portion of the cavity. This chalcedony appears to be later than the mordenite and to have formed a crust by saturating the pore space of the loose-textured mordenite. In some geodes of moderate size only a small area remains in the center where the mordenite is not saturated with silica, the specimen shown in plate 2, lower, being an example, while in extreme cases, noted only in the smaller masses, the entire content of the cavity has been saturated with chalcedony, or, more rarely, granular quartz. One striking specimen illustrated in plate 3, lower, has silky bundles of short fibers of mordenite attached to masses of small quartz spherulites which project from platy (argentine) calcite. Analc occurs as flattened crystals between the calcite plates. Both this spherulitic quartz and the calcite are probably younger than the mordenite and the calcite has apparently, in part, been dissolved away. The microscope shows the mordenite fibers of this specimen to be individually coated with a thin film of calcite. In other specimens the fibers were similarly incrustated with quartz. A part of the light cottony variety contained many of the small radial grains of quartz but was free from the incrustations. This was separated from its included quartz grains by alternate rubbing between hardwood boards and screening, the quartz grains when freed from the fiber, passing through the meshes of the sieve while the tufts of mordenite remained behind. This process was continued until no more gritty particles could be felt in the sample when it was examined optically and found to be pure and free from quartz. Upon analysis this sample gave the following results and ratios.

Analysis (1) and ratios of cottony mordenite.

Constituent.	Per cent.	Ratios.		
SiO ₂ -----	64.84	1.075	0.119 x 9	1.00 x 9
Al ₂ O ₃ -----	12.07	.118	.118 x 1	.99 x 1
CaO-----	3.08	.055		
MgO-----	.26	.006		
Na ₂ O-----	3.80	.061	.126 x 1	1.06 x 1
K ₂ O-----	.38	.004		
H ₂ O+110° C-----	10.42			
H ₂ O-110° C-----	4.37	.822	.137 x 6	1.15 x 6
Total-----	99.22			

The material of this analyzed sample was biaxial and negative with the orientation $X\Delta c=3^{\circ} 40'$, $Y=a$, $Z=b$, the indices of refraction being $\alpha=1.470$, $\beta=1.475$, $\gamma=1.475$, $\gamma-\alpha=0.005$.

The second sample analyzed came from a pure nodule about 8 centimeters in maximum diameter which has evidently been weathered upon the surface for some time, as it is weather stained; the original shell is bleached, and the mordenite is in places stained green by algae. The nodule is red on its original surface from a thin coating of heulandite, succeeded inward by a thin shell of chalcedony, inside which the mass consists of pure mordenite in fibers extending from all sides toward the center. The fibers are straight and close packed and reach a maximum length of 2 centimeters. The color is creamy white and the luster, on fresh fracture, is faintly silky. The analysis gave the following results:

Analysis (2) of weathered fibrous mordenite nodule.

Constituent.	Per cent.	Ratios.		
SiO ₂ -----	65.88	1.093	0.121 x 9	1.00 x 9
Al ₂ O ₃ -----	12.40	.121	.121 x 1	1.00 x 1
CaO-----	3.52	.063		
MgO-----	.48	.012		
Na ₂ O-----	3.52	.057	.138 x 1	1.13 x 1
K ₂ O-----	.56	.006		
H ₂ O+110°C-----	9.08	.504		
H ₂ O-110°C-----	4.32	.240	.124 x 6	1.02 x 6
Total-----	99.76			

The refractive indices of this sample, measured on the analyzed material are: $\alpha=1.472$, $\beta=1.475$, $\gamma=1.476$, $\gamma-\alpha=0.004$. All of the fibers which are thick enough to have appreciable birefringence were found to have a small inclined extinction.

Many of the specimens received are amygdules free from matrix which apparently were gathered, like so many pebbles, from the

surface. These vary in size and are very irregular in form but apparently they represent casts of the interiors of very irregular bubble cavities probably formed by the sudden expansion of steam in viscous lava. They all preserve the original outside crust of red color which resembles a stain of iron oxide, but which, upon more minute examination, is found to be the thin skin of heulandite which formed the first lining of the cavity. All of these heulandite coated masses are hard and compact, but they vary somewhat in internal structure and composition. Some of them are entirely filled with bluish chalcedony and quartz, others are mixtures of mordenite and chalcedony or of mordenite and quartz, while a majority contain only pure mordenite. The mordenite of the latter varies from distinctly radial fibrous to very compact in structure. The third analysis was made upon such a nodule which was exceedingly tough and difficult to break. Under a lens this shows a confused and interwoven fibrous structure and when examined under the microscope its structure is finely felted fibrous. The mean index of refraction, the only one determinable, is 1.473. This description applies equally well to a type specimen of How's original mordenite from Nova Scotia in the Roebling collection which has a mean index of refraction of 1.473 and a birefringence of about 0.005. The material from this nodule which was analyzed was shown to be pure and free from extraneous substances by optical examination. The analysis gave the following results:

Analysis (5) and ratios of compact nodule of mordenite.

Constituent.	Per cent.	Ratios.		
SiO ₂	67.24	1.115	0.124 x 9	1.00 x 9
Al ₂ O ₃	12.94	.127	.127 x 1	1.02 x 1
CaO.....	2.72	.049		
MgO.....	.28	.007	.126 x 1	1.01 x 1
Na ₂ O.....	4.08	.066		
K ₂ O.....	.36	.004		
H ₂ O+110° C.....	8.44	.746	.124 x 6	1.00 x 6
H ₂ O-110° C.....	5.00			
Total.....	101.06			

The fourth and last analysis of the Idaho mordenite was made upon several of the small masses from the peculiar amygdaloid rock mentioned on page 3. This rock consists of granular lava having half the volume occupied by gas cavities filled with pebblelike masses a few millimeters in diameter which differ strikingly in color. Mordenite occurs alone in this rock as snow-white masses of very compact texture, also as larger and looser textured flesh-pink masses, the color being due to a very thin outer coating of heulandite, and as

rare thin fibers attached to heulandite crystals lining hollow flesh-red masses of heulandite. The snow-white masses show on fracture the texture of porcelain and are lusterless and exceedingly tough. These, when ground for analysis were found to be pure with a very finely felted fibrous structure. The mean index of refraction of the analyzed material was 1.473. The analysis gave the following results and ratios:

Analysis (4) of small pebblelike masses of mordenite.

Constituent.	Per cent.	Ratios.		
SiO ₂ -----	66.25	1.099	0.122 x 9	1.00 x 9
Al ₂ O ₃ -----	11.88	.116	.116 x 1	.95 x 1
CaO-----	2.75	.049		
MgO-----	.44	.011	.133 x 1	1.09 x 1
K ₂ O-----	.69	.007		
Na ₂ O-----	4.05	.066		
H ₂ O+110° C-----	8.80	.488	.128 x 6	1.05 x 6
H ₂ O-110° C-----	5.05	.280		
Total-----	99.91			

The four analyses of the Idaho material agree in giving the silica ratio as 9 instead of 10 molecules and the water as 6. For convenience in comparing the silica content, the several analyses are brought together and their average compared with the values calculated to suit the two formulas (Na₂,Ca)O.Al₂O₃.9SiO₂.6H₂O. and (Na₂,Ca)O.Al₂O₃.10SiO₂.6H₂O in the following table, a 1 : 1 ratio between CaO and Na₂O being assumed in calculating the theoretical compositions:

Comparison of mordenite analyses with formula percentage values.

	1	2	3	4	Average.	9SiO ₂	10SiO ₂
SiO ₂ -----	64.84	65.88	67.24	66.25	66.06	66.81	69.12
Al ₂ O ₃ -----	12.07	12.40	12.94	11.88	12.32	12.59	11.72
CaO-----	3.08	3.52	2.72	2.75	3.02	3.45	3.21
MgO-----	.26	.48	.28	.44	.36		
Na ₂ O-----	3.80	3.52	4.08	4.05	3.86	3.83	3.56
K ₂ O-----	.38	.56	.36	.69	.50		
H ₂ O-----	14.79	13.40	13.44	13.85	13.87	13.32	12.39
	99.22	99.76	101.06	99.91	99.99	100.00	100.00

This comparison indicates quite conclusively that the correct formula for all of the several physical modifications of the Idaho mordenite is (Ca,Na₂)O.Al₂O₃.9SiO₂.6H₂O which is identical with the formula assigned to flokite and contains 1 molecule less of silica and 1 molecule less of water than the accepted formula for

the Colorado ptilolite $(Ca, K_2, Na_2)O \cdot Al_2O_3 \cdot 10SiO_2 \cdot 7H_2O$, and 1 molecule of silica and $\frac{2}{3}$ molecule of water less than the formula commonly given for mordenite, based upon Pirsson's Wyoming material $(Ca, K_2, Na_2)O \cdot Al_2O_3 \cdot 10SiO_2 \cdot 6\frac{2}{3}H_2O$. Boggild⁵ has recently concluded that flokrite is identical with ptilolite, while Walker⁶ suggests that ptilolite and mordenite are probably identical. Schaller, in the paper above referred to, however, has shown that mordenite and flokrite are identical, but that mordenite, which is monoclinic, is distinct, chemically as well as crystallographically, from ptilolite which is orthorhombic. The material from Wyoming described as mordenite by Pirsson, which is distinct from either mordenite or ptilolite (clinoptilolite, Schaller), was instrumental in confusing the species mordenite. The best available data on the refractive indices of these minerals is assembled below:

Refractive indices of mordenite and related minerals.

Mineral.	Locality.	Authority.	Refractive indices.			Extinction.
Mordenite---	Idaho-----	Koch-----	1.475	1.477	1.478	Undetermined.
Do-----	Idaho (1)---	Ross-----	1.470	1.475	1.475	Inclined.
Do-----	Idaho (2)---	do-----	1.472	1.475	1.476	Do.
Do-----	Idaho (3)---	do-----	-----	1.473	-----	Not determin- able.
Do-----	do (4)-----	do-----	-----	1.473	-----	Do.
Ptilolite-----	Colorado---	Larsen---	1.476	1.480	1.480	Parallel.
Mordenite---	N o v a Scotia.	do ¹ ---	-----	1.473	-----	Not determin- able.
Do-----	do-----	Ross ² ---	1.471	-----	1.475	Do.
Flokite-----	Iceland---	Callisen--	1.472	-----	1.474	Inclined.

¹ Specimen of How's original material from Morden, Nova Scotia, owned by Col. W. A. Roebling. The value given originally (1.465) in Larsen's tables (Bull. U. S. Geol. Surv. No. 679, p. 113, 1921) has been found to be an error.

² Specimen of recent collection by Walker and Parsons from Hall's Harbor, Kings County, Nova Scotia (Cat. U. S. N. M. 94, 552). Data determined by Ross and not previously published.

Two fibrous minerals, one orthorhombic with parallel extinction, and the other monoclinic, with inclined extinction, are represented by ptilolite and mordenite which differ one molecule in silica and one molecule in water. These minerals are very similar, however, both in composition and properties, and very careful work is necessary to distinguish between them. It may be mentioned, in passing, that erionite has the same formula type, the same habit, and similar optical properties, although the refractive indices are much lower. This mineral has the formula $(Ca, K_2, Na_2)O \cdot Al_2O_3 \cdot 6SiO_2 \cdot 6H_2O$. Miss Callisen made flokrite monoclinic on the basis of a constant extinction inclination of 5° on (010) combined with twinning on (100). These observations Boggild set aside as probably due to inexact ob-

⁵ O. B. Boggild. Dansk. Videnskab. Selskab. Mathemat.-Phys., vol. 4, No. 8, p. 19, 1922.

⁶ Thos. L. Walker. Contributions to Canadian Mineralogy, 1922. Univ. Toronto Geol. Series, No. 14, p. 59, 1922.

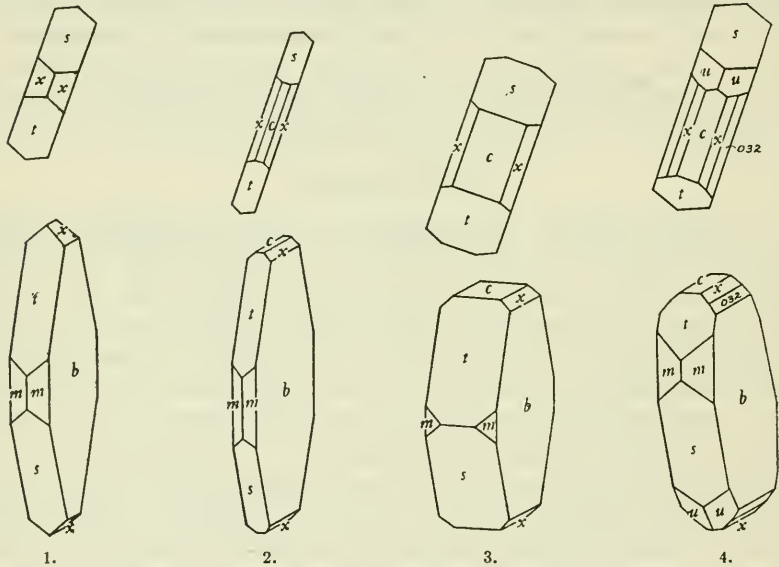
servation despite the fact that Thugutt had described a "ptilolite" from Seiser Alp which showed inclined extinction. With this in mind the Idaho material was very carefully examined, its composition and refractive indices being identical with those given for flokite. Since the fibers are very thin and the birefringence is very low an extinction obliquity of several degrees might readily evade observation. Such a small angle might also be attributed to lack of adjustment between the cross hairs and nicols of the microscope. After specially adjusting the microscope the Idaho material was found to give, as the mean of about 20 good measurements, an extinction inclination of $3\frac{1}{2}^{\circ}$, measured from the elongation of the fibers. Instead of containing errors of observation, Miss Callisen's work on flokite appears to be a very commendable and highly exact research which has furnished the key for the interpretation of the group.

The Idaho mordenites are interesting especially as furnishing a complete gradation between the physically very dissimilar compact mordenite from Nova Scotia and the cottony fibrous "flokite" from Iceland.

HEULANDITE.

Heulandite occurs in the specimens as a complete filling of small vesicles in the rock, as drusy linings of cavities, and as thin crusts forming the first lining of cavities later filled with mordenite, chalcedony, or quartz. The characteristic flesh-red masses in the amygdaloid consist of fine transparent heulandite, and many of these small masses are hollow and present fine terminations of acute wedge-shaped crystals, the habit being as shown in figures 1 and 2. These show very well developed cleavage parallel to the pinacoid $b(010)$ as well as some other less perfect cleavages at right angles to this plane. Usually two or several crystals are grown together in more or less parallel position, but the tendency to parallel growth is not so conspicuous as usual in the heulandite of this type. A majority of these pebbles are not hollow, but are solid masses of the heulandite. Those which do show open centers often have a few fine fibers of mordenite extending across the central cavity. Other heulandite-lined vesicles in the same rock are completely filled with closely packed cottony mordenite and the faintly pink to salmon colored masses which fill many of the larger bubble cavities are compact mordenite with a thin outer skin of heulandite. The numerous irregular masses which have weathered free from the inclosing rock, and which consist of compact mordenite, of mordenite saturated with quartz or with chalcedony, or of quartz or chalcedony alone, all have a brick-red outer coating which resembles a stain of ferric oxide, but which, when examined with a lens, is found to consist of a thin outer crust of crystalline heulandite. All of the larger geodal masses of mordenite, of whatever type, have a thin deposit of heulandite next the

inclosing rock. Optical examination of the clear crystals from hollow heulandite amygdules showed them to be transparent and colorless and devoid of any visible pigmentsing material to which the red color might be attributed. Optically the crystals lining the small cavities or making up the flesh-red amygdules of the amygdaloid rock are biaxial positive (+) with $2V=52^\circ$. The indices of refraction are $\alpha=1.482$, $\beta=1.485$, $\gamma=1.489$, $\gamma-\alpha=0.007$. The acute bisectrix (Z) is perpendicular to the $b(010)$ face, while the extinction, measured from the c crystallographic axis averages 35° , the optic plane being nearly parallel (measured 5° to 8°) to the trace of one of the terminal clinodomes, either $t(101)$ or $s(\bar{1}01)$. The crystals as seen between crossed nicols are frequently not entirely simple, being



FIGS. 1 TO 4.—HEULANDITE CRYSTALS FROM CHALLIS, IDAHO.

divided by sutures into areas which differ slightly in extinction angle. Thus the crystal measured and illustrated by the drawing (fig. 2), was found to be divided vertically by a straight line, on one side of which the extinction, measured from the vertical cleavage lines, gave $38\frac{1}{2}^\circ$ while on the other side it was $44\frac{1}{2}^\circ$ and a wedge entered at the termination of the crystal in which the extinction was 33° , the latter being about the normal extinction angle of homogeneous crystals. In addition to this peculiarity the crystals frequently show a very narrow outer border of a material of decidedly higher index of refraction.

The crystals of this heulandite which were measured did not give overly satisfactory angles, mainly because of the poor development,

bulging, or parallel growth in the vertical zone rendering accurate orientation on the goniometer very difficult. The average degree of agreement may be shown by giving, in detail, the measurements obtained upon two crystals, shown in figures 1 and 2, which were as follows:

Measurements obtained on heulandite (fig. 1).

Letter.	Miller.	Quality.	Measured.		Calculated.			
			ϕ	ρ	ϕ	ρ		
			°	'	°	'		
b	010	{ Poor, multiple-----	0	00	90	00	0	00
		{ do-----	0	25	90	00	—	—
m	110	{ Fair but faint-----	66	07	90	00	68	02
		{ Good-----	68	15	90	00	68	02
		{ Poor, faint-----	67	38	90	00	68	02
t	101	{ Poor, very faint-----	67	05	90	00	68	02
		{ Good-----	89	52	65	36	90	00
s	$\bar{1}01$	{ do-----	91	46	65	42	90	00
		{ do-----	89	22	64	14	90	00
x	011	{ do-----	1	05	43	20	1	39
		{ do-----	2	32	44	46	1	39

Measurements on heulandite crystal (fig. 2).

Letter.	Miller.	Quality.	Measured.		Calculated.			
			ϕ	ρ	ϕ	ρ		
			°	'	°	'		
b	010	{ Very good-----	0	00	90	00	0	00
		{ Excellent-----	0	00	90	00	—	—
m	110	{ Good-----	67	38	90	00	68	02
		{ do-----	67	41	90	00	—	—
c	001	{ do-----	91	30	1	06	90	00
t	101	{ Excellent-----	90	00	65	23	90	00
s	$\bar{1}01$	{ Good-----	90	00	64	44	90	00

The agreement, while not satisfactory, is sufficiently close to show the essential crystallographic identity of the mineral with heulandite. The abrupt displacement of certain forms so that they give angles a degree or more off is no doubt connected either with compound character or with the heterogeneous internal structure as seen in polarized light.

This material was analyzed, the material for analysis being selected small red nodules and the analyzed powder was shown to be

essentially pure and homogeneous by optical study. The percentages and ratios obtained are as follows:

Analysis and ratios of heulandite.

Constituent.	Per cent.	Ratios.		
SiO ₂ -----	61.14	1.014	0.145 x 7	1.00 x 7
Al ₂ O ₃ -----	14.52	.142	.142 x 1	.98 x 1
CaO-----	3.60	.064		
MgO-----	.28	.007	.153 x 1	1.05 x 1
K ₂ O-----	.94	.010		
Na ₂ O-----	4.48	.072		
H ₂ O-----	14.16	.787	.157 x 5	1.09 x 5
Total-----	99.12			

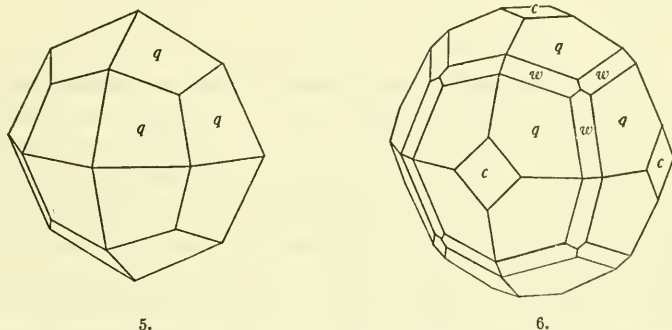
This analysis gives the formula $(Ca,K_2,Na_2)O.Al_2O_3.7SiO_2.5H_2O$. This differs from the formula for heulandite given by Dana in containing one more molecule of silica. The replacement of lime by alkalies has, furthermore, progressed to the point where the combined soda and potash are in excess, both molecularly and by weight, of the lime.

A form of heulandite of somewhat different properties occurs rarely in the amygdaloid rock as small solid pebblelike bodies coated on the outside by deep green chlorite and, where fractured, showing coarse granular structure, well defined cleavage, pearly luster, and a faintly pink color. A similar material occurs as drusy crusts of brilliant crystals of faintly pink color lining small flat open cavities in the rock adjacent to the large masses of mordenite. These crystals when examined optically are seen, like the preceding, to be made up of sectors not identical in extinction angle, the angle between adjacent sectors varying 10° or more. Moreover, they are strongly zoned, the outer zone having the following optical properties: Biaxial, positive (+), $2V=68^\circ$, $\alpha=1.494$, $\beta=1.496$, $\gamma=1.501$, $\gamma-\alpha=0.006$, while the properties of the cores are: Biaxial positive (+), $2V=90^\circ$, $\alpha=1.483$, $\beta=1.487$, $\gamma=1.490$, $\gamma-\alpha=0.007$. Crystallographically these are, like the others, in fair agreement with the heulandite angles, the forms identified being $b(010)$, $m(110)$, $c(001)$, $t(101)$, $s(\bar{1}01)$, $x(011)$, and $w(032)$. The latter is a rare form previously noted only on heulandite from Scotland. In habit these pale crystals are much stouter than the others, as shown in figures 3 and 4, and they are grown together in parallel groups over considerable areas, the plane of contact being $b(010)$.

ANALCITE.

Analcite occurs as single crystals and groups of aggregated crystals embedded near the centers of the larger masses of cottony mordenite and as crusts and druses of crystals lining cracks in the adjacent

rock or filling gashes in the mordenite which probably result from the solution of plates of calcite as shown in plate 1, upper right. Individual crystals of the analcite reach an extreme diameter of 14 millimeters. Where free from inclusions the analcite is clear and colorless, but the crystals commonly inclose fibers of mordenite and spherulites of quartz, giving them a milky appearance. They are for the most part simple trapezohedrons of the form $q(112)$, which is a common form for analcite as shown in figure 5. Occasionally however, one shows faces of the cube $a(100)$ and of the trigonal trisoctahedron $w(233)$ which, though previously known, are rare forms on analcite. A modified crystal is shown in figure 6. Certain very interesting crystals occur in the platy argentine calcite. These are attached to the calcite plates by the equatorial plane and, where space was available, the top halves have developed completely. Where the space between the calcite plates was thin the analcites



FIGS. 5 AND 6.—ANALCITE CRYSTALS FROM MORDENITE MASS, CHALLIS, IDAHO.

are very much flattened and are bounded only on their edges by narrow crystal planes. Both undeformed and greatly flattened crystals are shown attached to calcite in plate 3, right. The disk-like crystals may reach 1 centimeter in diameter with a thickness of only 0.2 millimeter, although most of them are thicker than this, with a smaller diameter. Selected ones of these are ideal thin sections, and show admirably the birefringence and division into sectors. Such a crystal photographed in polarized light between crossed nicols is shown in plate 3, upper. The flattened analcites adhere to the quartz films which coat the platy calcite and usually show very numerous quartz spicules attached to their surface. This quartz was ground off of the crystal shown in the photograph. Optically the analcite is biaxial and negative with large axial angle and a mean index of refraction of 1.486. The biaxial interference figure is extremely sharp and definite and this, together with the geometrical perfection of the division into sectors and the sharpness of the

lamellæ, makes it hard to accept the idea that the mineral owes its nonisotropic character to anomalies explained by internal strain.

A sample for analysis was selected carefully and its homogeneous character and purity were established microscopically. The analysis gave the following composition and ratios:

Analysis and ratios of analcite.

Constituent.	Per cent.	Ratios.		
SiO ₂	57.47	0.953	0.238 x 4	1.19 x 4
Al ₂ O ₃	20.85	.204	.204 x 1	1.03 x 1
CaO.....	.52	.009		
MgO.....	.21	.005		
K ₂ O.....	.64	.007	.199 x 1	.98 x 1
Na ₂ O.....	10.94	.177		
H ₂ O+110° C.....	8.43	.468	.234 x 2	1.17 x 2
H ₂ O-110° C.....	None.			
Total.....	99.06			

The above ratios are not satisfactorily close to whole numbers to conform to the analcite formula given by Dana, both water and silica being high. Parsons⁷ recently, in discussing the composition of analcite from Nova Scotia, has shown that all of the analyses of analcite given by Dana can be satisfactorily interpreted by the assumption that the mineral is composed of an isomorphous mixture of two compounds of the composition (A) Na₂O.Al₂O₃.6SiO₂.3H₂O and (B) Na₂O.Al₂O₃.2SiO₂.H₂O. Considered from this standpoint the Idaho material may be regarded as made up of almost exactly two parts of (A) and one of (B) molecularly, as shown by the following table in which the condensed figures of the analysis are given in column 1 compared with the percentages calculated for a mixture of the 2 : 1 composition in column 2.

	1	2
	Found.	Calculated.
SiO ₂	57.47	57.71
Al ₂ O ₃	20.85	20.96
Na ₂ O (+CaO+MgO+K ₂ O).....	12.31	12.71
H ₂ O.....	8.43	8.62
Total.....	99.06	100.00

The paragenetic position of the analcite is late, as it grew between the laminae of calcite or occupied cavities left by removal of calcite

⁷ Arthur L. Parsons. Univ. of Toronto Geol. Series No. 14. Contributions to Canadian Mineralogy, 1922, pp. 34-38, 1922.

and incloses mordenite and spherulitic quartz. No other mineral is deposited on the analcite, and it is probably the youngest of the minerals represented in the Challis specimens.

CHLORITE.

About one-fourth of the total number of small pebblelike fillings in the amygdaloid rock consist of a soft, foliated, brownish-green chlorite. These chlorite fillings, which reach an extreme diameter of 7 millimeters, are easily freed from the surrounding matrix and when crushed yield a homogeneous sample for analysis. This chlorite does not occur in the same vesicles with any of the zeolitic minerals, but it is sparingly distributed in the silicified portions of the inclosing rock near the large zeolite-filled cavities. Under the microscope the chlorite is seen to consist of yellow-green irregular folia. These are biaxial and optically negative (-) with 2V near 15°. The indices of refraction, which are high for a chlorite are, $\alpha=1.615$, $\beta=1.637$, $\gamma=1.638$, $\gamma-\alpha=0.023$. The mineral is strongly pleochroic with X and Y olive-green and Z brownish-yellow. This material was analyzed yielding the following results and ratios:

Analyses and ratios of brownish-green chlorite.

Constituent.	Per cent.	Ratios.		
SiO ₂ -----	30.76	0.510	0.170 x 3	1.00 x 3
Al ₂ O ₃ -----	12.12	.119}	.176 x 1	1.03 x 1
Fe ₂ O ₃ -----	9.12	.057}		
FeO-----	22.76	.317}	.160 x 4	.94 x 4
MnO-----	1.24	.018}		
CaO-----	Trace.	---		
MgO-----	12.36	.307}	.160 x 4	.94 x 4
H ₂ O+110° C-----	9.76	.542}		
H ₂ O-110° C-----	1.80	.100}		
Total-----	99.92			

This analysis yields as the formula, $4RO.R_2O_3.3SiO_2.4H_2O$, with $RO=MgO : FeO=1 : 1$ and $R_2O_3=Fe_2O_3 : Al_2O_3=1 : 2$. This can not be definitely assigned to any member of the chlorite group but is most closely related to diabantite and delessite, chlorites occurring characteristically as amygdule fillings in basic igneous rocks. The content of ferric iron is noteworthy, and this doubtless explains the relatively high index of refraction and birefringence of the mineral. In a recent description of diabantite from Nova Scotia, Walker⁸ obtained from an analysis a formula slightly different from that of

⁸ Thomas L. Walker. Univ. Toronto Geol. Series No. 14, p. 47, 1922.

Hawes, and points out that both his and Hawes's minerals can be interpreted as isomorphous mixtures of two compounds, namely (a) $RO.R_2O_3.2SiO_2.2H_2O$, and (b) $2RO.SiO_2.H_2O$. This is distinctly not true of the present analysis in its present form. However, if the ferric iron be calculated back to ferrous iron and the water below 110° be excluded, the formula obtained is $4FeO.3MgO.Al_2O_3.5SiO_2.5H_2O$, which may be regarded as composed of Walker's (a) $\times 1$ with $RO=MgO$ plus (b) $\times 1$ with $RO=MgO$ plus (b) $\times 2$ with $RO=FeO$. The analysis, recalculated on this basis, is given in column 1 below, while in column 2 is given the calculated composition of a mixture of the above formula:

	1	2
SiO ₂	31.64	33.30
Al ₂ O ₃	12.47	11.33
FeO.....	31.86	31.74
MnO.....	1.28	-----
MgO.....	12.71	13.63
H ₂ O.....	10.04	10.00
Total.....	100.00	100.00

Heated before the blowpipe in the forceps this chlorite exfoliates somewhat, becomes magnetic, and finally fuses with some difficulty to a black magnetic slag. In the closed tube it yields abundant water having an acid reaction, indicating a small fluorine content. It is quickly and completely soluble in hot 1 : 1 hydrochloric acid.

In the same specimens there occurs a second chlorite which never completely fills the cavities but merely forms a thin lining 0.5 millimeter or less in thickness in cavities containing fillings of mordenite and serves as coloring matter in the surrounding andesite. It is impossible to obtain enough of this material in pure form for analysis. It is deep blue green in the specimen and under the microscope is seen to consist of finely felted shreds and scales of a deep blue-green color which, in the aggregate, do not show any noticeable pleochroism. The indices of refraction are, $\alpha=1.606$, $\gamma=1.608$, $\gamma-\alpha=0.002$. Aside from the difference in color, these chlorites differ sharply in birefringence.

In the following table the optical properties of these two chlorites are repeated in comparison with those of several other occurrences of similar chlorites.

	1	2	3	4	5	6
α -----	1.615	1.606	1.555	-----	1.540	1.605
β -----	1.637	-----	1.595	1.605	1.590	1.619
γ -----	1.638	1.608	1.595	-----	1.605	1.619
Sign-----	(-)	-----	(-)	(-)	(-)	(-)
2V-----	15°	Small.	0°	Small.	Large.	0°
X-----	Olive-green.	Blue-green.	Pale yellow.	Olive-buff.	Gray-green.	Various.
Y-----	Brown-yellow.	Blue-green.	Olive-green.	Olive-buff.	Gray-green.	Various.
Z-----	Brown-yellow.	Blue-green.	Olive-green.	Olive-buff.	Gray-green.	Various.
Biref-----	0.023	0.002	0.040	-----	0.065	0.014

(1) Challis analyzed chlorite (Ross).

(2) Challis blue-green chlorite (Ross).

(3) Nova Scotia, analyzed chlorite of Walker (Larsen).

(4) Bergen Hill, New Jersey, diabantite (Larsen, Bull. 679, U. S. G. S., p. 67).

(5) Plainfield, New Jersey, diabantite (Larsen, Bull. 679, p. 67).

(6) Delesite (Larsen, Bull. 679, p. 255).

The results show the marked variability in optical properties as well as in composition of the materials which have been referred to diabantite and delesite. Examinations of new occurrences of these minerals can scarce do more at present than to add accurate data to the literature that it may in the future be available for use in the interpretation of the groups as a whole.

CALCITE (ARGENTINE).

Several specimens of calcite are included in the Challis material with the statement that they come from the centers of the larger mordenite geodes. These are all of the unusual variety of calcite which shows lamellar or platy structure and parting parallel to the basal pinacoid (0001), and which is commonly given the varietal name "argentine." The largest specimen of this argentine received has plates 16 centimeters in diameter and while containing quartz and analcite shows no mordenite. Another large specimen, shown in plate 3, lower, is evidently a solution remnant and includes analcite, quartz, and mordenite. A third specimen, in which the platy character is not so evident, is a rounded cast of the central portion of a geodal cavity and is coated on the outside with fibrous mordenite. When clean cleavages from the interior of this mass are dissolved in acid, long silky needles or mordenite remain behind. The broadly platy specimens are snow-white in color. The characteristic pearly luster on the basal pinacoid, usually shown by argentine, is lacking, doubtless because the plates have a uniform thin coating of peculiarly reticulated quartz. A specimen in the United States National Museum from Republic mining district, Washington, is identical

with the Challis argentine in appearance and like it has the calcite plates coated with thin reticulate layers of quartz. The Washington argentine is associated with laumontite.

The large argentine masses clearly are later, in age, than both the mordenite and the spherulitic quartz and the calcite is older than the reticulated quartz and the analcite, which occurs as flattened crystals between the calcite plates. In the specimen shown in plate 1, lower, however, the calcite plates are embedded in the mordenite and thin sections show that the calcite plates of this specimen not only certainly are earlier than the mordenite, but that they are older than the early heulandite deposit which lines the cavity and coats the free plates of calcite on both sides. Elsewhere in the large mordenite specimens there are flat gashes, now lined with analcite, which are apparently casts left by the removal by solution of early calcite plates. There are obviously two generations of the calcite in the specimens, both of which have the unusual argentine habit. The habit of the calcite may be due to the fact that the solutions from which it crystallized were highly saturated with silica and the calcite plates and their surfacing films of quartz are more or less contemporaneous, the silica presumably having deposited in colloidal form.

CONCLUSION.

The assemblage of minerals here described occurs as fillings of cavities, often of very irregular form and large size, in what is probably a flow of rather glassy andesite with a porphyritic development of augite, poured out in a Miocene lake basin. The cavities with their fillings may be so closely spaced as to make up a large proportion of the bulk of the rock. In general, the augite phenocrysts of the andesite are quite unaltered and there is no evidence of extensive alteration of the groundmass, so that it is evident that the minerals of the cavities were not derived by the breaking down of any of the constituents of the immediately adjacent rock. So far as can be determined from a study of the specimens available the order of deposition has been as follows, beginning with the earliest mineral deposited: Chlorites (diabantite, etc.), chalcedony, calcite (argentine), heulandite, mordenite, quartz (spherulitic), calcite (argentine), quartz (films), analcite.

The deposition of both quartz and chalcedony was apparently repeated or was continuous over a considerable period. Of the minerals, mordenite, a comparatively rare zeolite, is by far the most abundant. The area deserves further study and may be expected to produce other minerals of interest if carefully explored.

EXPLANATION OF PLATES.

PLATE 1.

Upper left. Geodal mass of cottony type of mordenite with chalcedonic shell.

Upper right. Analcite crystals in cottony mordenite.

Lower. Argentine calcite inclosed in compact fibrous mordenite. Note thin shell of heulandite which lines the cavity. The small black specks on or near the calcite plates are small dendrites of manganese oxide. All natural size.

PLATE 2.

Upper. Small pure mass of compact, felted-fibrous mordenite filling gas cavity in andesite.

Center. Two specimens of amygdaloidal andesite containing amygdules of mordenite, heulandite, and chlorite.

Lower. Mordenite-filled cavity, all except the central part of the loose-textured mordenite being saturated with granular quartz. All natural size.

PLATE 3.

Upper. Natural thin flattened analcite crystals from between plates of argentine calcite. Photographed between crossed nicols to show anomalous birefringence and division into sectors. $\times 20$.

Right. Argentine (calcite) coated with quartz spicules and bearing small flattened analcites. Natural size.

Lower. Tufts of mordenite fibers attached to groups of quartz spicules projecting from platy argentine calcite. Natural size.





MORDENITE, ANALCITE, AND ARGENTINE.

FOR EXPLANATION OF PLATE SEE PAGE 19.



MORDENITE MASSES AND AMYGDALOIDAL ROCK, CHALLIS, IDAHO.

FOR EXPLANATION OF PLATE SEE PAGE 19.



ANALCITE, ARGENTINE CALCITE, MORDENITE, AND QUARTZ.

FOR EXPLANATION OF PLATE SEE PAGE 19.

ON THE GENERA OF THE ICHNEUMON-FLIES OF THE
TRIBE PANISCINI ASHMEAD, WITH DESCRIPTIONS AND
DISCUSSION OF RELATED GENERA AND SPECIES

By R. A. CUSHMAN,

Of the Bureau of Entomology, United States Department of Agriculture.

This paper is a review of the genera included by Ashmead and others in the tribe Paniscini. In the opinion of the writer most of these genera are not related to *Paniscus* but are more or less anomalous representatives of several groups, placed together because of general superficial resemblance to each other. Each genus is placed in what seems to the writer to be its natural position, with reasons assigned for this placing. The greater part of the paper consists of a study of certain genera of the Tryphonine subtribe Mesoleiina and a review of the North American representatives of the restricted tribe Paniscini.

The genera *Paniscus* Schrank, *Opheltes* Holmgren, and *Absyrtus* Holmgren were placed by Holmgren in close proximity with *Ophion*, and here they have been considered to belong by practically all subsequent workers, Ashmead¹ finally grouping them with three other genera to form the tribe Paniscini. But Thomson² dissented from this placing and insisted that they should be referred to the Tryphoninae in close proximity to *Perilissus*, pointing out the characters wherein they resemble the latter subfamily much more closely than the Ophioninae. Chief among these is the form of the first abdominal segment and the position of its spiracle. Thomson was, in my opinion, much nearer the truth in regard to the relationship of these genera than were the others, but with his placing of them within the subfamily I do not agree, as will appear later.

The tribe Paniscini of Ashmead, as originally constituted, included the genera *Paniscus* (Gravenhorst [sic!]) Schrank, *Absyrtus* Holmgren, *Opheltes* Holmgren, *Parabates* Foerster, *Cidaphus* Foerster, and

¹ Proc. U. S. Nat. Mus., vol. 23, 1900, p. 95.

² Opusc. Ent., fasc. 9, 1883, p. 873; fasc. 12, 1888, pp. 1185 and 1193.

Opheltoideus Ashmead. To these Morley³ has added his two Oriental genera, *Tetragonalys* and *Parca*, and Enderlein⁴ his *Sauterellus* and *Apatagium*, based on Oriental species, and *Prosthodocis*, based on the Ethiopian *Paniscus antefurcalis* Szepligeti and a South American species.

As thus constituted the tribe consists of at least five discordant elements.

Parca, as I have already pointed out,⁵ is Mesostenine and synonymous with *Earrana* Cameron.

Cidaphus and *Tetragonalys* are synonymous and belong rather to the Mesochorini. Here *Cidaphus* replaces *Plesiophthalmus* Foerster, which in the opinion of most of the recent authors is synonymous with it. Szepliget⁶ separates the two on venational and claw characters and places them with the entirely unrelated *Nesomesochorus* Ashmead in the new subfamily Neomesochorinae (sic!). Szepliget⁶'s determination of *Mesochorus alarius* Gravenhorst, the commonly accepted type of both *Cidaphus* and *Plesiophthalmus*, is apparently a quite different insect from that of practically all other writers, for he characterizes it as having the areolet nearly triangular, the subdiscoideus inserted somewhat above the middle of the postnervulus, and the claws simple. For the purpose of the present paper it seems best to follow the majority of the European writers and consider the two genera as synonyms. Because of the page precedence of *Cidaphus* in addition to the preoccupation by Motschulsky in 1857 of *Plesiophthalmus* it is necessary to use *Cidaphus* as the generic name. Viereck⁷ has proposed the genus *Plesiophthalmidea* for *Plesiophthalmus paniscoides* Ashmead. His reason for so doing is not clear, for this species does not disagree in any particular with the original description of *Plesiophthalmus*, and is certainly congeneric with *alarius* Gravenhorst as commonly interpreted by European authorities.

The type of the undescribed *Opheltoideus johnsoni* Ashmead, genotype of *Opheltoideus*, is apparently lost. As pointed out by Bradley⁸ certain species of *Parabates* will run to this genus because of their lack of the areolet, and the best disposition to make of the genus appears to be, as Bradley has done, to synonymize it with *Parabates*. Enderlein⁹ places three South American species in the genus and redescribes it on the basis of these species. Since Bradley has already synonymized it with *Parabates* and since Enderlein's species are certainly not *Parabates* the *Opheltoideus* of Enderlein needs a

³ Fauna Brit. Ind., Hym., vol. 3, pt. 1, 1913, p. 346.

⁴ Stett. Ent. Zeit., 1912, pp. 125-144.

⁵ Philippine Journ. Sci., vol. 20, 1922, p. 564, fig. 6.

⁶ Gen. Ins., fasc. 114, 1911, p. 70.

⁷ Bull. 83, U. S. Nat. Mus., 1914, p. 119.

⁸ Ann. Mag. Nat. Hist., ser. 9, vol. 3, 1911, pp. 319-324.

⁹ Stett. Ent. Zeit., 1912, pp. 125-144.

new name. The very small ocelli, lacking notauli and long ovipositor of Enderlein's species would seem to indicate that he has erred in placing them in the Paniscini. I have not been able to identify the genus as interpreted by Enderlein as anything in the United States National Museum, but since he has placed it in the Paniscini the first tergite is supposedly slender with the spiracles at or before the middle. This together with the long ovipositor and pectinate claws would seem to indicate that he has referred to this tribe representatives of some Lissonotine genus, which, as is shown in the next paragraph, he did in the case of *Sauterellus*.

Sauterellus planiscutellatus Enderlein from Formosa, the basis of the genus, I am able to recognize as a species of *Leptobatopsis*, a Lissonotine genus. Of this species I have before me both sexes also from Formosa and also collected by Sauter. In his key to the genera of the Paniscini Enderlein ascribes simple claws to *Absyrtus* to distinguish it from *Sauterellus*. In this he is, of course, in error.

To *Apatagium* in Enderlein's key will run all of the species of *Parabates* known to me that have the areolet complete. Most of them, however, differ from the description of the genus in that the second recurrent is strongly curved—not straight or nearly straight. But I have before me one specimen from Java, type locality of two of Enderlein's species, in which this vein is straight in the middle and curved at each end. It appears to be neither of Enderlein's species. Variation in the form of this vein occurs in *Paniscus* and also in the present genus as recorded by its author, and I would not consider the character of generic significance. I, therefore, do not hesitate to synonymize *Apatagium* with *Parabates*.

Prosthodocis is founded on the single character of the antefurcal nervulus as distinguished from the postfurcal or interstitial nervulus of *Paniscus*. This I do not consider as of generic significance, and would synonymize *Prosthodocis* with *Paniscus*.

The foregoing eliminations and synonymizing brings us back practically to the three genera originally treated of by Holmgren (*Parabates* had not then been segregated from *Paniscus*). That *Opheltes* and *Absyrtus* are at all closely related to *Paniscus* and *Parabates* or should be grouped in tribal relation with them I do not believe. There is, in my opinion, nothing about them that should exclude them from the Mesoleptini and more especially from the subtribe Mesoleiina as defined by Schmiedeknecht. *Paniscus* and *Parabates*, on the other hand, I would place close to the Tryphonini and Cteniscini on account of their very similar habits of oviposition, with its accompanying modification of the ovipositor, and their subsequent development. These are at present very unsatisfactory characters to work with because our knowledge of this

phase of the structure and life history of the Ichneumonidae is so limited. But they are much more reliable as indicating relationship than are the superficial resemblances of general form and color, which, after all, constitute the only basis for grouping the various genera of the Paniscini together and for ranking the tribe with the Ophioninae. In respect to these biological characters *Opheltes* and *Absyrtus* are more closely allied to *Ophion* than are *Paniscus* and *Parabates*.

The egg of the true Paniscini, as is well known, is very large and is attached externally to the body of the host by a pedicel which is thrust through the skin of the host. In oviposition the egg itself is not inclosed in the ovipositor but is attached to it by the enlarged base of the pedicel exactly as is so frequently observed in specimens of *Polyblastus*. The ovipositor is attenuate at the apex beyond a more or less distinct ventral enlargement. This type of ovipositor occurs in all groups that produce stalked eggs: Cteniscini and Tryphonini, as well as the Paniscini.

The ovipositor of *Opheltes* and *Absyrtus*, on the other hand, has on the dorsal side near the apex a distinct notch; the egg, at least



FIG. 1.—OVIPOSITORS OF a. PANISCUS; b. OPHELTES, c. ABSYRTUS

in *Opheltes* and probably in *Absyrtus*, is elongate oval without a pedicel and in oviposition is inclosed within the ovipositor; and the larva is internally parasitic. This type of ovipositor and variations of it is found in the Ophioninae, Lissonotini, Glyptini, and Mesoleptini. All of these, so far as their biology is known, are internal parasites.

Genus EARRANA Cameron.

Earrana CAMERON, Spolia Zeyl., vol. 3, pt. 10, 1905, p. 119, pl. B, fig. 3.

Parca MORLEY, Rev. Ichn. Brit. Mus., pt. 2, 1913, p. 133; Fauna Brit. Ind., Hym., vol. 3, Ichn., pt. 1, 1913, p. 301, fig. 102.

Earrana CUSHMAN, Philippine Journ. Sci., vol. 20, 1922, p. 564, fig. 6.

An Oriental Mesostenine genus allied to *Nematopodius*.

Genus CIDAPHUS Foerster.

Cidaphus FOERSTER, Verh. Nat. Ver. Preuss. Rheinl., vol. 25, 1868, p. 149.

Plesiophthalmus FOERSTER, Verh. Nat. Ver. Preuss. Rheinl., vol. 25, 1868, p. 170.

Tetragonalyis MORLEY, Rev. Ichn. Brit. Mus., vol. 2, 1913, p. 132; Fauna Brit. Ind., Hym., vol. 3, Ichn., pt. 1, 1913, p. 359, fig. 101.

Plesiophthalmidea VIERECK, Bull. 83, U. S. Nat. Mus., 1914, p. 119.

CIDAPHUS BARBARICA (Morley).

Tetragonalys barbarica MORLEY, Rev. Ichn. Brit. Mus., vol. 2, 1913, p. 132;
Fauna Brit. Ind., Hym., vol. 3, Ichn., pt. 1, 1913, p. 360, fig. 101.

The North American species of this genus may be separated by the following key:

KEY TO THE NORTH AMERICAN SPECIES OF *CIDAPHUS*.

1. First tergite not laterally grooved to near base, glymmae short, oblique, closer to spiracles than to base *paniscoides* Ashmead.
First tergite grooved laterally to near base, glymmae long, parallel to upper and lower surfaces of tergite, midway between spiracles and base 2.
2. Areolet twice as long as broad; antennae pale ferruginous with extreme apex infusate *occidentalis*, new species.
Arolet less than twice as long as broad; subapical fourth of antennae blackish, extreme apex pale *australis*, new species.

CIDAPHUS PANISCOIDES (Ashmead).

Plesiophthalmus paniscoides ASHMEAD, Ent. News, vol. 3, 1892, p. 107.

Plesiophthalmidea paniscoides VIERECK, Bull. 83, U. S. Nat. Mus., 1914, p. 119.

In addition to the type male which is from Massachusetts, there are in the national collection males from Bartlett, New Hampshire;



FIG. 2.—FIRST ABDOMINAL SEGMENT OF *CIDAPHUS*: a. *PANISCOIDES*; b. *OCCIDENTALIS*.

New York, and Pennsylvania; and a female from Plummer Island, Maryland; the last captured by H. L. Viereck on August 9, 1912.

CIDAPHUS OCCIDENTALIS, new species,

Very distinct from *paniscoides* (Ashmead) in the formation of the first tergite.

Female.—Length 13 mm.

Head punctate, rather coarsely and very densely so on face; clypeus broadly rounded at apex, medially impressed, coarsely and sparsely punctate; frons laterally transversely striate; ocelli separated from the eyes by a narrow but distinct space, postocellar line distinctly more than half the diameter of an ocellus. Thorax shining, very faintly coriaceous; notauli very faintly impressed; nervulus antefurcal and slightly reclivous; nervellus distinctly curved above break; areolet twice as long as wide; propodeum completely areolated, but with costulae and apical abscissae of median carinae weak, areola small, practically pentagonal, distinctly longer than broad. Abdomen slender, compressed from beyond third segment, shining; first segment decurved, spiracles distinctly beyond middle, petiole grooved laterally nearly to base, the groove vertically rugose basally, glymmae midway between spiracles and base, long, parallel to upper and lower surfaces of petiole; ovipositor sheath nearly as long as third tergite.

Flavo-testaceous, with head except clypeus, mouthparts and lower cheeks, black; antennae infuscated at apex; wings yellowish hyaline, stigma paler than veins.

Type-locality.—Revelstoke, British Columbia.

Type.—Cat. No. 25973, U.S.N.M.

Two females, the type taken August 14 by R. P. Currie and the paratype from Pullman, Washington, taken August 25, 1898, by C. V. Piper.

CIDAPHUS AUSTRALIS, new species,

Very closely allied to *occidentalis* differing practically only as follows:

Female.—Length 13 mm.

Face more coarsely and less densely punctate, the space between the punctures finely roughened; ocelli nearly touching the eyes; costulae and apical abscissae of median carinae practically wanting; nervulus strongly reclivous; areolet less than twice as long as broad; subapical fourth of flagellum blackish, apex almost flavous.

Type-locality.—Langdale, Chambers County, Alabama.

Type.—Cat. No. 25974, U.S.N.M.

One female taken by H. H. Smith.

The black of the flagella is not quite symmetrical, that of one embracing joints 13–32 and of the other joints 15–34, and this color may be accidental; but it has the appearance of naturalness.

ENDERLEINIA, new name.

Ophelloideus ENDERLEIN, Stett. Ent. Zeit., 1912, p. 107 (not Ashmead, 1900).

This genus is unknown to me, the name being proposed for *Ophelloideus* Enderlein, preoccupied by *Ophelloideus* Ashmead.

Its type and generic characters are those ascribed to *Ophelloideus* by Enderlein.

The three described species are Neotropical.

Genus LEPTOBATOPSIS Ashmead.

Leptobatopsis ASHMEAD, Proc. Linn. Soc. N. S. Wales, vol. 25, 1900, p. 349.

Sauterellus ENDERLEIN, Stett. Ent. Zeit., 1912, p. 112.

Leptobatopsis CUSHMAN, Philippine Journ. Sci., vol. 20, 1922, p. 591.

As indicated above this genus is Lissonotine.

LEPTOBATOPSIS PLANICUTELLATUS (Enderlein).

Sauterellus planiscutellatus ENDERLEIN, Stett. Ent. Zeit., 1912, p. 113.

Specimens from Formosa collected by Sauter agree in every respect with Enderlein's generic and specific descriptions, except that the occipital carina is developed to a greater or lesser extent below, though frequently largely concealed by the prothorax.

Subfamily TRYPHONINAE.

Tribe MESOLEPTINI.

Subtribe MESOLEIINA.

In the Mesoleiina *Opheltes* comes closest to *Protarchus* Foerster. In *Opheltes* most of the features characteristic of *Protarchus* are exaggerated, especially the glymmae of the first tergite, and the genus has many features peculiar to itself. But I believe there can be no doubt of its close relationship to *Protarchus*. Of indubitable significance in this connection is the fact that the two genera are parasitic on related tenthredinid genera, *Opheltes* on *Cimbex* and *Protarchus* on *Trichiosoma*. Furthermore, the new genus *Hypopheltes*, described below, combines many of the characters of the two genera. The following key will distinguish these three genera as well as the recently described *Protarchoides* Cushman and two other new genera, one from Japan allied to *Opheltes* and one from North America allied to *Protarchus*.

KEY TO CERTAIN GENERA OF MESOLEIINA.

1. Clypeus transversely impressed and arcuately emarginate at apex; frons not carinate or ridged laterally, at most subtuberculate just above antennae; second recurrent curved with an outwardly convex curve near the top, its bulla divided; abdomen not compressed 2.
Clypeus not impressed, its apex broadly rounded; frons carinate or ridged laterally; second recurrent straight, its bulla not divided; abdomen compressed .. 4.
2. Frons deeply concave with a low tubercle on either side just above level of antennae; notauli deeply impressed anteriorly and reaching middle of mesoscutum *Protarchus* Foerster.
Frons shallowly concave and without tubercles; notauli obsolete or short 3.
3. Hind tibiae and tarsi, especially the tarsi compressed; clypeus unarmed; areolet present *Protarchoides* Cushman.
Hind tibiae and tarsi not compressed; clypeus with a small acute tooth medially at junction of basal and apical areas (see fig. 4); areolet absent.
Neoprotarchus, new genus.
4. Glymmae not confluent, the petiole not especially compressed; dorsal surface of propodeum much shorter than posterior, the median carinae rather weak, areola quadrate, broad and short; claws simple *Hypopheltes*, new genus.
Glymmae confluent the petiole strongly compressed; dorsal surface of propodeum longer than the posterior, elevated medially near base, the median carinae high, areola narrow, most frequently incomplete laterally, when complete elongate triangular, claws pectinate 5.
5. First tergite with dorso-lateral carinae distinct only at extreme base, without median furrow; propodeal spiracles long oval; areola incomplete laterally; basal joint of flagellum nearly or quite twice as long as second; diameter of lateral ocellus longer than ocell-ocular line; eyes distinctly divergent below; inner orbits strongly carinately ridged; rufous, with head, thorax and abdomen black marked, antennae largely red; wings sometimes dark at apex but without a well defined maculation *Opheltes* Holmgren.
First tergite with dorso-lateral carinae distinct to spiracles and with a distinct median furrow from near base to near apex; propodeal spiracles broad oval, areola complete, triangular; basal joint of flagellum barely a half longer than second; diameter of lateral ocellus shorter than ocell-ocular line; eyes scarcely divergent below; inner orbits weakly ridged; ferruginous with only flagellum and apex of abdomen black; wings with well defined apical cloud.
Nephopheltes, new genus.

Genus PROTARCHUS Foerster.

Protarchus FOERSTER, Verh. Nat. Ver. Preuss. Rheinl., vol. 25, 1868, p. 201.

Zacalles DAVIS, Trans. Amer. Ent. Soc., vol. 24, 1897, p. 283 (not Foerster).

No North American species has been referred to this genus. But *Zacalles magnus* Davis belongs here.

Head and thorax coarsely and closely punctate, especially the pleura and propodeum; head also opaque shagreened; clypeus rather small, transversely impressed before apex, the apex broadly emarginate; mandibles short and stout with short equal teeth; malar space distinct; frons concave, flanked on either side by a rounded tubercle just above the antennae; ocelli rather large, the space between the paired ones deeply impressed; temples slightly convex, sloping; eyes very slightly emarginate opposite antennae; antennae stout, tapering at apex; first flagellar joint about twice as long as second; occipital carina complete and strong, the occiput deeply concave; notauli very deep anteriorly, becoming obsolete at middle; epomia absent; prepectal carina strong to about half way up the pleura; scutellum convex, not margined; propodeum with apical carina strong, petiolar area closed at sides and frequently with a median carina, reaching nearly to middle of propodeum; other carinae obsolete, the lateral represented by strong ridges separating the pleural and lateral areas, the median areas indistinctly defined, very narrow; spiracles large, oval; wings large; stigma long with radius before middle; basal vein curved at base; nervulus strongly post-furcal and inclivous; second abscissa of radius a long sigmoid curve; areolet oblique, subtriangular, usually petiolate; disco-cubitus angulate or subangulate, frequently with ramellus distinct; second recurrent with a convex curve near the top, the bulla divided, nearly interstitial with the second intercubitus; nervellus reclivous, broken above middle; hind legs long and stout; hind tibia and tarsus not compressed; inner calcarium reaching nearly to middle of basitarsus; last tarsal joint nearly as long as third and nearly twice as long as fourth; claws simple; abdomen scarcely compressed, rather coarsely punctate basally, subpolished apically; first tergite about half as wide at base as at apex, the sides nearly straight, glymmae separated by a broad basin, median carinae distinct to beyond spiracles, latter at about the middle, the tergite ridged laterally but not carinate beyond spiracles; second tergite with distinct rounded thyridia; all tergites visible; hypopygium compressed; ovipositor briefly exerted but not extending beyond apex; sheath broad, rounded at apex.

PROTARCHUS MAGNUS (Davis).

Zacalles magnus DAVIS, Trans. Amer. Ent. Soc., vol. 24, 1897, p. 283.

A specimen from Francona, New Hampshire, differs from Davis's description in having the vertex and thorax black, the latter with yellow markings, the coxae, trochanters, and hind femur black; and

only the third tergite entirely red, the first, second, and fourth bicolored.

This species is very closely allied to, perhaps synonymous with, the European *Protarchus rufus* (Gravenhorst).

Genus **PROTARCHOIDES** Cushman.

Protarchoides CUSHMAN, Proc. U. S. Nat. Mus., vol. 61, art. 8, 1922, p. 25.

At once distinguished from *Protarchus* Foerster by its compressed hind tibiae and tarsi, short hind calcaria and apical tarsal joint, shallowly concave frons without tubercles, and short, shallow notauli.

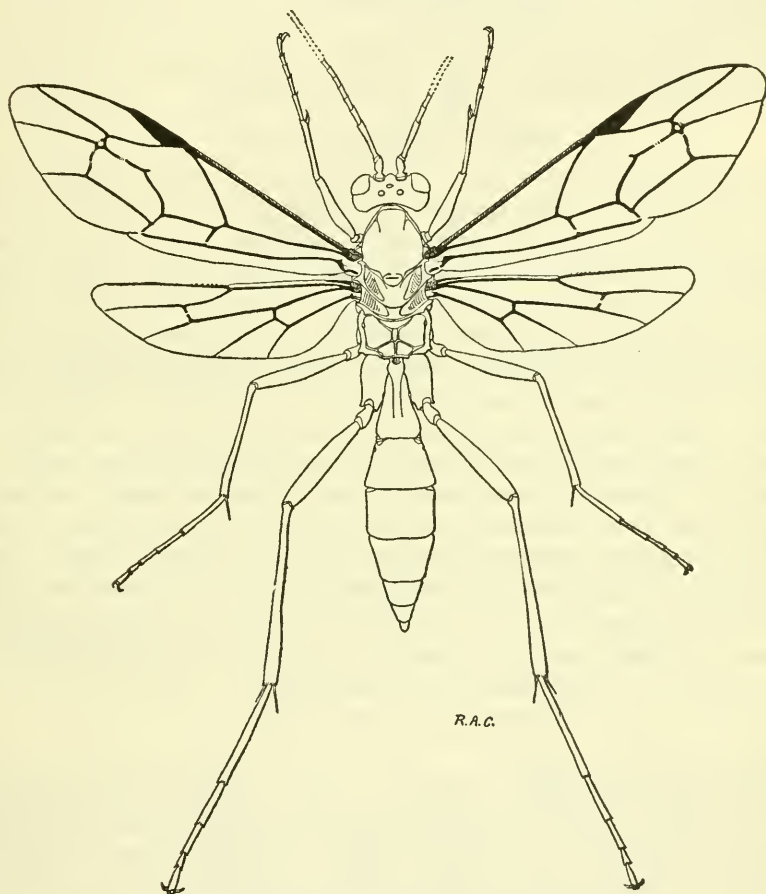


FIG. 3.—*PROTARCHOIDES MANDIBULARIS* CUSHMAN, FEMALE.

PROTARCHOIDES MANDIBULARIS, new species.

Very close to, and possibly synonymous with the genotype, *longipes* Cushman, but differing as follows:

Female.—Length 17 mm.; antennae 17 mm.

Mandibles and palpi largely yellow; antennae paler; clypeus piceous; pronotum with a rather deep impression along posterior

margin which, joining the transverse one below, sets off a distinct convex area at the upper part; callose posterior margin of mesopleurum broad and densely punctate; lateral abscissa of apical propodeal carina distinct; areolet large and briefly petiolate; discocubitus distinctly angulate and with a more or less distinct ramellus; tegulae paler. Otherwise like *longipes*.

Male.—Essentially like female but with a median facial spot and tegulae yellowish.

Type-locality.—Wellington, British Columbia.

Allotype-locality.—Roque Bluff, Maine.

Type.—Cat. No. 25975, U. S. N. M.

One female, the type, taken July 28, 1904, and one male, the allotype, taken August 10, 1907, by C. W. Johnson.

NEOPROTARCHUS, new genus.

In Schmiedeknecht's key to the Mesoleiina¹⁰ runs to the euryproctine genus *Himertus* Foerster, but differs from it by the characters distinguishing the subtribes Mesoleiina and Euryproctina, especially by the possession of lateral foveae at the base of the petiole and by the long hind calcaria.

It is very closely related to *Protarchoides* Cushman, differing from that genus by the medially dentate clypeus, wanting areolet, and noncompressed hind tibiae and tarsi, as well as in the sculpture, which is fine shagreening with punctuation on face and sides of thorax; propodeal carinae wanting except apices of lateral carinae; inner hind calcarium more than half as long as basitarsus; nervellus broken far above middle and strongly reclivous; temples more strongly receding; first tergite without dorsal median carinae. The apical joints of the hind tarsi are missing from the unique specimen, but from the general conformation of the rest of the legs it would appear that they would be relatively longer than in *Protarchoides*.

Genotype.—*Neoprotarchus ater*, new species.

NEOPROTARCHUS ATER, new species.

Male.—Length 12 mm.

Face densely, opaquely punctate; clypeus basally sparsely punctate and more or less transversely striate; mandibles shagreened and sparsely punctate; malar space half as long as basal width of mandible; diameter of lateral ocellus two-thirds as long as ocellular line. Thorax practically impunctate dorsally, finely and distinctly so on pleura and sternum; notauli not defined but represented by broad shallow impressions; scutellum convexly elevated, not margined; speculum small, polished; propodeum opaque shagreened, laterally obscurely transversely striate, without carinae except apical portion of lateral carinae, petiolar area poorly defined

¹⁰ Opuscula Ichneumonologica, fasc. 35, 1913, p. 2796.

above, areola and basal areas represented by a median impression. Abdomen subopaque, very finely shagreened; first tergite broadly petiolate without dorsal carinae but medially longitudinally impressed, spiracles at middle.



FIG. 4.—CLYPEUS OF NEOPROTARCHUS ATER CUSHMAN.

Black with facial spot, broad antennal annulus, scutellum, and all tibiae basally white; front tibia apically and tarsus basally pale testaceous; wings slightly yellowish hyaline, venation brown.

Type-locality.—Mill Valley, California.

Type.—Cat. No. 25976, U.S.N.M.

One male taken June 7, 1915, by E. P. Van Duzee.

HYPOPHELTES, new genus.

In the structure of clypeus and frons, longitudinally impressed mesopleura, venation of the wings, and compressed abdomen this genus resembles *Opheltes*; while in the simple claws, broadly separated glymmæ and receding temples it is more closely related to *Protarchus*. In many of the characters set forth below it differs from both.

Head transverse, temples narrowed; eyes divergent below, entire within; clypeus not separated, broad, flat, apex broadly rounded; mandibles large, constricted near base, teeth rounded, lower slightly the longer; maxillary palpi not especially long; malar space short; frons concave, flanked on either side by a strong ridge; ocelli very large, the ocellar area bounded laterally by a deep groove; antennae as long as body, attenuate at apex, scape subcylindrical with apex weakly oblique, first flagellar joint not nearly twice as long as second and swollen above near base; epomia absent; notauli deep and meeting before the scutellum; prescutum with a median longitudinal ridge; scutellum broad, strongly elevated basally, declivous behind; mesopleurum with a broad longitudinal impression above which it is elevated; prepectal carina reaching top of this impression; propodeum short, carinae very strong, basal transverse carina wanting, petiolar area occupying two-thirds of dorsal length, spiracles very large, broadly oval, directed posteriorly; legs slender; hind basitarsus nearly as long as remaining joints combined; claws simple: inner calcarium about a fourth as long as basitarsus; wings large; stigma very narrow with radius near base; apical abscissa of radius nearly straight; areolet petiolate, quadrangular, second recurrent before middle; recurrent straight with bulla undivided; discocubitus evenly

curved, without trace of ramellus; nervulus nearly interstitial; nervellus broken nearly in the middle; abdomen strongly compressed from base of third tergite; first tergite long, rather narrow, especially before the tuberculate spiracles, latter slightly before middle; glymmae separated by a deep basal basin; thyridia very minute; seventh tergite membranous medially nearly to base; ovipositor sheath acute at apex.

Genotype.—*Hypopheltes pergae*, new species.

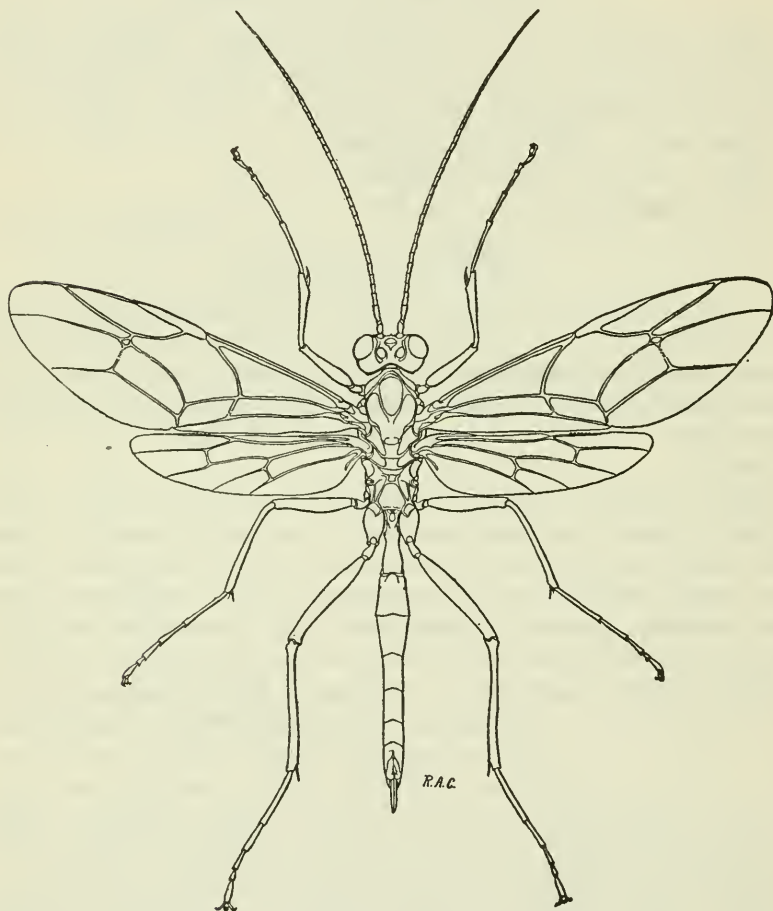


FIG. 5.—HYPOPHELTES PERGAE CUSHMAN, FEMALE.

HYPOPHELTES PERGAE, new species.

Female.—Length 20 mm.; antennae 20 mm.

Head polished behind, coarsely punctate in front; malar space a third as long as basal width of mandible; diameter of lateral ocellus twice as long as ocell-ocular line which equals post-ocular line; first flagellar joint with apical portion very little longer than second; thorax polished, mesopleurum rugosely roughened, vertically below

the impression and horizontally above; metapleurum coarsely, irregularly roughened, subtuberculate in middle; abdomen highly polished.

Ferruginous, the legs and antennae concolorous; abdomen piceous; wings hyaline, venation brown, stigma paler especially along posterior border, costa and wing bases also paler; wing tips slightly clouded.

Host.—*Perga*, species.

Type-locality.—Sydney, Australia.

Type.—Cat. No. 25977, U.S.N.M.

One female reared October 19, 1892.

Genus *OPHELTES* Holmgren.

Head behind eyes broad; eyes usually divergent below; clypeus not separated, apex broadly rounded, not impressed; mandibles not constricted at base, teeth equal and subacute; maxillary palpi very long; malar space half as long as basal width of mandible; frons deeply concave, flanked by sharp carinae; ocelli very large, surrounded by a deep groove; antennae as long as body, attenuate at apex, scape subcylindrical, apex oblique; first flagellar joint nearly twice as long as second, cylindrical; epomia present but short; notauli deep anteriorly but becoming obsolete in middle of mesoscutum; prescutum with a weak median longitudinal ridge; scutellum rather narrow, elevated in middle; mesopleurum with a broad longitudinal impression, above which is a longitudinal welt; prepectal carina reaching top of this impression and curving backward along its dorsal margin; propodeum rather long, its posterior face short and nearly perpendicular, its dorsal face strongly acutely elevated near base, the closely approximate median carinae extending backward from this point to the apical carina, latter very strong; spiracles large oval, directed laterally; hind basitarsus much shorter than remaining joints combined; claws strongly pectinate; inner calcarium fully a third as long as basitarsus; wings large; stigma very narrow, radius near base; apical abscissa strongly curved, areolet pentagonal, recurrent near apex; recurrent straight with bulla undivided; discocubitus curved, without trace of ramellus; nervulus post-furcal; nervellus broken above middle, reclivous; abdomen compressed from base of third tergite; first tergite long, narrow, compressed at base, glymmae confluent, spiracles slightly before middle; thyridia rather large; seventh tergite not membraneous medially; ovipositor sheath rounded at apex.

In the following key are tabulated the species of the world:

KEY TO SPECIES OF *OPHELTES*.

1. Notauli lacking; propodeal spiracles oval, not elongate; stigma shorter and broader; radius nearly straight; nervulus very slightly postfurcal; nervellus broken at upper fourth (China) *chinensis* Morley.
- Notauli distinct; radius distinctly curved at both base and apex of apical abscissa
..... 2.

2. Abdomen broader and less strongly compressed, second tergite much broader at apex than at base and hardly longer than broad at apex (Japan).

major, new species.

Abdomen more strongly compressed, second tergite much narrower (holarctic).

glaucopterus Linnaeus.

OPHELTES GLAUOPTERUS (Linnaeus).

There can, I think, be no doubt that the North American *flavipennis* (Provancher) and the typical European form are conspecific. They may, perhaps, be treated as races or varieties more or less easily distinguishable by a tendency in the American race to a darker red and more black on the abdomen and the more acutely conical scutellum in the European race. However, I have seen only two European specimens, and it may be that with a larger number of specimens these differences would be found not to hold.

The Southern European variety *fuscipennis* (Gravenhorst) has its counterpart in America in an undescribed dark-winged variety (*barberi*, new variety) from the vicinity of Washington, District of Columbia.

The species as a whole shows remarkable variation in both structure and color. The most remarkable of the structural variations is in the form of the head; the temples varying from hardly swollen and no wider than the eyes to very strongly swollen and much wider than the eyes. The new southern variety, *barberi*, described below has the temples more strongly swollen than any of the other specimens before me, there being in fact a rather distinct interval between the form of the head in this variety and in the northern form. The degree of swelling of the temples is, however, rather closely associated with size, and the two specimens of *barberi* are larger than any of the others. Associated with the form of the head is a certain amount of variation in the strength of the frontal carinae and emargination of the eyes, the wider the head in general the weaker the carinae and the emargination of the eyes.

The conical scutellum of the typical form is approached very closely in both of the American varieties, but in the majority of the specimens of *flavipennis* it is merely convex.

The form of the propodeum varies greatly, especially with respect to the length of the petiolar area and the distinctness of the costulae. The latter are very seldom actually present but are sometimes indicated by an elevation, though frequently the lateral areas are flat.

Associated apparently with size are certain variations in venation. In the smallest specimens the nervulus is interstitial or even slightly antefurcal and the second discoidal cell is very narrow at base, sometimes less than half as wide as the apex of the brachial cell; while in the largest specimens the nervulus is strongly postfurcal and

the discoidal cell nearly as wide at the base as is the brachial at apex. Less definitely associated with size are the form of the areolet, which varies from broadly sessile to almost subpetiolate; the position of the second recurrent, which may be from strongly antefurcal to slightly postfurcal with respect to the second intercubitus; and the position of the fracture of the nervellus.

The color variation is better discussed under the varieties.

OPHELTES GLAUOPTERUS, variety FLAVIPENNIS (Provancher).

Campoplex flavipennis PROVANCHER, Nat. Can., vol. 6, 1874, p. 143.

Opheltes glaucopterus PROVANCHER, Nat. Can., vol. 11, 1879, p. 145.

Opheltes glaucopterus, variety flavipennis MORLEY, Rev. Ichn., pt. 2, 1913, p. 134.

Through the kindness of Prof. H. C. Severin, of the South Dakota Agricultural College, who has sent me a fine series reared and collected in the early nineties by Dr. J. M. Aldrich, I have been able to make a much more satisfactory study of the variation than would otherwise have been possible. Combined with the dozen specimens in the National Collection, these show an almost complete gradation in all of the variations of both structure and color to be found within the variety.

The color difference mentioned by Morley as distinguishing this variety from typical *glaucopterus* does not hold, for many of the specimens have the propodeum more or less red. In *flavipennis*, however, the fifth tergite and usually more or less of the fourth are black, while in *glaucopterus*, according to Schmiedeknecht (Opusc. Ichn.) the change in color takes place on or beyond the fifth. This is true of the two European specimens of *glaucopterus* examined.

This variety varies in color from the phase described by Provancher, in which the thorax is black with only the scutellum and notauli and margins of the mesoscutum red, the occipital and ocellar black spots broadly confluent, and the coxae largely black to those in which the pronotum, mesoscutum, scutellum, propodeum dorsally, the upper part of mesopleura and metapleura, the vertex behind the ocelli, and the coxae, are entirely or largely red. The phase with the upper part of the mesopleurum red is represented by only a single specimen from South Dakota. It differs hardly at all in color from the new variety *barberi*.

The phase with largely black mesoscutum is also rather exceptional, the usual color of this region being red with the prescutum black anteriorly.

Occasionally the fifth tergite is red in the anterior lateral angles.

In size this variety varies from 17 to 23 mm.

Of the 34 specimens examined only one is a male. The scarcity of the males in Europe has been noted by Morley, who states that out of about 40 specimens in the British Museum only two were males.

In the above series are specimens from Canada, Connecticut, Long Island, New York, Illinois, Colorado, South Dakota, and Idaho.

OPHELTES GLAUOPTERUS, variety **BARBERI**, new variety.

Female.—Differs from *flavipennis* in its larger size (26–27 mm.), more strongly swollen and wider temples, darker yellow wings with the apices deeply infumate and from most individuals of *flavipennis* in having that portion of the mesopleurum above the furrow, the propodeum dorsally and the coxae almost entirely red.

Type-locality.—Plummer Island, Maryland.

Type.—Cat. No. 25978, U.S.N.M.

Two female specimens from the type-locality, both taken by H. S. Barber, the type at light on July 19, 1920, and the paratype on July 26, 1908.

OPHELTES MAJOR, new species.

Female.—Length 26 mm.; antennae 26 mm.

Closely allied to *glaucopterus* Linnaeus, but at once distinguishable by its much stouter form, this being especially obvious in the very broad and weakly compressed abdomen. The thorax is also obviously broader and deeper in proportion to its length. The propodeal areola is complete, the carinae strong from their junction to the apical carina; while the legs are slightly stouter than in *glaucopterus*.

In color it resembles typical specimens of *flavipennis* (Provancher) in having the propodeum entirely black, but the black of the abdomen extends nearly or quite to the base of the fourth tergite, the mesoscutum and scutellum are red, the former with a black median vitta and fainter lateral vittae. The wings are deeply infumate at apex.

Male.—Essentially like the female.

Type-locality.—Gifu, Nippon, Japan.

Type.—Cat. No. 25979, U.S.N.M.

Described from two females and one male, the type and allotype, from Gifu, Y. Nawa, collector, and bearing his number 58; and the paratype female labelled simply "Japan, Mitsukuri."

The species apparently varies structurally in much the same manner as does *glaucopterus*. In the type and allotype the temples are very broad and swollen and the propodeum long and dorsally without any indication of costulae; while in the paratype the temples are hardly broader than the eyes and the propodeum is shorter above and transversely elevated in the positions of the costulae.

NEPHOPHELTES, new genus.

This genus is easily recognized by the characters made use of in the key. What others of its features are of more than specific significance are embodied in the description of the type species.

Genotype.—*Nephopheltes japonicus*, new species.

NEPHOPHELTES JAPONICUS, new species.

Female.—Length 17 mm.; antennae 18 mm.

Head smooth, practically impunctate; temples slightly wider than eyes; face barely wider than frons, slightly wider than greatest diameter of eye; frons with a median pit-like impression, inner orbits not carinately ridged, but with a minute tubercle opposite upper margin of antennal foramina; diameter of lateral ocellus

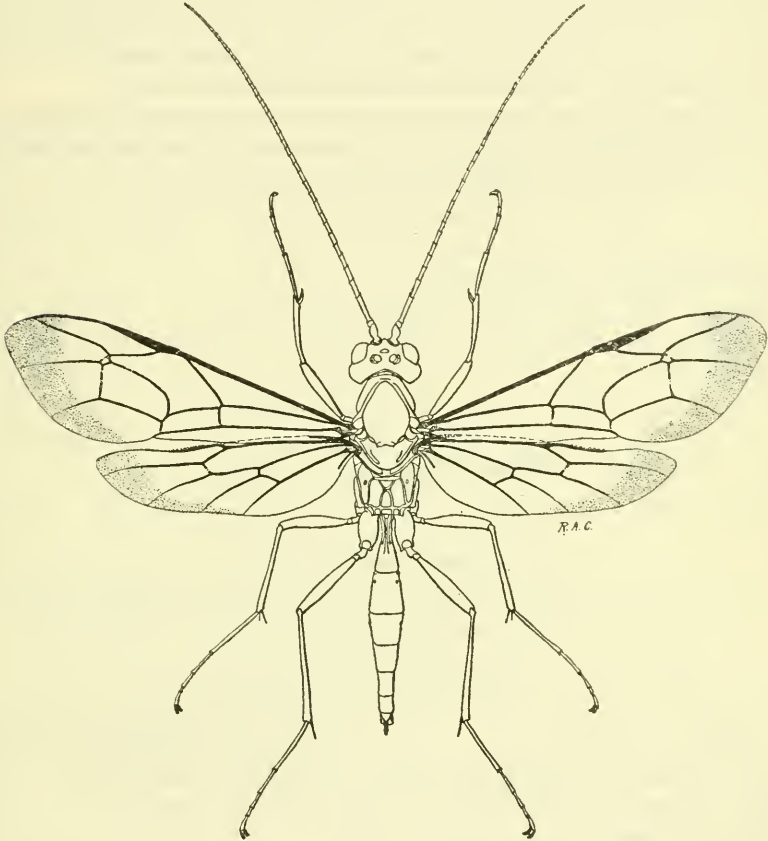


FIG. 6.—NEPHOPHELTES JAPONICUS CUSHMAN, FEMALE.

slightly longer than post-ocellar line, but scarcely as long as ocellular line; malar space two-thirds as long as basal width of mandible; clypeus broadly rounded and slightly prominent at apex, not separated from face; mandibles stout not constricted; apical truncation of scape weakly oblique; first joint of flagellum little more than half longer than second. Thorax smooth, practically impunctate; notauli obsolescent; transverse impression of pronotum strong; scutellum convex, not elevated; mesopleurum with lower posterior

angle high and flange-like, longitudinal impression strong; propodeum smooth, spiracle small, broadly oval, carinae high, areola complete, triangular, much longer than wide at apex, basal area also defined, triangular, costulae and costellae entirely wanting, petiolar area divided by three longitudinal ridges; legs as in *Opheltes* except femora are a little stouter; areolet oblique trapezoidal; second discoidal cell nearly as wide at base as is brachial at apex; nervellus broken at about upper fourth. Abdomen hardly falcate; first tergite with spiracles at middle, with distinct dorso-lateral carinae to spiracles, and a distinct median groove from near base to near apex; second and third tergites little longer than wide at apex.

Dull ferruginous with flagellum and abdomen beyond third segment black; sheath ferruginous; legs testaceous, hind tarsus and apex of tibia darker; wings yellow with apices infumate.

Male.—Differs from female practically only in having the temples slightly narrower and notauli more distinct.

Type-locality.—Gifu, Japan.

Type.—Cat. No. 25980, U.S.N.M.

One female and one male collected by Y. Nawa, and bearing his number 59.



FIG. 7.—BRACHIAL CELL OF ABSYRTUS: *b*. BASAL VEIN; *br*. BRACHIUS; *d*. DISCOIDEUS; *dc*. DISCOCUBITUS; *m*. MEDIUS; *n*. NERVULUS; *pn*. POSTNERVULUS; *sd*. SUBDISCOIDEUS; *sm*. SUBMEDIUS.

Genus ABSYRTUS Holmgren.

The closest relative of this genus is *Alexeter* Foerster, from which it differs practically only in having the claws strongly pectinate, the brachial vein angulate (see fig. 7), and the ocelli larger. In the last character it differs hardly at all from certain species of *Alexeter* that are probably of crepuscular habits.

Three North American species are known to me. They may be distinguished by the following key:

KEY TO NORTH AMERICAN SPECIES OF ABSYRTUS.

1. Propodeum with all longitudinal carinae more or less distinct; temples broad and swollen; nervulus broken and frequently with a more or less distinct stump of a vein extending into the brachial cell.....*perilissoides*, new species.
Propodeum without longitudinal carinae; temples narrow; nervulus not broken.....2.
2. Propodeum with a distinct but very short petiolar area and posterior lateral areas.....*arealis*, new species.
Propodeum without a petiolar area or posterior lateral areas.
paniscoides (Ashmead).

ABSVRTUS PANISCOIDES (Ashmead).

Perilissus paniscoides ASHMEAD, Trans. Amer. Ent. Soc., vol. 23, 1896, p. 187 (excluding male).

Eczetesis paniscoides DAVIS, Trans. Amer. Ent. Soc., vol. 24, 1897, p. 253.

Absyrtus paniscoides CUSHMAN, Proc. U. S. Nat. Mus., vol. 61, art. 8, No. 2429, 1922, p. 2.

As pointed out in the last reference cited Ashmead's species is composite, the male being that of *Parabates monticola* Cushman.

It differs from the two other North American species and from *luteus* Holmgren in its entire lack of propodeal areolation.

ABSVRTUS AREALIS, new species.

Distinguishable at once from the other two North American species by the areolation of the propodeum. In this it is like *luteus* Holmgren, but differs from that species in its larger ocelli.

Female.—Length 9 mm.

Shining, minutely shagreened, face opaquely, abdomen very indistinctly so; temples strongly convexly narrowed; clypeus medially inflexed at apex, the lateral angles thin and rather prominent; mandibular teeth acute at apex, lower tooth distinctly the longer; ocell-ocular line less than half the diameter of an ocellus. Propodeum without longitudinal carinae but with distinct petiolar and posterior lateral areas, the former very short; areolet much longer than wide; nervulus not broken; nervellus broken distinctly above middle. Abdomen slender, strongly compressed at apex; post-petiole more than twice as long as wide at apex.

Entirely luteous except a black spot inclosing ocelli.

Male.—Differs only sexually from female.

Type-locality.—Cabin John Bridge, Maryland.

Type.—Cat. No. 25981, U.S.N.M.

Two specimens taken by R. M. Fouts, the type on August 5, and the allotype on July 1, 1917.

ABSVRTUS PERILISSOIDES, new species.

The swollen head, nearly completely areolated propodeum, and weakly compressed abdomen give this species a strong superficial resemblance to the subgenus *Spanotecnus* of the genus *Perilissus*, but the broken brachial vein at once indicates its true affinities. The large head, strong longitudinal carinae of the propodeum, and broken nervulus distinguish it at once from any other described species.

Female.—Length 10 mm.

Subopaque shagreened, face opaque, clypeus inflexed at apex, lateral angles not prominent, shining and with a few coarse punctures; mandibular teeth rounded at apex, the lower larger but barely longer than upper; temples swollen, nearly as broad as eyes;

ocell-ocular line about two-thirds as long as ocellar diameter. Propodeum with distinct longitudinal and apical carinae; areolet much longer than wide; nervulus broken by the stump of a vein; nervellus broken slightly above middle. Abdomen rather stout, weakly compressed at apex; postpetiole less than twice as long as wide at apex.

Ferruginous with ocellar spot black and trochanters and tarsi pale.

Male.—More slender than female with postpetiole distinctly more than twice as long as wide at apex; temples broader than eyes; abdomen not at all compressed.

Type-locality.—Hartford, Connecticut.

Type.—Cat. No. 25982, U.S.N.M.

One female from the type-locality June 24, 1904, and one male taken by K. F. Chamberlain, June 15, 1919, at Durham, Connecticut.

Tribe PANISCINI.

As indicated above this tribe as here treated consists only of the genera *Paniscus* Schrank and *Parabates* Foerster, and is most closely related to the tribes Tryphonini and Cteniscini.

The two genera are separable by the following key:

KEY TO GENERA PANISCINI.

Occiput margined; nervulus usually postfurcal; ovipositor strongly exerted.

Paniscus.

Occiput immargined; nervulus interstitial or nearly; ovipositor usually not strongly exerted

Parabates.

The characters employed in the above key are really all comparative and the two genera are not more than subgenerically distinct. Several authors have so treated them. But since the group as here limited is so homogeneous this treatment is unnecessary and less convenient than to consider them as genera. In certain species of *Paniscus* the occipital carina is so faint as to be visible only from certain positions; the nervulus is very variable in its position and angle; while the long ovipositor is not at all unusual in *Parabates*.

Genus PANISCUS Schrank.

Paniscus SCHRANK, Fauna Boica, vol. 2, pt. 2, 1802, p. 316.

Paniscus GRAVENHORST, Ichn. Eur., pt. 3, 1829, p. 622.

Neteleia GRAY, Ann. and Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 339.

Bucheckerius SCHULZ, Spolia Hym., 1906, p. 285.

Paropheltes CAMERON, Journ. Bombay Nat. Hist. Soc., 1907, p. 111.

Prosthodocis ENDERLEIN, Stett. Ent. Zeit., 1912, p. 142.

As indicated by the above synonymy *Paniscus* was first proposed by Schrank; not by Gravenhorst, to whom it was for many years credited. Schrank mentioned only one species in connection with the genus, *Ichneumon luteus*, which he cited as an example. From the context it is evident that Schrank intended *Paniscus* as a name

for all those species of the Linnean genus *Ichneumon* that have the abdomen falcate, but in defining the genus we are obliged to consider only the one species mentioned.

The next mention of the genus was by Gravenhorst, who restricted it to the species comprising what we now know as the genera *Paniscus*, *Parabates*, and *Opheltes*, but not including *Ichneumon luteus*, which he referred to *Ophion* and which has, since its fixation as such by Curtis in 1836, been recognized as the genotype of *Ophion*.

Gray, in an article on the hooks of the hind wing in Hymenoptera, divided Gravenhorst's *Paniscus* into two genera, designating *glaucopterus* as the type of *Paniscus* and *inquinatus* Gravenhorst as the type of his new genus *Neteleia*, the latter genus being, therefore, what we now know as *Paniscus*.

Bucheckerius Schulz and *Paropheltes* Cameron are, as has been pointed out by Morley¹¹, based on species of *Paniscus*.

The fact that *Ichneumon luteus* is the only species mentioned by Schrank in connection with *Paniscus* and is also the type of the genus *Ophion* would seem to make necessary the synonymizing of *Paniscus* with *Ophion*. But if it can be shown that a genus is based on specimens rather than on a species, the type of the genus is the species represented by the specimens rather than the species named as type, in the opinion of the International Commission on Nomenclature. This, I think, can be done in the case of *Paniscus*. On an earlier page (p. 262) of the same publication in which *Paniscus* was first proposed Schrank discussed *Ichneumon luteus* and described the eggs of *Paniscus*. At this place he also referred to three earlier publications, the first his own Enumeratio Insectorum Austriae (No. 750); the second the German edition of DeGeer's Memoires pour Servir a l'Histoire des Insectes (vol. 2, pt. 2, 1771, p. 170—p. 880 in original edition—pl. 29, figs. 15–26); and the third Schaeffer's Icones Insectorum circa Ratisbonam Indigenorum (vol. 1, pt. 1, 1766, pl. 1, fig. 10). Between the first reference and the DeGeer reference occurs the sign of equality. In other words, Schrank's idea of *luteus* was the same as that of DeGeer. The latter author gives an excellent account of the biology of what we know as *Paniscus*, and remarkably good figures of the adult in both sexes, the egg, the larva, the egg shell with exuvia attached, the cocoons, and details of the claws, genitalia, and method of copulation. The figures of the adults were drawn, DeGeer states, from specimens reared from the bundle of cocoons figured. In short, the genus *Paniscus* of Schrank as restricted by its only included species may be interpreted as having been based on specimens studied and figured by DeGeer. The Schaeffer figure is very poor, though, perhaps, somewhat more similar in its general aspect to *Ophion* than to *Paniscus*.

¹¹ Rev. Ichn. Brit. Mus., pt. 2, 1913, pp. 117, 123.

The insect figured by DeGeer is not the *Ichneumon luteus* Linnaeus as established by long usage. It was said by him to have been parasitic on "une grosse chenille a double queue du Saule," with a marginal reference to volume one of his own work (pl. 23, fig. 6). The latter is the larva of the puss-moth, *Dicranura vinula*, the most frequently mentioned host of *Paniscus cephalotes* Holmgren, with which DeGeer's description agrees very well. I, therefore, consider [*Ichneumon luteus* DeGeer (not Linnaeus)]=*Paniscus cephalotes* Holmgren.

The type citation should be as follows:

PANISCUS Schrank.

Faun. Boica, vol. 2, pt. 2, 1802, p. 316. One species.

Type.—[*Ichneumon luteus* DeGeer (not Linnaeus)]=*Paniscus cephalotes* Holmgren; *Ichneumon luteus* Rossi (by designation of Viereck, Bull. 83, U. S. Nat. Mus., 1914, p. 109); not tenable since Schrank did not mention Rossi's work in either of his discussions of *Ichneumon luteus*; *Paniscus glaucopterus* Linnaeus (by designation of Gray, Ann. and Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 341), not originally included. (Monobasic).

No recent revision of the North American (north of Mexico) species of *Paniscus* has been published, the only keys to such species being those of Provancher¹². In the earlier article Provancher tabulated eight species, seven described for the first time, to which he later¹³ added another. In the "Faune" he transferred five of these nine to other genera and synonymized another with *geminatus* (Say), so that his second key included only three species: *P. geminatus* (Say), *albovariegatus* Provancher, and *albatarsatus* Provancher. Morley¹⁴ included six North American species, one new, in a key to American species.

Fifteen species from North America (north of Mexico) have been described in or referred to the genus: One by Say, one by Olivier, eight by Provancher, three by Ashmead, one by Viereck, and one by Morley. Five of Provancher's have properly been transferred to other genera, while the sixth is so treated on a later page of the present paper. I have been unable to recognize the species of Olivier and Morley because of insufficient description, although the latter is included in the key to species; *albovariegatus* Provancher is included in the key but without entire assurance that it is properly placed; *appendiculatus* Provancher is not included in the key because the description applies equally well to at least two of the species described as new, and I hesitate to apply Provancher's name to either, because his type is probably still in existence, though probably with the label removed and placed with his *geminatus* (Say), with which species he synonymized it.¹⁵ Provancher's

¹² Nat. Can., vol. 6, 1874, p. 105; and Faune Ent. Can. Hym., 1883, p. 360.

¹³ Nat. Can., vol. 8, 1876, p. 328.

¹⁴ Rev. Ichn. Brit. Mus., pt. 2, 1913, p. 102.

¹⁵ Mr. A. B. Gahan, of the U. S. National Museum, searched for the type of *appendiculatus* and arrived at this conclusion.

species is not synonymous with *geminatus* as defined here nor with the new variety described. The types of all three of Ashmead's species and of Viereck's one species are in the National Collection and are part of the material studied.

I am not at all convinced that all of the species recognized in this paper are distinct, because the range of specific variation in structure, sculpture, and color is very difficult, at present apparently impossible, to determine. I have therefore made use of the most obvious available characters for the definition of species, realizing that most of these characters are subject to variation, but believing that the key will be found workable for a very large percentage of all specimens. Most of the species recognized have been confused with *geminatus* (Say).

KEY TO SPECIES OF PANISCUS FROM NORTH AMERICA NORTH OF MEXICO.

1. Scutellum not at all margined laterally; head and thorax polished; notauli evident only anteriorly; highly ornamented with yellow... *pulcher*, new species.
Scutellum margined laterally at least at base; head and thorax distinctly punctate; notauli usually strong throughout..... 2.
2. Propodeum with a median rounded elevation near base, without carinae but the apical carina represented on each side by a rounded tubercle; scutellar carinae extending only about half way to apex; metapleurum roundly elevated above at apex; a very large species..... *trituberculatus*, new species.
Propodeum not as above..... 3.
3. Propodeum coriaceous, not or barely transversely aciculate.
inmaculatus Morley.
Propodeum more or less distinctly transversely aciculate..... 4.
4. Hind femur distinctly less than two-thirds as long as tibia, rather stout; face (measured from antennal foramina to clypeal foveae) distinctly broader than long; clypeus broad and broadly concavely truncate, the basal groove hardly arched above level of foveae..... 5.
Hind femur slender, at least two-thirds as long as tibia; face usually as long as broad; clypeus not broad, narrowly truncate, basal groove arched above level of foveae..... 11.
5. Antennae short, stout, the middle flagellar joints nearly quadrate..... 6.
Antennae longer and more slender, the middle flagellar joints nearly or quite twice as long as thick..... 7.
6. Occipital carina strong except medially above..... *brevicornis*, new species.
Occipital carina very weak..... *caviverticilis*, new species.
7. Temples as broad as eyes or nearly..... 8.
Temples much narrower than eyes..... 10.
8. Scutellum practically immargined; clypeus transversely elevated, margin reflexed..... *clypeatus*, new species.
Scutellum margined to apex; clypeus flat or nearly..... 9.
9. Antennae much shorter than body; temples fully as wide as eyes; eyes nearly flush with surface of head..... *temporalis*, new species.
Antennae about as long as body; temples hardly as wide as eyes; eyes somewhat bulging..... *pardalis*, new species.
10. Antennae shorter than body, joints beyond middle distinctly less than twice as long as thick; tibiae and tarsi with many conspicuous spines, those of hind basitarsus nearly as long as diameter of the joint..... *spinipes*, new species.

- Antennae about as long as body; joints beyond middle fully twice as long as thick; tibiae and tarsi not especially conspicuously spined, the spines fewer and smaller, those of hind basitarsus barely half as long as diameter of the joint..... *neomexicanus*, new species.
11. Apical tarsal joints very long and slender, that of middle leg in female at least as long as second joint, in male at least as long as third; claws very large with about twenty teeth in female, in male very closely pectinate.
unguicularis, new species.
- Apical tarsal joints shorter and stouter, if approaching above proportions the claws not conspicuously large and with fewer teeth..... 12.
12. Mesopleura, metapleura, and sides of propodeum very densely and rather coarsely punctate 13.
- Pleura with finer and well separated punctures, metapleura sometimes obliquely striate 16.
13. Propodeum dorsally coarsely punctate; not transversely striate.
subfuscus Cresson.
- Propodeum more or less distinctly transversely striate, rarely finely granular without distinct striae 14.
14. Temples rather broad and strongly convex; ocelli distant from eyes; hind femur rather stout, barely three-fourths as long as tibia..... *cockerelli*, new species.
- Temples very narrow, sloping sharply from shortly behind eyes; ocelli proximate to the eyes; hind femur slender, more than three-fourths as long as tibia 15.
15. 13 mm. or more; ocelli touching the eyes..... *ocellatus* Viereck.
11 mm. or less; ocelli distinctly though narrowly separated from the eyes.
ocellatus, var. *microocellatus*, new variety.
16. Metapleurum obliquely striate throughout, not at all punctate..... 17.
Metapleurum punctate or nearly smooth, sometimes obscurely striate below.. 20.
17. Mesoscutum, mesosternum, epipleura, and venation blackish; second recurrent vein strongly antefurcal *nigripectus* Ashmead.
Not black marked as above, stigma always pale; second recurrent vein interstitial or postfurcal 18.
18. Slender, first tergite about five times as long as wide at apex; hind femur very slender; antennae attenuate at apex, the subapical joints about three times as long as thick..... *californicus*, new species.
Stouter, first tergite about four times as long as wide at apex; hind femur rather stout; antennae not especially slender apically, the subapical joints scarcely twice as long as thick..... 19.
19. Temples narrow, sloping; vertex yellow..... *arizonensis*, new species.
Temples broad and strongly convex; vertex piceous..... *leo*, new species.
20. Vertex yellow or concolorous with face 21.
Vertex black or piceous 24.
21. Mesothorax with distinct pale yellow markings 22.
Mesothorax without a distinct pattern of yellow 23.
22. Abdomen brownish at apex..... *albovariegatus* Provancher.
Abdomen not brownish at apex; scutellum margined only at base.
alaskensis Ashmead.
23. Second intercubitus sharply bent, the areolet subquadrangular; ocelli practically contiguous with the eyes; larger..... *pallens*, new species.
Second intercubitus nearly straight, the areolet triangular; ocelli not nearly touching the eyes; 9 mm..... *pallens*, var. *barberi*, new variety.
24. Propodeum with a long, straight, gradual slope from base to apex, the apophyses practically wanting; first tergite about six times as long as wide at apex.
townsendi, new species.

- Propodeum more distinctly rounded or with distinct apophyses; first tergite less than five times as long as wide at apex.....25.
25. Spiracles of first tergite not far before middle; second tergite not much longer than wide and but little more than half as long as first.....*texanus* Ashmead.
Spiracles of first tergite far before middle; second tergite much longer than wide and distinctly more than half as long as first.....26.
26. Ocelli not nearly contiguous with the eyes (closer in male than in female); apophyses weak; small, 10 mm. or less.....*geminatus* (Say).
Ocelli practically contiguous with the eyes; apophyses strong; large.
geminatus, var. *sayi*, new variety.

PANISCUS PULCHER, new species.

Very distinct in the entire lack of scutellar carinae and the highly contrasting color pattern of the thorax.

Female.—Length 15 mm.; antennae 15 mm.

Polished throughout and practically without sculpture; temples buccate but much narrower than eyes; occipital carina very weak; face slightly wider than long, the sides slightly convergent below; frons as wide as narrowest part of face; eyes shallowly emarginate; clypeus strongly transverse, broadly and rather deeply emarginately truncate and transversely elevated; ocelli narrowly separated from eyes, postocellar line nearly as long as ocellar diameter; antennae slender, first flagellar joint much shorter than next two combined, middle joints nearly twice as long as thick. Pronotum slightly roughened in lateral groove; notauli short but deep; scutellum entirely without carinae; mesopleurum with a strong Y-shaped groove with its base near the posterior margin; prepectal carina strong and terminating abruptly at the lower branch of the groove; propodeum inconspicuously transversely striate, apical carina strong but not prominent laterally, weakly indicated medially; areolet placed nearly longitudinally, the lower side nearly continuous with rest of cubitus, second intercubitus broken; recurrent nearly straight below middle, incurved above, interstitial, lower bulla well below middle; nervulus postfurcal by more than half its length, perpendicular or nearly; postnervulus broken at its upper third; nervellus broken above its upper fourth; hind femur slender, two-thirds as long as tibia; tibia nearly as long as tarsus; tarsi very slender, apical joint of middle tarsus much shorter than third and only a little larger than fourth, claws small with about ten large teeth and a few small basal ones. Abdomen not strongly compressed; first tergite slightly more than three times as long as wide at apex, spiracle at basal third; second tergite barely longer than wide at apex, slightly less than two-thirds as long as first; sheath two-thirds as long as first tergite.

Testaceous, this color becoming almost piceous on mesoscutum; head largely yellow, this color including vertex; antennae testaceous; thorax with yellow markings as follows: Margins of mesoscutum and

two streaks in position of notauli reaching to scutellum, scutellum except medially at base, pronotum largely, fully half of mesopleurum in irregular spots, postscutellum and a spot flanking it on each side, lower side of metapleurum, and the propodeal carina; base of petiole also yellow; legs, except yellow knees, entirely testaceous; wings hyaline, venation dark, stigma luteous, costa and tegulae pale yellow.

Male.—Essentially like female; genital sheath very shortly exerted, strongly compressed and very broad at apex; tarsal claws much more densely pectinate than in female.

Type-locality.—Roswell, New Mexico.

Allotype-locality.—Las Cruces, New Mexico.

Type.—Cat. No. 25983, U.S.N.M.

Described from two females, the type taken April 15 by T. D. A. Cockerell and the paratype, from which the abdomen beyond the third tergite is missing, taken on *Larrea* at Las Cruces, New Mexico, in the spring of 1896 by Elgin Holt; and the allotype without other than the locality label.

PANISCUS TRITUBERCULATUS, new species.

Much larger than any other North American species and otherwise very distinct in the structure of the propodeum.

Female.—Length 25 mm.; antennae 22 mm.

Temples nearly flat and strongly receding; occipital carina strong and complete though obsolescent medially and approaching very closely to the ocelli; face nearly quadrate; clypeus rather long, simply convex, and weakly emarginately truncate; frons much narrower than face; ocelli very large, touching the eyes, postocellar line barely a third as long as ocellar diameter; antennae slender, first flagellar joint nearly as long as combined length of second and third, middle joints twice as long as thick. Thorax finely opaque; notauli deep and extending well back on disk of mesoscutum; scutellum carinate only basally; mesopleurum shining, inconspicuously punctate, furrows obsolete; metapleurum tuberculate above; propodeum very finely transversely opaquely aciculate, with a rounded tubercle in basal middle and the apical carina represented by lateral rounded hardly carinate tubercles; areolet petiolate, hardly as long as high, the second intercubitus strongly broken; second recurrent slightly postfureal, nearly evenly curved, posterior bulla below middle; nervulus shortly postfureal; postnervulus broken below upper third, inclivous; nervellus broken at about upper two-fifths; legs long and stout; hind femur three-fourths as long as tibia; tibia very nearly as long as tarsus; tarsi rather stout, very densely and finely pubescent beneath, fourth joint of middle tarsus about a third longer than broad at apex, apical joint slightly longer than second, claws very large with about eighteen large teeth and a few small

basal ones. First tergite long, nearly four times as long as wide at apex; second tergite two-thirds as long as first, nearly twice as long as wide and nearly parallel-sided; sheath slightly shorter than first tergite.

Rufo-testaceous with head, including vertex, more yellowish; wings hyaline, veins dark, stigma pale testaceous and costa stramineous.

Type-locality.—Santa Rita Mountains, Arizona.

Paratype-locality.—Mountain View, California.

Type.—Cat. No. 25984, U.S.N.M.

Described from two females, the type taken by E. A. Schwarz and the paratype in June, 1892, by E. M. Ehrborn.

The paratype is uniformly paler than the type. It lacks the antennae.

PANISCUS IMMACULATUS Morley.

Paniscus immaculatus MORLEY, Rev. Ichn. Brit. Mus., pt. 2, 1913, p. 109.

This species is unknown to me, but its description is very suggestive of what I consider *subfuscus* Cresson from the West Indies. The latter differs from Morley's determination of the same species in its yellow vertex and very narrow temples; it is represented in the National Collection by one female specimen from Florida and eleven, including both sexes, from the West Indies.

It may, on the other hand, be a synonym of *ocellatus* Viereck, in which the transverse aciculation of the propodeum is sometimes almost entirely replaced by dense punctuation.

PANISCUS BREVICORNIS, new species.

In spite of the conspicuously short and short-jointed antennae, specimens of this species have been confused in the national collection with *geminatus* (Say).

Female.—Length 13.5 mm.; antennae 10 mm.

Stout; temples gibbous, nearly as broad as eyes; ocelli distinctly though briefly separated from eyes, postocellar line nearly as long as diameter of lateral ocellus; frons distinctly narrower than face; eyes shallowly emarginate; face parallel-sided, much broader than long, with fine but distinct, well separated punctures, the interspaces very finely shagreened; clypeus very short and broad, the basal groove deep and nearly straight, broadly arcuately truncate at apex, the margin slightly reflexed, surface coarsely and sparsely punctate; occipital carina complete except for a median interruption about as long as postocellar line; antennae short, rather stout, scape nearly as thick as long, first joint of flagellum hardly three times as long as thick at apex, very nearly as long as second and third combined, middle joints only slightly longer than thick. Thorax shining; pronotum laterally irregularly striate; mesoscutum very finely and rather sparsely punctate; notauli deep anteriorly but fading out on

the disk; scutellum sparsely punctate, carinae complete to apex, the space between more than twice as broad at base as at apex and three-fourths as broad as long; mesopleurum and metapleurum finely and rather densely punctate; propodeum strongly arched from base to apex, finely transversely striate, apically irregularly roughened, apophyses weak, spiracles elongate oval; second intercubitus broken; recurrent interstitial with second intercubitus or slightly antefurcal or postfurcal, nearly evenly curved; posterior bulla well below middle; nervulus postfurcal by more than half its length, perpendicular; postnervulus broken at its upper third; abscisula about three times as long as intercubitella; nervellus broken at a right angle at about its upper third; hind femur stout, distinctly less than two-thirds as long as tibia and hardly or barely as long as combined length of coxa and trochanter; tibia four-fifths as long as tarsus; tarsi slender, apical joint of middle tarsus about as long as third and a half longer than fourth, claws small with about ten large teeth and a few small basal ones. Abdomen weakly compressed, first tergite about a third longer than second and three and a half times as long as wide at apex, spiracles just beyond basal third; second one and a half times as long as wide at apex.

Dull brownish testaceous; face, clypeus, orbits, and vertex yellow; antennae ferruginous, slightly infuscate apically; wings hyaline, veins dark, stigma and costa pale; tibiae at base and tarsi yellow.

Male.—Length 14 mm.; antennae 12 mm.

Differs from the female essentially in the relatively shorter ocellular and postocellar lines due to the slightly larger ocelli; less strongly arched propodeum; and narrower abdomen; tarsal claws scarcely more densely pectinate than in female.

Type-locality.—Wellington, Kansas.

Type.—Cat. No. 25985, U.S.N.M.

Described from thirty-nine females and twenty-two males; eighteen females and ten males taken at light at the type-locality by E. G. Kelly; one female from Baldwin, Kansas; one female from Stillwater, Oklahoma (A. N. Caudell); eight females and three males from Texas; one female and two males from Colorado (C. F. Baker); one female from the Flathead Indian Reservation, Montana (Hopkins U. S. No. 8595, Josef Brunner); one male from Brookings South Dakota; one female from Sullivan, Indiana (J. W. Spencer); one female from Wetumpka, Alabama (H. H. Smith); one female from North Carolina (T. Pergande); one female from Virginia; one female and one male from the District of Columbia; two males from Pennsylvania (C. F. Baker); one female from New York; one female and two males from New Haven, Connecticut (W. E. Britton); one female probably from Massachusetts, collected by George Dimmock and bearing his No. 1138 m; and one female and one male unlabeled.

This series shows considerable variation in most of the characters mentioned above. In size the females vary from 11 to 16 mm. and the males the same.

The color varies from bright to dull brownish testaceous. The latter color which occurs only in Kansas specimens may be due to the method of killing or preservation. A few specimens have the head entirely testaceous.

In the most weakly sculptured individuals the striae of the propodeum become obsolete and are replaced by shallow transversely arranged punctures.

PANISCUS CAVIVERTICALIS, new species,

Very closely related in its short antennae and femora to *brevicornis* Cushman, but differing as follows:

Female.—Length 10 mm.; antennae 8 mm.

Frons as broad as face; vertex rather deeply concave between ocelli; clypeus (malformed?) very deeply emarginate with a strong transverse elevation bordering the margin, more finely and densely punctate; occipital carina very nearly wanting; flagellum hardly attenuate at apex, only 38-jointed (in *brevicornis* there are from 46 to 52 joints depending largely on the size of the insect); propodeal spiracles broadly oval; second intercubitus nearly straight, second recurrent interstitial; nervellus broken at upper fourth; hind femur nearly two-thirds as long as tibia; second tergite little longer than broad at apex, less than two-thirds as long as first, first hardly three times as long as broad at apex.

Color as in *brevicornis* but brighter and with face and frons medially testaceous.

Type-locality.—Platte Canyon, Colorado.

Type.—Cat. No. 25986, U.S.N.M.

One specimen, which may be an abnormal specimen of *brevicornis*.

PANISCUS CLYPEATUS, new species.

From the other species with short femora and broad temples this species is distinct in its almost entire lack of scutellar carinae and its strongly transversely elevated clypeus.

Female.—Length 12 mm.; antennae (broken, but from the proportions of the remaining joints probably about as long as the body).

Head large; temples buccate, nearly as broad as eyes, sparsely punctate; face much broader than long and about a third broader than frons, parallel-sided, elevated medially, sparsely punctate, the interspaces faintly shagreened; clypeus very short and broad, strongly transversely elevated, apex reflexed and broadly but strongly arcuately truncate; frons polished, flat; ocelli rather small, distant from eyes; eyes rather shallowly emarginate; antennae slender, middle flagellar joint somewhat less than twice as long as thick.

first flagellar joint unusually short, its shorter side being little longer than second joint. Thorax shining; mesoscutum shining, minutely punctate, notauli distinct only to summit of anterior slope; scutellum sculptured like mesoscutum, ridged laterally but distinctly carinate only at extreme base, broad; mesopleurum subpolished rather densely finely punctate; metapleurum strongly convex, striatopunctate; propodeum rounded, transversely finely striate, apophyses weak, spiracles broadly oval; areolet triangular, petiolate; second recurrent interstitial, nearly evenly curved throughout; nervulus postfureal by nearly its length; postnervulus broken at about its upper third; nervellus broken at about its upper fourth; legs stout; hind femur barely two-thirds as long as tibia; hind tarsi (broken); joints of middle tarsus relatively short and stout, apical joint about as long as third, which is barely three times as long as thick, claws small with about eight large teeth. Abdomen rather stout; first tergite only a little more than three times as long as broad at apex, spiracle at basal two-fifths; second tergite only one and one-half times as long as broad at base.

Rather pale testaceous; face, orbits, vertex, subalar tubercles, and sides and apex of scutellum yellow and faint indications of this color on margins of mesoscutum and in notauli; tarsi paler than rest of legs; antennae concolorous, blackish apically; wings hyaline, venation brown, stigma and costa pale.

Male.—Length 12 mm.; antennae 12 mm.

Essentially like female, but yellow markings of thorax more distinct and scutellum entirely yellow; tarsal claws not densely pectinate.

Type-locality.—Illinois.

Allotype-locality.—Near mouth of Four Mile Run, Virginia.

Type.—Cat. No. 25987, U.S.N.M.

Described from two females, the paratype from Ardmore, South Dakota (E. G. Holt, September 25, 1915), and one male (W. L. McAtee, September 17, 1916).

The paratype is badly stained about the head but is otherwise much like the type. In this specimen the hind tarsus is barely longer than the tibia. It and the allotype were received from the Bureau of Biological Survey, and the type from the C. F. Baker collection.

PANISCUS TEMPORALIS, new species.

Female.—Length 13 mm.; antennae 10 mm.

Temples strongly buccate, fully as wide as eyes, weakly punctate; face very broad, a third wider than frons, weakly elevated medially, rather densely punctate and faintly shagreened; clypeus very broad and short, nearly flat, very broadly arcuately truncate at apex, sparsely punctate; frons flat, weakly transversely striate; ocelli

briefly but distinctly removed from eyes; eyes only slightly elevated above general level of head, rather shallowly emarginate; antennae rather stout, attenuate at apex, middle joints scarcely twice as long as thick, basal joint of flagellum nearly as long as second and third combined. Thorax shining; mesoscutum minutely punctate, notauli distinct well on to disk; scutellum strongly margined to apex, the space inclosed by the carinae narrow and strongly convergent posteriorly; mesopleurum finely and rather densely punctate; metapleurum moderately convex but not elevated, slightly more densely punctate than mesopleurum; propodeum weakly rounded, transversely striate, apophyses moderate, area behind them irregularly roughened, spiracle long oval; areolet subsessile, second intercubitus sharply bent; second recurrent interstitial, curved above, nearly straight below; nervulus postfurcal by two-thirds its length; postnervulus broken at upper third; nervellus broken at upper third; femora stout, hind femur distinctly less than two-thirds as long as tibia; tarsi slender, hind tarsus slightly longer than tibia; apical joint of middle tarsus about as long as third, which is fully three times as long as thick, claws small with about ten large teeth. Abdomen rather slender; first tergite fully four times as long as broad at apex, spiracle at basal third; second tergite more than twice as long as broad at base, the sides weakly divergent.

Rufo-testaceous with face, frons, vertex and orbits yellow; antennae concolorous, slightly darker at apex; tarsi slightly paler than the rest of legs; wings hyaline, venation blackish, stigma and costa pale.

Type-locality.—Los Angeles County, California.

Type.—Cat. No. 25988, U.S.N.M.

One female.

PANISCUS PARDALIS, new species.

Female.—Length 13 mm.; antennae (broken, but in paratype as long as body).

Temples broad but narrower than eyes; eyes distinctly bulging, rather shallowly emarginate; face much broader than long and a third broader than frons, medially convex, sparsely punctate; clypeus very short and broad, nearly flat, very broadly and weakly arcuately truncate; frons flat, indistinctly transversely aciculate; ocelli distinctly separated from eyes; antennae slender, middle joints nearly twice as long as thick, first joint on its shortest side not much longer than second joint. Thorax shining; mesoscutum faintly coriaceous, impunctate, notauli extending onto disk; scutellum similarly sculptured, completely margined, space between carinae long, strongly convergent; mesopleurum shining, very weakly and sparsely punctate, the Y-shaped impression weak; metapleurum obliquely striate; propodeum weakly rounded from base to apex, transversely striate, apophyses very weak, spiracles long oval; areolet large, sessile,

quadrate, second intercubitus distinctly broken; second recurrent interstitial, rather weakly and evenly curved throughout; nervulus postfurcal by about two-thirds its length; postnervulus broken at upper third; nervellus broken slightly above upper third; hind femur distinctly less than two-thirds as long as tibia; tarsi slender, apical joint of middle tarsus about as long as third, claws small with about ten large teeth. Abdomen rather slender; first tergite four times as long as wide at apex, spiracle at basal third; second tergite nearly twice as long as wide at base, sides moderately divergent.

Testaceous; face and frons medially paler; clypeus, orbits, and vertex yellow; antennae fuscous except at base; wings hyaline, venation blackish, stigma and costa pale; legs concolorous, tarsi slightly paler.

Type-locality.—Ritzville, Washington.

Type.—Cat. No. 25989, U.S.N.M.

Two females taken May 13, 1921, by M. C. Lane.

The paratype is slightly larger than the type with the antennae more extensively testaceous at base and lacks the abnormal stubs of veins on the second intercubitus and second recurrent that are present in the type; but is otherwise very similar.

PANISCUS SPINIPES, new species.

Female.—Length 14 mm.; antennae 13 mm.

Temples rather broad and strongly convex but not distinctly buccate; face broader than long, sparsely punctate, medially somewhat elevated, nearly a half broader than frons; clypeus short and broad, convex, broadly truncate at apex; frons flat, subopaque, transversely aciculate; ocelli slightly removed from eyes; antennae rather slender, joints beyond middle less than twice as long as thick. Thorax shining; mesoscutum very finely and inconspicuously punctate, notauli extending well onto disk; scutellum margined throughout, space between carinae broad and rather weakly convergent; mesopleurum slightly more distinctly sculptured than mesoscutum; metapleurum very finely punctate; propodeum rather strongly rounded from base to apex, transversely striate, apophyses weak, spiracles broadly oval; areolet subpetiolate, subquadrangular; second recurrent slightly postfurcal, strongly curved above, nearly straight below middle; nervulus postfurcal by about two-thirds its length; postnervulus broken at upper third; nervellus broken at upper third; hind femur distinctly less than two-thirds as long as tibia; tarsi rather slender, apical joint of middle tarsus slightly longer than third, claws small with about ten large teeth; legs conspicuously spiny. Abdomen moderate; first tergite not quite four times as long as wide at apex, spiracles slightly beyond basal third; second tergite nearly twice as long as wide at base, subparallel-sided.

Testaceous; face, clypeus, frons, vertex, and orbits yellow; faint traces of this color in notauli, margins of mesoscutum, scutellum, and around wing bases; antennae concolorous, infusate apically; wings hyaline, venation blackish, stigma and costa pale; legs concolorous, tarsi slightly paler,

Male.—Essentially like female; but abdomen more slender, apical tarsal joints shorter, and claws somewhat more densely pectinate especially at apex.

Type-locality.—Washington, District of Columbia.

Allotype-locality.—Virginia.

Type.—Cat. No. 25990, U.S.N.M.

Described from twenty-four females and five males ranging from the vicinity of Washington and Connecticut west to Texas and Kansas, and represented from the following States and localities: District of Columbia; Virginia, Arlington, Falls Church (W. Middleton, August 21, 1914), Vienna (W. F. Turner, May 12, 1913), Cranesville (R. P. Currie, July 21, 1914), Charlottesville; Connecticut, Hartford (July 26, 1894); North Carolina, Pysiton and Langdale (H. H. Smith); Texas, Wolfe City (F. C. Bishopp, May, 1906), Tyler (F. C. Pratt, May 5, 1905), Victoria (J. D. Mitchell, April 19, 1913, and October 28, on *Helenium* species), Cotulla (F. C. Pratt, April 15, 1908), Kerrville (F. C. Pratt, April 11, 1907); Kansas, Riley County (Marlatt, September), Wellington (E. G. Kelly).

This series exhibits wide range in size, the largest being 17 mm. and the smallest 11 mm. in length. In the smaller specimens the ocelli are somewhat more distant from the eyes and the apical tarsal joints and first tergite relatively shorter.

One of the specimens from Victoria, Texas, a very small female, has the vertex piceous, possibly due to staining.

PANISCUS NEOMEXICANUS, new species.

Very close to *spinipes* Cushman and agreeing in nearly every respect with the description of that species; but the antennae are distinctly longer with more slender joints, the legs distinctly less conspicuously spiny, the ocelli nearly contiguous with eyes, the thorax nearly polished, and the first tergite more than four times as long as broad at apex.

Type-locality.—Bernalillo County, New Mexico.

Type.—Cat. No. 25991, U.S.N.M.

One female taken by B. Brown in June, 1896.

PANISCUS UNGUICULARIS, new species.

Remarkable principally for its very long, slender apical tarsal joints and very large, many-toothed claws.

Female.—Length 20 mm.; antennae 20 mm.

Temples strongly narrowed and weakly convex; face medially somewhat elevated, very finely shagreened and sparsely punctate fully a half wider than frons, slightly convergent below, about as wide as long; clypeus rather long, flat, apically broadly truncate, shagreened and with scattered coarse punctures; eyes rather deeply emarginate; frons flat, transversely aciculate; ocelli very large, contiguous with the eyes; antennae slender, middle joints more than twice as long as thick, basal flagellar joint on its shorter side about a fourth longer than second. Thorax subopaque; mesoscutum granular, notauli long; scutellum carinate to apex, the space between carinae narrow and strongly convergent posteriorly; mesopleurum finely and rather densely punctate; metapleurum indistinctly obliquely striate; propodeum rather strongly rounded from base to apex, transversely striate, apophyses strong, spiracles long oval; areolet subquadrate; second recurrent strongly and almost evenly curved throughout, interstitial; nervulus shortly postfureal (about one-third its length); postnervulus broken at upper third; nervellus broken at a slightly acute angle at about its upper two-fifths; hind femur slender, barely a fourth shorter than tibia; tarsi very slender, apical joint of middle tarsus very slender, curved, fully as long as second joint; claws very long, nearly straight to near apex, with about seventeen large teeth. Abdomen rather slender; first tergite four and one-half times as long as wide at apex, spiracle at basal third; second tergite two and one-half times as long as wide at base, sides weakly divergent.

Flavo-testaceous; head, except occiput, yellow, vertex slightly piceous; antennae testaceous, fuscous apically; thorax paler laterally and along margins of mesoscutum and scutellum; legs concolorous, tarsi stramineous.

Male.—Essentially like female but the apical tarsal joints shorter, that of middle leg being only about as long as the third joint, and the claws very densely pectinate throughout.

Type-locality.—Plummer Island, Maryland.

Type.—Cat. No. 25992, U.S.N.M.

Described from ten females and nine males ranging from New York and Indiana to North Carolina and Alabama and distributed as follows: New York, Ithaca (July 12, 1890); Indiana (C. F. Baker); Pennsylvania, Harrisburg (P. R. Myers, September 16, 1908); Linglestown (W. S. Fisher, June 26, 1917); Maryland, Plummer Island (A. K. Fisher, August 25, 1907, W. L. McAtee, August 24 and September 29, 1907), Chevy Chase Lake (H. H. Smith); District of Columbia (T. Pergande, October 8, 1884); Virginia, Rosslyn (H. H. Smith, T. Pergande, June 27); North Carolina (T. Pergande); Alabama, Pysiton, Clay County (H. H. Smith).

Very constant in size, structure, and sculpture.

PANISCUS SUBFUSCUS Cresson.

Paniscus subfuscus CRESSON, Proc. Ent. Soc. Phila., vol. 4, 1865, p. 57.

The inclusion of this West Indian species within the scope of this paper is based on a single female specimen taken by H. S. Barber on Paradise Key, Florida, February 22, 1919.

It is paler in color than specimens from the West Indies, but is otherwise identical. The densely and rather coarsely punctate propodeum without transverse striae is very characteristic.

I suspect *immaculatus* Morley is synonymous with this species.

PANISCUS COCKERELLI, new species.

This species, *subfuscus* Cresson, and *ocellatus* Viereck form a small group characterized by having the sides of the thorax, especially the metapleurum and sides of propodeum, very densely and rather coarsely punctate. From *subfuscus* the present species differs in its transversely striate propodeum and from *ocellatus* in its broad temples, distinct ocell-ocular space and rather short and stout femora.

Female.—Length 12 mm.; antennae 12 mm.

Temples rather broad and strongly convex; ocelli distinctly separated from the eyes; face slightly broader than long, faintly shagreened laterally and sparsely punctate, parallel-sided, about a third wider than frons; clypeus weakly convex, rather short, arcuately truncate, shining, sparsely punctate; antennae slender, middle joints more than twice as long as thick. Thorax shining; pronotum obliquely striate; mesoscutum sparsely and finely punctate, notauli long; scutellum sparsely punctate, margined to apex, space between carinae long and twice as wide at base as at apex; mesopleura rather densely punctate; the interspaces obscurely shagreened; metapleurum very densely and rather coarsely punctate; propodeum laterally sculptured like metapleurum, dorsally transversely striate, apophyses obsolescent, spiracles elongate; areolet sessile, subquadrangular, second recurrent interstitial, curved throughout, more strongly so above; nervulus postfurcal by about half its length; postnervulus broken at about upper third; nervellus broken at a right angle slightly above upper third; hind femur rather stout, barely three-fourths as long as tibia; apical tarsal joint of middle leg about as long as third joint, claws moderate with about eight large teeth. Abdomen rather stout; first tergite about three and one-half times as long as wide at apex; spiracles slightly beyond basal third; second tergite barely a half longer than wide at base; ovipositor sheath distinctly shorter than first tergite.

Pale testaceous; head, including vertex, largely yellow; antennae ferruginous, infusate toward apex; wings hyaline, venation dark brownish, stigma and costa paler but brownish rather than yellowish; legs concolorous, the tarsi stramineous; ovipositor sheath pale.

Type-locality.—Santa Fe, New Mexico.

Type.—Cat. No. 25993, U.S.N.M.

Described from three females, the type taken by Prof. T. D. A. Cockerell in June; paratype *a* from the Mojave Desert, Arizona (Ehrhorn, June, 1898); paratype *b* from Utah (C. F. Baker).

PANISCUS OCELLATUS Viereck.

Paniscus ocellatus VIIEECK, Proc. Ent. Soc. Wash., vol. 11, 1909, p. 211.

Similar to *cockerelli* Cushman but distinctly darker in color with only the orbits yellow in the female; more slender with the femora very slender and longer, the ocelli approximate to the eyes, the last tarsal joint shorter, the veins and stigma paler, and the propodeal apophyses more distinct.

There are about fifty specimens mostly from Kansas, Texas, and Colorado, with a few from Alberta, South Dakota, Arizona, Indiana, Alabama, and the District of Columbia.

As frequently occurs in this genus there is a distinctly smaller form of this species, which is described below.

PANISCUS OCELLATUS, variety **MICROOCELLATUS**, new variety,

Differs from the typical form practically only in its smaller size (11 mm. or less) and in having the ocelli distinctly separated from the eyes.

Type-locality.—Texas.

Type.—Cat. No. 25994, U.S.N.M.

Seven females and four males, the type, allotype, and two other females from Texas (Belfrage), one female from Kerrville and one female from Sabinal, Texas (F. C. Pratt), three males from Plano, Texas (E. S. Tucker), one female from Victoria, Texas, and one female from Wellington, Kansas (E. G. Kelly).

PANISCUS NIGRIPECTUS Ashmead.

Paniscus nigripectus ASHMEAD, Proc. U. S. Nat. Mus., vol. 12, 1890, p. 425.

This species is still known only from the unique type female. Its dark mesoscutum, mesosternum, lower portions of tergites, and stigma render it easily recognizable among North American species.

Morley considers it "obviously synonymous" with *melanostigma* Cameron, and it is apparently closely related to that species, differing so far as Cameron's description goes only in its dark mesosternum and lower half of abdomen and its distinctly ferruginous antennae.

In its obliquely striated metapleurum it is allied to the three following species.

PANISCUS CALIFORNICUS, new species.

The very slender first tergite, femora, and subapical flagellar joints distinguish this species from its closest relatives.

Female.—Length 16 mm.; antennae 15 mm.

Temples very narrow but rather strongly convex; ocelli very large, touching the eyes; face nearly a half wider than frons, about as long as wide, subopaquely shagreened and sparsely punctate; clypeus weakly convex about half as long as wide, weakly arcuate at apex; antennae very slender, attenuate toward apex, middle flagellar joint distinctly more than twice, those near apex nearly three times as long as thick. Thorax subopaque; mesoscutum shining, minutely coriaceous, notauli long; scutellum margined to apex, space between carinae long, about twice as wide at base as at apex; pronotum obliquely striate, mesopleurum closely minutely punctate; metapleurum obliquely striate; propodeum finely transversely striate, apophyses distinct; areolet petiolate, narrow, subquadrangular; second recurrent curved throughout, postfureal; nervulus only slightly postfureal; postnervulus broken slightly below upper third; nervellus broken at a slightly acute angle at about upper third; legs very slender, hind femur of uniform thickness; apical joint of middle tarsus as long as third joint, claws rather large with about twelve large teeth. Abdomen very slender at base, the first tergite about five times as long as wide at apex, second much more than twice as long as basal width, sides only slightly divergent; ovipositor sheath distinctly shorter than first tergite.

Rufo-testaceous; orbits, vertex, and clypeus yellow, face medially slightly reddish; antennae concolorous, apical half somewhat fuscous; wings hyaline, stigma pale; legs concolorous, tibiae and tarsi paler; ovipositor sheath fuscous.

Type-locality.—Berkeley, California.

Type.—Cat. No. 25995, U.S.N.M.

Two practically identical females taken by E. O. Essig.

PANISCUS ARIZONENSIS, new species.

Differs from *californicus* Cushman principally as follows:

Female.—Length 12.5 mm.; antennae 11 mm.

Ocelli distinctly but narrowly separated from eyes; face more densely and distinctly shagreened, as is also the clypeus; antennae not attenuate at apex, the subapical joints thick and about two-thirds as thick as long; mesoscutum subopaque and distinctly shagreened; propodeum coarsely transversely striate; areolet subpetiolate, recurrent interstitial; nervellus broken at a right angle at upper third; hind femur rather stout; claws small with about eight large teeth; first tergite little more than four times as long as wide at apex; second little more than twice as long as wide at base; ovipositor sheath fully as long as first tergite.

Similar in color to *californicus*, but the antennae fuscous only at apex.

Type-locality.—Chiricahua Mountains, Arizona.

Type.—Cat. No. 25996, U.S.N.M.

Three females from Arizona, the type taken by H. G. Hubbard; and two taken by E. A. Schwarz in the Santa Rita Mountains.

These three specimens show almost no variation.

PANISCUS LEO, new species.

Very close to *arizonensis* Cushman, but with the head distinctly broader and more strongly convex behind the eyes; antennae with subapical joints about twice as long as thick; nervulus more strongly postfurcal (about half its length); claws larger with about ten large teeth; ovipositor sheath hardly as long as first tergite.

Face entirely yellow; vertex piceous.

Female.—Length 12 mm.; antennae 11 mm.

Type-locality.—Oswego, New York.

Type.—Cat. No. 25997, U.S.N.M.

Two females, the type taken by Doctor Ludlow, and the paratype from Plummer Island, Maryland (W. L. McAtee). They are practically identical.

PANISCUS ALBOVARIEGATUS Provancher.

Paniscus albovariegatus PROVANCHER, Nat. Can., vol. 6, 1874, p. 106, male; vol. 11, 1879, p. 146; Faun. Ent. Can. Hym., 1883, p. 360, female.

The only way in which *Paniscus alaskensis* Ashmead differs from the description of this species is in having the abdomen uniformly colored not "brunâtre dans sa moitié postérieure," and but for the widely separated sources of the specimens I would be inclined to synonymize the two species. It should be noted that the species was described in the male, not, as indicated in Faune Entomologique du Canada, in the female.

Provancher does not mention the scutellum, which in *alaskensis* is margined only at base; nor did Mr. A. B. Gahan note anything concerning this sclerite when he examined the type.

PANISCUS ALASKENSIS Ashmead.

Paniscus alaskensis ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 237.

Described only in the male from Kukak Bay, Alaska, this species is represented by four of the five males of the type series, one from Cordova, Alaska (J. A. Kutsche); one from Kaslo, British Columbia (R. P. Currie); and one from Lake Tahoe, California (H. G. Dyar); as well as one female from each of the following localities: Hoquiam, Washington (H. E. Burke); Pullman, Washington (C. V. Piper); Santa Barbara, California (L. O. Howard); Cusack Ranch, Colorado; and one labeled simply "Mullan" (probably Idaho).

I strongly suspect this species of being synonymous with *albovariegatus* Provancher.

Very characteristic are the only basally margined scutellum and the usually distinct yellow color pattern of the thorax. Aside from

these two characters, the more briefly postfurcal nervulus, and the yellow vertex, the species is very similar to *geminatus* (Say).

PANISCUS PALLENS new species.

Female.—Length 16 mm; antennae (broken but in another female of the same size 14 mm.).

Temples very narrow and weakly convex; ocelli large, practically contiguous with the eyes; face fully a half wider than frons, fully as long as wide, minutely subopaquely shagreened and sparsely punctate; clypeus weakly convex, weakly arcuately truncate, sculptured like face but with coarser punctures; antennae (broken but in another female with the middle and subapical joints hardly twice as long as thick, tapering toward apex). Thorax shining, weakly sculptured; notauli long; scutellum margined to apex, the space between the carinae long, about twice as wide at base as at apex; metapleurum rather densely but weakly punctate; propodeum very finely transversely striate, apophyses rather weak; areolet subpetiolate, subquadrangular; second recurrent interstitial, straight below, strongly curved above; nervulus postfurcal by less than half its length; postnervulus broken at about upper third; nervellus broken at a right angle at upper third; legs moderate, apical joint of middle tarsus nearly or quite as long as second, claws rather large with about twelve large teeth. Abdomen moderate; first tergite four and one-half times as long as wide at apex; second tergite more than twice as long as wide at base, nearly parallel-sided; ovipositor sheath much shorter than first tergite.

Pallid testaceous; head except occiput, scutellum, sutures between pleura, and anterior margin of pronotum stramineous; antennae bright ferruginous; legs concolorous, tibiae and tarsi stramineous; wings hyaline, venation dark, stigma and costa pale; sheath pale at base, fuscous at apex.

Male.—Essentially like female; apical tarsal joint shorter; claw smaller with teeth much denser especially at base and apex. The pale color of thorax more extensive.

Type-locality.—Rosslyn, Virginia.

Allotype-locality.—Plummer Island, Maryland.

Type.—Cat. No. 25998, U.S.N.M.

Nine females and five males as follows: Type (H. H. Smith); allotype and two other males from same locality (H. S. Barber, at light); Virginia, near Plummer Island (H. L. Viereck); Falls Church and Vienna, Virginia (R. A. Cushman); District of Columbia; Coleta, Alabama (H. H. Smith); Thomson's Mills, Georgia (H. A. Allard); Nueces, Texas (C. L. Marlatt); Las Cruces, New Mexico (T. D. A. Cockerell); Denver, Colorado.

In size the typical form varies from 14 mm. (the smallest male) to 18 mm. (the largest female). Certain conspicuously smaller speci-

mens that differ somewhat otherwise from the typical form are described below as a variety.

The specimen on which the present writer's notes on *Paniscus geminatus* (Say), published in the Proceedings of the Entomological Society of Washington (vol. 15, 1913, pp. 155-157), were based is the Vienna, Virginia, specimen listed above.

PANISCUS PALLENS, variety BARBERI, new variety.

Differs from the typical form in its conspicuously smaller size (9-12 mm.) and in having the ocelli distinctly though usually only slightly removed from the eyes. The type is a female.

Type-locality.—Cranmoor, Wisconsin.

Allotype-locality.—Plummer Island, Maryland.

Type.—Cat. No. 25999, U.S.N.M.

Three females, the type taken by C. W. Hooker, one from Greenville, Texas (F. C. Bishopp), and one from Santa Fe, New Mexico (T. D. A. Cockerell); and two males, the allotype taken at light by H. S. Barber and the other on the Virginia shore of the Potomac River opposite Plummer Island by H. L. Viereck.

PANISCUS TOWNSENDI, new species.

Female.—Length 15 mm.; antennae 13 mm.

Temples rather broad, convex; ocelli slightly removed from eyes; face distinctly broader than long and hardly a half broader than frons, subopaque shagreened, sparsely punctate; clypeus nearly flat, hardly half as long as broad, broadly truncate, more shining and more coarsely punctate than face; antennae slender, attenuate at apex, middle joints fully twice as long as thick, subapical joints about a half longer than thick. Thorax shining, weakly punctate, almost without shagreening; notauli long; scutellum margined to apex, the intercarinal space long, hardly twice as broad at base as at apex; propodeum long, nearly straight above in profile, transversely finely striate, apophyses subobsolete; areolet subquadrangular, subsessile; recurrent interstitial, strongly curved throughout; nervulus postfurcal by about half its length; postnervulus broken at upper third; nervellus broken at a right angle at its upper third; legs slender; apical joint of middle tarsus hardly as long as third, claws small, with about eight large teeth. Abdomen slender; first tergite more than five times as long as wide at apex, spiracle at basal third; second tergite two and one-half times as long as wide at base, sides slightly divergent; sheath about two-thirds as long as first tergite.

Bright rufo-testaceous; orbits yellow; vertex black; face paler testaceous; antennae concolorous, fuscous apically; scutellum paler; wings hyaline, venation brownish, stigma and costa pale; legs concolorous, tibiae and tarsi paler; sheath pale fuscous.

Male.—Essentially like female but abdomen even more slender.

Type-locality.—South Fork of Eagle Creek, White Mountains, New Mexico.

Type.—Cat. No. 26000, U.S.N.M.

One female and four males all taken at the type-locality by C. H. T. Townsend.

PANISCUS GEMINATUS (Say).

? *Ophion chloris* OLIVIER, Encyc. Method. Ins., vol. 8, 1811, p. 509.

Ophion geminatus SAY, Contrib. Maclur. Lyc. Phila., vol. 1, 1828, p. 76 (LeConte ed., vol. 1, p. 379).

Paniscus geminatus NORTON, Proc. Ent. Soc. Phila., vol. 1, 1863, p. 364.—CUSHMAN and GAHAN, Proc. Ent. Soc. Wash., vol. 23, 1921, p. 169.

The identity of this species is discussed in the last mentioned reference above. It is the most abundant species in the East. With it in the National Collection have been confused many of the new species described above as well as *ocellatus* Viereck.

In its typical form this is a small species not exceeding 10 mm. in length, of uniform testaceous color with the vertex black, the ocelli distinctly separated from the eyes, the clypeus rather long and narrowly truncate, the propodeum finely transversely striate with apophyses weak, the antennae and legs slender with the apical tarsal joints and claws moderate, the latter with about eight large teeth in the female and somewhat more densely pectinate at the apex in the male than in the female.

It is represented in the National Collection by about sixty specimens of both sexes from New Hampshire to South Dakota, south to Florida and Texas. It probably is generally distributed throughout the United States and Canada east of the Rocky Mountains. Records of its occurrence outside of this region are probably due to mis-determination.

As with several of the species this species occurs in two forms, a majority of the specimens being conspicuously larger than the typical form. This large form, which is the one usually referred to in literature as *geminatus*, is described below.

PANISCUS GEMINATUS, variety SAYI, new variety.

Much larger than the typical form, ranging in size from 13 to 19 mm. in length and differing otherwise in having the ocelli contiguous with the eyes and the propodeal apophyses stronger.

Type-locality.—Falls Church, Virginia.

Type.—Cat. No. 26001, U.S.N.M.

The type series consists of five specimens of each sex, all from the vicinity of Washington, District of Columbia, selected from a series of about seventy-five. This variety has the same distribution as the typical form.

PANISCUS TEXANUS Ashmead.

Paniscus texanus ASHMEAD, Proc. U. S. Nat. Mus., vol. 12, 1890, p. 425.

The description of this species consists of a statement of a few characters by which it is said to differ from *geminatus* (Say). It is apparent that Ashmead's conception of *geminatus* was of a large insect, for he says of *texanus* that it is much smaller. As a matter of fact, it is slightly larger than the insect described by Say. In comparing the first and second flagellar joints Ashmead apparently looked at the upper or inner side in *texanus* and at the outer side in "*geminatus*," for, as a matter of fact, there is very little if any difference in the relative length of these two joints in the two species. The strength of the notauli is somewhat variable within a species, as are also the position of the nervulus in relation to the basal vein and the length of the ramulus.

Unfortunately the unique type of *texanus* lacks the abdomen and portions of many of the appendages. What is left has a somewhat different aspect from *geminatus*: the thorax is stouter, being nearly as high as long, with the dorsal sclerites, especially mesoscutum and scutellum relatively broader than in *geminatus*. This, together with the abdominal characters assigned to it by Ashmead and used in the above key should serve to distinguish it if it is actually specifically distinct. Certainly among the many specimens available for study there is none exactly like it in thoracic structure.

NORTH AMERICAN SPECIES OF PANISCUS NOT INCLUDED IN THE ABOVE KEY.

PANISCUS APPENDICULATUS Provancher.

Paniscus appendiculatus PROVANCHER, Nat. Can., vol. 6, 1874, p. 105.

Provancher himself reduced this to synonymy with *geminatus* (Say), but its yellow vertex excludes it from that species as here restricted. I am unable to recognize it definitely. It is probably either *spinipes* Cushman or *pallens* Cushman, but the characters by which those species are distinguished are not mentioned by Provancher.

NORTH AMERICAN SPECIES ERRONEOUSLY REFERRED TO PANISCUS.

The following species have been referred to *Paniscus* erroneously.

(PANISCUS) ALEXETER ALBOTARSATUS (Provancher).

This species has stood in *Paniscus* until very recently, when it was transferred by the present writer to *Alexeter*.

In his last mention of this species Provancher describes it as having the ocelli contiguous with each other, but A. B. Gahan, who has examined the type, notes that they are their own diameter from the eyes, which would indicate that they are small and not contiguous. This is the case with a specimen compared by Mr. Gahan with the

type. It is probable that Provancher's observation on this feature was taken on a specimen erroneously determined as *albotarsatus*.

(PANISCUS) ALEXETER CANALICULATUS (Provancher).

This species was transferred by its author to *Mesoleptus* and later by Davis to *Alexeter*.

S. A. Rohwer has examined the type and was of the opinion that Davis was correct in placing it in *Alexeter*. He also was of the opinion that it is the male of *Mesoleptus uniformis* Provancher, the type of which he also examined, despite its possession of the areolet which *uniformis* lacks. If the two are synonymous *canaliculatus* is the name to use as it has precedence.

(PANISCUS) MESOLECTUS INTERRUPTUS (Provancher).

According to notes on the type of this species, made by S. A. Rohwer, it will run in Davis's key to *Gausocentrus*, or, if the sculpture of the cheeks is ignored, to *Zemiodes*. In the latter genus it agrees fairly well with *Zemiodes coloradensis* Davis. Mr. Rohwer makes the further statement that it looks like *Hadrodactylus*. He notes that the three median areas of the propodeum are confluent, the bounding carinae nearly parallel, the costulae present, the propodeum shining, the notauli obsolete, the gastrocoeli large, and the carinae of the first tergite not reaching the apex. I have been unable to find any specimen in the National Collection that agrees entirely with Provancher's description and Mr. Rohwer's notes.

(PANISCUS) QUEBECENSIS (Provancher) = EXETASTES SUAVEOLENS Walsh.

Provancher himself reduced his species to synonymy. Mr. Rohwer was unable to find the type of *quebecensis*, but notes that all the specimens in the Provancher collection under *suavcolens* are the same.

(PANISCUS) RUFULUS (Provancher) = ASTIPHROMMA UNIFORMIS (Cresson).

Provancher transferred this species to *Mesochorus*. Comparison of specimens of *uniformis* with Provancher's description together with A. B. Gahan's notes on the type of *rufulus* leaves no doubt that it is synonymous with *uniformis*.

(PANISCUS)? CLEPSIPORTHUS SEMINIGER (Provancher).

Provancher transferred this species to *Mesoleptus* and Davis, without seeing the type, referred it to *Alexeter*. Mr. Rohwer ran the type, in Davis's key, to *Clepsiporthus*, where the presence of the areolet distinguishes it from *rubiginosus* (Cresson). I have seen no specimen that agrees exactly with the description, the nearest thing to it being an undetermined specimen that I would refer to *Alexeter*. This specimen differs only in having the head largely black instead of red.

Genus PARABATES Foerster.

Parabates FOERSTER, Verh. nat. Ver. preuss Rheinl., vol. 25, 1868, p. 150.

Parabatus THOMSON, Opusc. Ent., fasc. 12, 1888, p. 1194.

Opheltoideus ASHMEAD, Proc. U. S. Nat. Mus., vol. 23, 1900, p. 95.

Apatagium ENDERLEIN, Stett. Ent. Zeit. 1912, p. 115.

Bradley has recognized both *Parabates* and *Parabatus* as subgenera of *Paniscus*, restricting the former to those species that have the areolet incomplete.

That the bases of *Parabates* and *Opheltoideus*, that is the specimens on which their authors based these genera, really belong to the genus as at present recognized I do not believe; for in his manuscript, so frequently referred to by Schmiedeknecht and recently become the property of the Bureau of Entomology, Foerster indicated as the type of his genus an undescribed species the specific name of which indicates that it was tricolored, a character quite foreign to the present genus; and the fact that Ashmead called his genus *Opheltoideus* would seem to indicate that it had greater similarity to *Opheltes* than to *Paniscus*. But so far as their published descriptions go there is no way to distinguish them from the present conception of *Parabates*, and the only course left open is to treat them as they are here treated.

This genus differs constantly from *Paniscus* only in lacking the occipital carina, though its species usually have the ovipositor short, and in *Paniscus* the nervulus is usually distinctly postfurcal.

The species of *Parabates* divide naturally into two groups on the length of the ovipositor, some having it very short while others have it approaching in length that of *Paniscus*. In the North American species at least this is accompanied by a difference in the comparative length of the apical tarsal joint. The latter character can be used for separating the males of the two groups.

The North American species may be distinguished by the following key:

KEY TO THE NORTH AMERICAN SPECIES OF PARABATES.

1. Ovipositor very short, the sheath not extending above top of apical truncature of abdomen; apical joint of hind tarsus in female nearly or quite as long as third, in male longer than fourth 2.
 Ovipositor long, sheath linear; apical joint of hind tarsus in female much shorter than third, in male not longer than fourth..... 5.
2. Lateral portions of apical carina represented at most by weak noncarinate elevations..... 3.
 Lateral portions of apical carina more or less distinct..... 4.
3. First tergite without sculpture; 13 mm.....*deceptor* (Morley) Bradley.
 First tergite minutely shagreened; less than 10 mm.....*smithi*, new species.
4. Postscutellum margined to apex and usually with a more or less distinct transverse sharp ridge or carina, abdomen slender, first tergite more than three times as long as wide at apex, second nearly twice as long as wide at base.
 *cristatoides*, new species.
 Postscutellum not margined to apex and without a transverse sharp ridge or carina; abdomen stout, first tergite less than three times as long as broad at apex, second not nearly twice as long as wide at base.....*crassus*, new species.
5. Apical carina of propodeum strong laterally, represented in male by distinct transverse elevations; areolet large, distinct; nervellus broken at or below upper third*exsertus*, new species.
 Apical carina of propodeum wanting; areolet small, frequently incomplete; nervellus broken at or above upper fourth.....*monticola* Cushman.

PARABATES DECEPTOR Morley.

Parabatus deceptor MORLEY, Rev. Ichn. Brit. Mus., p. 2, 1913, p. 129, male.

Paniscus (Parabatus) latungula, subspecies *deceptor*, BRADLEY, Bull. Brooklyn Ent. Soc., vol. 13, 1918, p. 105, female.

Morley's original description based on a unique male from Nova Scotia and including both key characters and those of the formal description is very brief as follows: Stout; 13 mm.; antennae shorter and stouter than in *cristatus* Thomson; scutellum not margined; propodeal carina wanting, with apophyses obsolete; stigma broad, flavescent; gastrocoeli deep.

Bradley professed to recognize it in a female from Ithaca, New York, and reduced Morley's species to subspecific rank under *latungula* Thomson.

I am unable to identify it among the species in the National Museum.

PARABATES SMITHI, new species.

Female.—Length 9 mm.

Minutely shagreened, subopaque; temples sharply convexly narrowed; face about as long as broad, medially elevated; clypeus short, broadly concavely arcuate at apex; malar space obliterated; ocelli very narrowly separated from eyes, ocell-ocular line two-thirds the diameter of an ocellus; antennae slightly longer than body, very slender, middle joints more than twice as long as thick. Thorax minutely sparsely punctate, especially on mesoscutum and mesopleura; scutellum sharply margined to apex; postscutellum margined but not transversely cristate; propodeum very finely and obscurely transversely striate, apical carina indicated laterally by faint rounded elevations; legs slender, apical joint of hind tarsus subequal to third; areolet small, petiolate; nervellus broken at about upper third. First tergite slightly more than three times as long as broad at apex, second less than twice as long as broad at base; ovipositor short, sheath narrow lanceolate, not extending above apical truncature of abdomen.

Pale testaceous, thorax nearly stramineous laterally; face, frons, vertex, posterior orbits, and clypeus yellow; antennae concolorous; hind tarsi stramineous; wings hyaline, venation pale.

Male.—Like female except that ocelli touch the eyes, the abdomen is barely compressed at apex, and the apical joint of hind tarsus is relatively shorter though still distinctly longer than the fourth joint.

Type-locality.—Coleta, Alabama.

Type.—Cat. No. 26002, U.S.N.M.

Described from the following specimens: All in the National Museum; the type and allotype taken by H. H. Smith; one female from Coosa River, Chilton County, Alabama (H. H. Smith); one

female from North Carolina (collection of T. Pergande); one female from Falls Church, Virginia (R. C. Shannon); three females and one male from Rosslyn, Virginia (H. H. Smith); one female from Plummer Island, Maryland (H. S. Barber); two females from Georgetown, District of Columbia (H. H. Smith); one male from Philadelphia, Pennsylvania, (collection of W. J. Fox). These thirteen specimens exhibit but little variation, the greatest being in the comparative length and width of the face and of the second tergite.

PARABATES CRISTATOIDES, new species.

At once distinguishable from the foregoing species by its strong lateral traces of the propodeal carina and transversely cristate post-scutellum, as well as its larger size.

Very closely related to *cristatus* Thomson but differing constantly in the longer apical tarsal joint, which in *cristatus* is distinctly shorter than the third and in the present species almost exactly as long; in *cristatus* also the abdomen is distinctly stouter, the second tergite being much less than twice as long as wide at base.

Female.—Length 15 mm.

Shining, very faintly shagreened, only the mesoscutum and propodeum subopaque; temples strongly convex but narrow; ocelli touching eyes; face hardly as long as broad, laterally impressed, medially, elevated; clypeus rather flat, arcuately truncate at apex; antennae about as long as body, slender, middle joints twice as long as thick. Scutellum carinately margined to middle, thence ridged to apex; postscutellum laterally carinate and medially transversely cristate; propodeum transversely striate, lateral portions of apical carina strong, the area behind it concave on each side and polished; legs slender; apical joint of hind tarsus almost as long as third; areolet large, briefly petiolate; nervellus broken at about upper third. Abdomen rather slender, the first tergite more than three times as long as broad at apex and the second nearly twice as long as broad at base; ovipositor short, the sheath narrow lanceolate not reaching above top of apical truncature of abdomen.

Ferruginous with antennae and legs concolorous, head largely yellow, hind tarsi stramineous, venation pale.

Male.—Differs practically only in being more slender with abdomen only weakly compressed at apex, and having the apical tarsal joint relatively shorter though still much longer than fourth joint.

Type-locality.—Kaslo, British Columbia.

Type.—Cat. No. 26003, U.S.N.M.

Four females and two males taken at the type-locality by R. P. Currie; two females from Washington; and one male from Fort Wrangle, Alaska.

The size is uniform except for one female which is only 9 mm. long.

PARABATES CRASSUS, new species.

Female.—Length 11 mm.

Subopaque shagreened; temples sharply convexly narrowed; ocelli touching the eyes; face broader than long, medially convex, sparsely punctate, clypeus short, broadly truncate; malar space practically obliterated; antennae (broken) with middle joints less than twice as long as thick. Thorax stout; mesoscutum minutely punctate, notauli sharply impressed nearly to middle; scutellum broad, margined to somewhat beyond middle, closely punctate; mesopleurum shining, especially above, sparsely punctate below; metapleurum and propodeum obscurely, finely, transversely striate, propodeum behind apical carina shining and obscurely roughened, lateral portions of carina fine but distinct; apical joint of hind tarsus as long as third; areolet distinctly petiolate; nervellus broken at about upper fourth. Abdomen stout, first tergite distinctly less than three times as long as broad at apex, second hardly a half longer than broad at base; ovipositor short, sheath narrow lanceolate, not extending above apical truncature of abdomen.

Pale ferruginous with antennae and legs concolorous; head largely yellow; tarsi and tibiae somewhat paler; wings hyaline, venation pale.

Type-locality.—Oswego, New York.

Type.—Cat. No. 26004, U.S.N.M.

One female taken May 25, 1895.

PARABATES EXSERTUS, new species.

Female.—Length 13 mm.

Temples strongly convexly narrowed; ocelli large, touching the eyes; face as long as wide, medially elevated, laterally concave, minutely subopaquely shagreened, with scattered weak punctures; clypeus sculptured like the face, concavely truncate at apex; antennae slender, middle joints about twice as long as thick. Thorax very finely subopaquely shagreened; pronotum weakly obliquely striate in the impression; mesoscutum impunctate, notauli finely impressed to middle; scutellum margined only at extreme base; postscutellum neither margined nor transversely carinate; mesopleurum finely and rather closely punctate; propodeum finely transversely striated above, with sharp lateral portions of apical carina, the area behind the carina distinctly concave on each side; legs slender, apical joint of hind tarsus about three-fourths as long as third joint; areolet large, barely petiolate, nervulus subinterstitial and reclivous; nervellus broken at about upper third. Abdomen slender, strongly compressed, first tergite more than three times as long as broad at apex, second twice as long as broad at base; sheath nearly as long as first tergite.

Flavo-ferruginous; head including vertex largely, thorax laterally, lateral margins of mesoscutum, notauli, and scutellum flavous; antennae ferruginous; legs concolorous; wings hyaline, stigma pale, veins dark.

Male.—Much like female, but propodeal carina replaced by strong noncarinate ridges and abdomen not compressed.

Type-locality.—Rosslyn, Virginia.

Type.—Cat. No. 26005, U.S.N.M.

Described from one female and one male (the type and allotype) collected by T. Pergande, one female from Georgetown, District of Columbia, and two from Pysiton, Clay County, Alabama, the last three collected by H. H. Smith.

PARABATES MONTICOLA Cushman.

Perilissus paniscoides ASHMEAD, Trans. Amer. Ent. Soc., vol. 23, 1896, p. 187 (excluding female).

Paniscus albotarsatus Provancher, DAVIS, Trans. Amer. Ent. Soc., vol. 24, 1897, p. 253 (not Provancher).

"*Ctenacme monticola* Ashm. MS.," SLOSSON, Ent. News, vol. 11, 1900, p. 320.

Parabates monticola CUSHMAN, Proc. U. S. Nat. Mus., vol. 61, Art. 8, 1922, p. 20.

Much smaller than *exsertus* and easily distinguishable by the key characters.

The areolet is very variable, the second intercubitus being sometimes entirely wanting and sometimes normally developed, that is, distinct above and hyaline below.

NOTES ON CESTODE PARASITES OF SHARKS AND SKATES.

By EDWIN LINTON,

Of the Medical Department of the University of Georgia, Augusta.

INTRODUCTION.

While this paper was prepared for publication at the medical department of the University of Georgia, the greater part of the laboratory work upon which it is based was done while I was enjoying the privileges of the laboratories of the United States Bureau of Fisheries, Woods Hole, Massachusetts, and the zoological department of the University of Missouri.

All collections made in the Woods Hole region in the months from September to June, inclusive, with the exception of a few dates in the early part of September and the latter part of June, were made by the late Vinal N. Edwards, whose collections were made during a long series of years, and in all the months of the year. Some of this material proves to be new; some of it makes it possible to revise and add to earlier descriptions, which were often regrettably meager; much of it supplies new records of habitats, and of seasonal distribution.

In all cases where the locality from which material was obtained is not given, the Woods Hole region is to be understood.

Of the many examples of the encysted stages of selachian cestodes on which I have notes I have included but few which have not been satisfactorily identified. The most frequently recurring forms in the Woods Hole region are: *Otobothrium crenacolle*, *Rynchobothrium bulbifer*, *R. imparispine*, and *Tetrarhynchus bisulcatus*. A list of the intermediate hosts in which the larval cestode, *Phyllobothrium loliginis*, has been found was recently published (1922b).

The valuable Index Catalog of Stiles and Hassall¹ makes it unnecessary to burden this paper with extensive references to the literature. I have thought it best, however, to include references to those of my own papers which deal with the tapeworms of sharks and skates.

¹ Hygienic Laboratory, Bulletin 85, Washington, 1912.

It should be noted that the sharks recorded in the years prior to 1922 as *Carcharhinus obscurus* were probably either *C. commersonii* or *C. milberti*.

The scientific names of fishes mentioned in this paper are, for the most part, those used by Jordan and Evermann in their Fishes of North and Middle America. Departures from that nomenclature have been made at the suggestion of the Bureau of Fisheries.

LIST OF CESTODES NOTED IN THIS PAPER.

Those marked with an asterisk are either described in greater or less detail or have had additions or emendations made to former descriptions.

<i>Anthobothrium</i> * <i>laciniatum</i> .	* <i>Ichthyotaenia adherens</i> .
<i>pulvinatum</i> .	<i>Discocephalum peltatum</i> .
<i>Spongiobothrium variabile</i> .	<i>Otobothrium crenacolle</i> .
<i>Echeneibothrium variabile</i> .	<i>dipsacum</i> .
<i>Rhinebothrium flexile</i> .	* <i>penetrans</i> .
<i>longicolle</i> .	<i>Rhynchobothrium attenuatum</i> .
* <i>macallumi</i> .	<i>bulbifer</i> .
<i>minimum</i> .	* <i>exile</i> .
<i>Crossobothrium angustum</i> .	<i>heterospine</i> .
<i>laciniatum</i> .	<i>hispidum</i> .
* <i>Monorygma perfectum</i> .	* <i>insigne</i> .
<i>species</i> .	<i>imparispine</i> .
* <i>Orygmatobothrium forte</i> .	<i>lomentaceum</i> .
<i>paulum</i> .	<i>longicorne</i> .
<i>Anthocephalum gracile</i> .	<i>longispine</i> .
<i>Phyllobothrium foliatum</i> .	<i>speciosum</i> .
<i>Calyptribothrium minus</i> .	<i>tenuispine</i> .
<i>occidentale</i> .	<i>tumidulum</i> .
* <i>Trilocularia gracilis</i> .	* <i>uncinatum</i> .
<i>Lecanicephalum peltatum</i> .	<i>vagneri</i> .
<i>Calliobothrium eschrichtii</i> .	<i>species</i> .
<i>verticillatum</i> .	Larval stages, spe-
<i>Acanthobothrium paulum</i> .	cies not deter-
<i>coronatum</i> .	mined.
<i>Onchobothrium uncinatum</i> .	<i>Synbothrium filicolle</i> .
* <i>Phoreciobothrium exceptum</i> .	* <i>malleum</i> .
* <i>lasium</i> .	<i>Tetrarhynchus bicolor</i> .
* <i>pectinatum</i> .	<i>bisulcatus</i> .
* <i>triloculatum</i> .	<i>elongatus</i> .
* <i>Platybothrium cervinum</i> .	* <i>palliatum</i> .
* <i>parvum</i> .	<i>robustus</i> .
<i>Thysanocephalum thysanocephalum</i> .	<i>Scolex polymorphus</i> .
<i>Parataenia medusia</i> .	

NEW SPECIES.

CESTODE.	HOST.
<i>Ichthyotaenia adherens</i> -----	<i>Cestracion zygaena</i> .
<i>Orygmatobothrium forte</i> -----	<i>Cestracion zygaena</i> .
<i>Phoreciobothrium exceptum</i> -----	<i>Cestracion zygaena</i> .
<i>pectinatum</i> -----	<i>Cestracion zygaena</i> .

CESTODE.	HOST.
<i>Rhinebothrium maccallumi</i> -----	<i>Dasybatis centrura</i> .
<i>Rhynchobothrium insigne</i> -----	<i>Carcharhinus milberti</i> .
<i>uncinatum</i> -----	<i>Vulpecula marina</i> .
<i>Synbothrium malleum</i> -----	<i>Dasybatis centrura</i> .
<i>Tetrarhynchus palliatus</i> -----	<i>Cestracion zygaena</i> .

LIST OF PAPERS BY THE AUTHOR ON SELACHIAN CESTODES, OR IN WHICH
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- 1889b. Notes on Entozoa of Marine Fishes of New England. Report U. S. Fish Commission for 1886, pp. 453-511, pls. 1-6.
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1900. Fish Parasites collected at Woods Hole in 1898. *Bulletin U. S. Fish Commission for 1899*, pp. 267-304, pls. 33-43.
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- 1907a. An Abnormal Cestode Proglottid. *Biological Bulletin*, vol. 12, pp. 155-157, figs. 1, 2.
- 1907b. A Cestode Parasite in the Flesh of the Butterfish. *Bulletin U. S. Bureau of Fisheries*, vol. 26, pp. 111-132, pls. 1, 2.
- 1907c. Notes on *Calyptrobothrium*, a Cestode Genus in the Torpedo. *Proceedings U. S. National Museum*, vol. 32, pp. 275-284, figs. 1-8.
- 1907d. Notes on Parasites of Bermuda Fishes. *Proceedings U. S. National Museum*, vol. 33, pp. 85-126, pls. 1-15.
- 1907e. Preliminary Report on Animal Parasites of Tortugas. *Fifth Year-book of the Carnegie Institution of Washington*, pp. 112-117.
- 1908a. Second Report on Animal Parasites of Tortugas. *Sixth Year-book of the Carnegie Institution of Washington*, pp. 114-116.
- 1908b. Helminth Fauna of the Dry Tortugas. I. Cestodes. Publication 102, Carnegie Institution of Washington; Papers from the Tortugas Laboratory, 1, pp. 157-190, pls. 1-11.
- 1908c. Preliminary Report on Helminths collected at the Dry Tortugas in 1908. *Seventh Year-book of the Carnegie Institution of Washington*, pp. 124-127.

- 1910a. Notes on the Distribution of Entozoa of North American Marine Fishes. Proceedings 7th International Zoological Congress (Boston, 1907), pp. 686-696.
- 1910b. Notes on the Flesh Parasites of Marine Food Fishes. Bulletin U. S. Bureau of Fisheries, vol. 28, pp. 1195-1209.
1911. In "Biology of Woods Hole and Vicinity." Bulletin U. S. Bureau of Fisheries, vol. 31, pt. 2, pp. 585-589.
1912. Cestode Cysts in the Flesh of Marine Fish, and their Bearing on Food Values. Transactions American Fisheries Society for 1912, pp. 1-9.
1914. On the Seasonal Distribution of Fish Parasites. Transactions American Fisheries Society for 1914, pp. 48-56.
1915. Fish Parasites and the Public Health. Transactions American Fisheries Society for 1915, pp. 19-28.
1916. Notes on two Cestodes from the Spotted Sting Ray. Journal of Parasitology, vol. 3, pp. 34-38, pl. 1, text-figs. 1, 2.
1921. *Rhynchobothrium ingens* sp. nov., a Parasite of the Dusky Shark. Journal of Parasitology, vol. 8, pp. 22-32, pls. 4, 5.
- 1922a. A Contribution to the Anatomy of *Dinobothrium*. Proceedings U. S. National Museum, vol. 60, pp. 1-13 (author's reprint), pls. 1-4.
- 1922b. A New Cestode from the Maneater and Mackerel Sharks. Proceedings U. S. National Museum, vol. 61, pp. 1-16, pls. 1-3 (author's reprint).

ANTHOBOTHRIUM PULVINATUM Linton.

- 1890, pp. 754-759, pl. 3, figs. 10-13; pl. 4, figs. 1-3.
- 1897a, pp. 439-440, pl. 33, fig. 1.
- 1900, p. 275.
- 1901, p. 432.
- 1905, p. 346, fig. 125.
- 1910a, p. 695.
- 1911, p. 585.

Records of this cestode not before published:

Dasybatis centrura.

Collected in six of the years from 1903 to 1922, inclusive: On 1 date in June, 1, and a few free proglottides; length in sea water 150 mm., lengthening to 340 mm. after lying in fresh water for half an hour; on 3 dates in August, 1 on each date, maximum length 280 mm., a few free proglottides on one date; on 2 dates in September, 1 and a few free proglottides on one date, 3 on the other; on 1 date in October, 1 and a large number of free proglottides, length 175 mm. (U.S.N.M., Helm. Coll. 7731.)

Squalus acanthias.

1912, May 22: 1, length 115 mm. Other dimensions of formalin specimen: Diameter of scolex 2.75, of neck 1.5; breadth of strobile, middle, 4; thickness of strobile, middle, 2.57. There were nine ripe proglottides, length of longest 5, breadth 3; ova, average of four, 0.048 by 0.028 in the two principal diameters. The ova have thin, transparent shells, and are oval with more or less pointed ends.

ANTHOBOTHRIMUM LACINIATUM Linton.

Plate 1, figs. 1-1c.

1890, pp. 754-759, pl. 3, figs. 10-13; pl. 4, figs. 1-3.

1897a, p. 439.

1900, p. 272.

1901, pp. 426, 427, 428, 429.

1905, pp. 339, 343, fig. 126.

1907c, p. 116.

1908b, p. 167.

1911, p. 585.

Cestodes referred to this species have been recorded from *Carcharhinus milberti*, *C. obscurus*, *C. platyodon*, *Isurus tigris*, and *Uestracion zygaena*. Following are records of finds of the species, with notes, not before published:

There is much variation in this species, especially in the character of the anterior portion of the strobile, which, for convenience, may be referred to as the neck. This fact was noted in the original description of the species when two varieties were distinguished and named *longicollis* and *brevicollis* respectively. In some instances the neck is longer relatively than is shown in the sketch of *longicollis*. Moreover, the first segments to appear are, in some cases, very short and devoid of laciniae, the laciniae appearing later. Thus, in three specimens from *C. obscurus*, the neck of one is 0.9 mm. in length, and is laciniate at the base; the neck of another is about 2.4 mm. in length, the first segments are very short and are not laciniate; the neck of the third is 0.32 in length and is laciniate. In a lot of these cestodes from *C. milberti*, all of which were long-necked, the neck of one was 1.75 mm. in length and laciniate, of another 2.9 mm. in length and non-laciniate, first segments also non-laciniate and very short. The neck and strobile are armed with short spines, a feature not noted in the original description, but mentioned in connection with record of specimens from the sharp-nosed shark collected at Beaufort, N. C.

The differences between strobiles which are weakly laciniate and those which are strongly laciniate would call for specific differentiation were it not for the existence of intermediate forms. The only differentiation that seems to be at all practicable would be the recognition of two groups, one having the neck of variable length but laciniate at base, and the proglottides beginning abruptly; the other having the neck more or less elongated, non-laciniate at base, the proglottides beginning as closely crowded, transverse striae.

Since strobiles of the first group are either smooth or with but faint indication of spines, and more or less flaccid, while strobiles of the second group are of firmer texture and densely spinose, I am

inclined to regard the strobiles of the first group as older than those of the second group.

Anatomy of a proglottis.—The genital apertures are irregularly alternate, and situated at about the anterior third of the length; in a segment 3.5 mm. in length the genital pore was 1.2 mm. from the anterior end. The cirrus is long and slender, bulbous at base and spinous. The vas deferens is voluminous, situated antero-medially to the base of the cirrus-pouch in a bend of the vagina. The testes fill the median region of the proglottis from the ovary to the anterior end. The vagina opens at the common pore anterior to the cirrus. In some cases it makes a loop-like bend around and in front of the dense mass of coils of the vas deferens, then follows the median line to near the posterior end, where it narrows to a slender sperm duct near the shell gland. The ovary forms two wing-like lobes, symmetrically placed with reference to the median line at the extreme posterior end of the proglottis. The shell gland is enclosed between the posterior halves of the lobes of the ovary. The vitelline glands are conspicuous, deeply staining bodies, as seen in whole mounts, lying along the lateral margins of the proglottis, from the ovaries to the anterior end. Outlines of the uterus are not clearly shown in my preparations; ova in ripe proglottides are distributed throughout the interior in front of the ovary, in some cases most abundant from the middle to the anterior third, where they may appear as a dense mass. The ova spherical, thin shelled, often collapsed in mounted segments, and 0.015 mm. in diameter, more or less.

Carcharhinus milberti.

Collected in three of the years from 1915 to 1922: On two dates in July, 4 and 13, with many free proglottides, 2 sharks, length 112 centimeters; on six dates in August (on one date, few in 1 of 6 sharks), 1 to 15, with many free proglottides, in each of 7 sharks, 112 to 210 centimeters in length, maximum length of strobile 18 mm.; on one date in September, 10, length about 20 mm., the anterior unsegmented portion slender and armed with short, bristly spines.

(U.S.N.M., Helm. Coll. 7659.)

C. commersonii.

1922, August 7: 2 from a 112 centimeter shark.

1923, August 6: 7, maximum length 60 mm., and a large number of free proglottides, from a 290-centimeter shark.

August 7: 19, maximum length 40 mm., from a 321-centimeter shark.

August 15: 115, maximum length 30 mm., from a 153-centimeter shark. One in each of 3 out of 7 sharks examined on three other dates in August.

C. obscurus.

Collected in nine of the years from 1905 to 1918: On four dates in July, few to many, maximum length 26 mm. (one date, few in 1 of 3 sharks), 6 sharks examined; on eight dates in August, 1 to numerous in each of 11 sharks; on three dates in September, 2 to 12, and numerous free proglottides, in 3 sharks.

It is to be remarked that the size of the host is no index of the number of parasites. For example, 3 of this cestode were found in a shark measuring 305 centimeters in length, many in a 110 centimeter shark, and 1 in a 165 centimeter shark.

It is likely that many of the sharks of the Woods Hole region, recorded as *C. obscurus*, were either *C. milberti* or *C. commersonii*. With the identification of species based on the character of the denticles, *C. milberti* was found to be abundant. *C. commersonii* was noted, *C. obscurus* was not seen. For many of the identifications of sharks in the summer of 1922 I am indebted to Dr. H. M. Smith. In the summer of 1923 the 17 sharks belonging to the genus *Carcharhinus* that were examined were all found to be *C. commersonii*.

Cestracion zygaena.

1908, August 3: Several small strobiles and fragments, scoleces macerated, one of them evidently *A. laciniatum*.

Galeus glaucus.

1905, August 5: 12, rather, small scoleces of most of them imperfect, apparently macerated: two were filiform at the anterior end.

1913, July 5: Several fragments, but no scoleces.

1923, July 23: 46, from a 245-centimeter shark; all small, maximum length 10 mm.

Raja eglanteria.

1905, August 12: 2 scoleces. Referred with some hesitation to this species. A memorandum sketch of the ova shows them to be circular in outline, with a thin shell which is separated from a segmenting cell mass by a clear space; diameter of shell 0.03, of cell mass 0.02. A memorandum sketch of an everted cirrus shows it to be slightly constricted near the base, then swollen and tapering gradually to the tip, and armed with short spines (fig. 1c).

Scoliodon terrae-novae.

1915, July 15: Few.

SPONGIOBOTHRIUM VARIABILE Linton.

1889, pp. 462-464, pl. 2, figs. 13-19.

1890, pp. 778-780.

1897a, p. 442.

1900, p. 275.

1901, p. 433.

1905, p. 347.

1908b, p. 168.

1910a, p. 695.

1911, p. 589.

Records of this cestode not before published:

Dasybatis centrura.

Collected in six of the years from 1903 to 1922, inclusive: On two dates in June, few on one date, 4 and fragment on the other; on one date in July, 40, bothria mobile, in some cases with rather long and slender pedicels, and with a tendency to attach themselves to the bottom of the dish; on two dates in August, many on one date, collected by Dr. G. A. MacCallum, 1, length 40 mm., in alcohol, on the other; on two dates in September, few on one date, 10 on the other, bothria seen to be pedicellate; on one date in October, 4, maximum length 40 mm.

1923: On one date in July and one in August; 1 on each date; length 30 mm.

(U.S.N.M., Helm. Coll. 7660.)

ECHENEIBOTHRIUM VARIABILE van Beneden.

1889b, pp. 460-462, pl. 1, figs. 9-13.

1890, pp. 766-767.

1897a, p. 440.

1900, p. 274.

1901, p. 431.

1911, p. 586.

Records of this cestode not before published:

Raja diaphanes.

Collected in 12 of the years from 1904 to 1916, inclusive: On 4 dates in April, 30 skates examined; 1 to 3 strobiles, maximum length 30 mm. On 10 dates in May, 51 skates examined, 1 to 3 strobiles, maximum length 90 mm.; numerous free, ripe proglottides on 3 dates; on one date 35 skates were examined, and but 1 strobile found, length 10 mm. On 1 date in June, 1 skate examined; 2 strobiles, length 45 mm., and a few free, ripe proglottides, largest 8 mm. in length. On 2 dates in August; 2 skates examined; 2 strobiles. On 2 dates in September; 1 to 3 strobiles, maximum 30 mm., and a few free proglottides. On 12 dates in October; 74 skates examined; 1 to 14 strobiles, maximum 30 mm. free proglottides on one date. On 2 dates in November; 1 to 3 strobiles, maximum 25 mm.

Not found in large numbers in this skate. For example: On May 15, 1914, 14 strobiles were found in 1 of 35 skates examined for parasites by Mr. Edwards.

A scolex, stained and mounted by Dr. G. A. MacCallum on August 17, 1914, showed that there are 8 loculi on each bothrium, one at each end, and separated by three paired loculi

Raja eglanteria.

1910, September 21: Free proglottides, about 15, largest about 6.5 by 2 mm.

Raja erinacea.

Collected in 6 of the years from 1905 to 1913, inclusive: On 1 date in April, 1, length 21 mm.; on 2 dates in July, 6, and free proglottides on 1 date, 4, each 100 mm., or more in length, slender, on the other; on 2 dates in August, 2, small, and a few free proglottides on 1 date, number not recorded on the other, large and small, maximum length 60 mm., in alcohol; on 1 date in October, 3 and a few fragments, from 2 skates; on 1 date in November, many free proglottides.

-(U.S.N.M., Helm. Coll. 7661.)

R. stabuliformis.

Collected in 4 of the years from 1907 to 1916, inclusive: On 2 dates in April, 1 length 45 mm., on 1 date, 4, with numerous fragments, and free proglottides on the other; on 1 date in May, a few short chains of immature proglottides, 2 with scoleces, and a large number of free proglottides, largest from 5 to 8 mm. in length, and from 2 to 3 mm. in breadth. One immature scolex, which appears to belong to this species, would probably have been recorded as *Scolex polymorphus* if it had not been associated with scoleces of *E. variabile*. On 1 date in June, 1, and free proglottides; on 2 dates in October, 1, length 10 mm. on 1 date, 1 and a few fragments on the other.

RHINEBOTHRIUM FLEXILE Linton.

1890, pp. 768-771; pl. 5, figs. 3-5.

1900, p. 275.

1901, p. 433.

1905, pp. 342, 347.

1908a, p. 167.

1910a, p. 695.

1911, p. 587.

Records of this cestode not before published:

Dasybatis centrura.

Collected in 6 of the years from 1903 to 1922, inclusive: On 1 date in July, 3; on 2 dates in August, 1 on 1 date, 12 on the other, collected by Dr. G. A. MacCallum; on 3 dates in September, 1 to 15.

(U.S.N.M., Helm. Coll. 7662.)

1923: 20 on one date in July, maximum length 16 mm.; 4 on one date in August, all small.

Larval stage.

Scomber colias.

1910, August 22: A cyst from the viscera of a chub mackerel contained a larval *Rhinebothrium* which appears to belong to this species. The cyst measured 1 by 0.17 mm., and was thin walled; blastocyst not satisfactorily made out; larva with strap-shaped bothria, provided with many loculi, and hinged in the middle, so that the scolex, when flattened under the cover glass, appeared to have eight bothria directed forward; length of bothrium 0.7 mm.

RHINEBOTHRIUM LONGICOLLE Linton.

1890, pp. 775-778, pl. 6, figs. 1-4.

1897a, p. 441, pl. 33, figs. 2-4.

1900, p. 275.

1901, pp. 433, 434.

1911, p. 585.

Records of this species not before published.

Dasybatis centrura.

1914, August 1: 6, collected by Dr. G. A. MacCallum.

Myliobatis freminwillii.

1903, July 11: 5 strobiles with scoleces, and about 8 with scoleces missing; length of longest about 28 to 30 mm.

(U.S.N.M., Helm. Coll. 7663.)

Rhinoptera quadriloba.

1917, July 12: 40, mostly adult and measuring as much as 100 mm. when straightened out in the killing fluid with camel's hair brushes; ripe segments 3 mm. in length: two small strobiles measured 15 and 24 mm. in length, respectively.

RHINEBOTHRIUM MINIMUM (Beneden)

1897a, pp. 441-442, pl. 33, fig. 5.

1901, p. 431.

1911, p. 587.

Records of this cestode not before published:

Raja eglanteria.

1906, May 14: 5 strobiles with scoleces, with fragments and free proglottides.

Raja stabuliformis.

Collected in 5 of the years from 1904 to 1914, inclusive; on 1 date in April, 2 scoleces with short strobiles, about 5 mm. in length, and numerous free proglottides; on 3 dates in May, 1 to 2 with numerous free proglottides; on 1 date in October, 1.

(U.S.N.M., Helm. Coll. 7664.)

RHINEBOTHRIUM MACCALLUMI, new species.

Plate 1. figs. 2-4.

Scolex with four, short-pedicelled bothria, which, when flattened, are nearly elliptical, being slightly narrowed at the anterior end (fig. 3), each provided with about 16 pairs of loculi (fig. 4); neck practically none.

Strobile filiform, slightly swollen near the junction with the scolex; segments begin near the scolex, at first as fine transverse lines; first distinct segments much shorter than broad, increasing in length gradually, becoming longer than broad; adult proglottides not seen, last proglottides slender and rod-like with length three times the breadth.

Dimensions of specimen mounted in balsam (fig. 2): Length 28; bothrium, length 1.05, breadth 0.50; diameter, at junction of strobile and scolex 0.18, at enlargement back of junction 0.21, at point 1 mm., back of junction 0.16, at middle of length of strobile 0.18; distance to first distinct segments 2.8; length of first distinct segment 0.02, breadth 0.16; length of segments at middle of strobile 0.21, breadth 0.18; length of last segment 0.48, breadth 0.16; average length of last 10 segments 0.40.

There were approximately 150 segments in the last 24 mm. of the strobile.

The bothria in one of the mounted specimens were flattened so as to show the plan of loculi. In this specimen they were as shown in figure 4, that is, 16 pairs, with an odd, terminal loculus at the anterior end.

Adult proglottides were not seen, but from the positions of rudiments of cirrus-pouches, the genital apertures were seen to be irregularly alternate, near the middle of the length of the proglottis, and near the lateral margin.

Type.—U.S.N.M., Helm. Coll. 7665.

Dasybatis centrura.

1922, July 15: 3, from spiral valve of a large sting ray.

1923, August 20: 3.

CROSSOBOTHRIMUM ANGUSTUM (Linton).

Plate 1, fig. 5.

1889b (*Orygmatobothrium angustum*), pp. 463-469, pl. 3, figs. 1-3.

1890, pp. 796-799, pl. 7, fig. 3.

1897a, p. 443.

1900, p. 272.

1901 (*C. angustum*), pp. 426, 427.

1905, pp. 339, 343.

1908a, p. 114.

1910a, p. 693.

1911, p. 585.

Records of this cestode not before published:

Carcharhinus commersonii.

1907, July 26: 3 strobiles, and a few fragments; collected by Dr. Davenport Hooker, at Tortugas, Florida.

1923. On 7 dates in August, and one in September: Many, 14, 57, 1, 1, 1, 1, 5, 3; maximum length noted 34 mm.

Carcharhinus limbatus.

1915, August 6: 175, and numerous free proglottides in spiral valve.

1923, August 23: 55, very slender, maximum length 80 mm., from a 199-centimeter shark.

Carcharhinus milberti.

See page 7 for remarks on the species *C. milberti* and *C. obscurus*.

This is a common parasite of this and of the dusky shark, where it is usually associated with other small cestodes in the spiral valve. For example, the record for July 3, 1922, shows 6 *C. angustum*, 69 *A. laciniatum*, and 185 *P. lasium*, with large numbers of free proglottides in the spiral valve of a shark.

Collected in the years 1915 and 1922. On 2 dates in July, 3 sharks examined, 31 in one, 6 in another, and few in another, the latter collected by Dr. G. A. MacCallum; on 8 dates in August, 17 sharks examined: (1) a few found in each of 3 out of 6 sharks; (2) very numerous; (3) 1 from each of 2 210-centimeter sharks; (4) 3, with free proglottides; (5) 5 from a 135-centimeter shark; (6) 113 from a 135-centimeter shark; (7) 9 from a 210-centimeter shark, 4, maximum length 22 mm., from a 210-centimeter shark, 71, maximum length 22 mm., from 165-centimeter shark, 24, maximum length 23 mm., from a 135-centimeter shark; (8) 36, with free proglottides.

Carcharhinus obscurus.

See page 7 for remarks on the species *C. milberti* and *C. obscurus*. See also under *C. milberti*.

Collected in 11 of the years from 1905 to 1918, inclusive: On 4 dates in July: (1) 200 or more, maximum length 20 mm.; (2) 30, young strobiles; (3) many; (4) few, in 1 of 3 sharks. On 7 dates in August: (1) to (4) numerous on each date, with large numbers of free proglottides; (5) 2, associated with 3 *A. laciniatum* and 8 *P. lasium*; (6) 33 in 1, and 3 in another of 3 sharks; (7) 14. On 9 dates in September: (1) few; (2) very numerous, with free proglottides, maximum length 20 mm.; (3) 50 or more, with many free proglottides, no other species found; (4) 8, with free proglottides, from 60-centimeter shark; (5) 20, maximum length 18.5 mm., with free proglottides; (6) 95, maximum length 23 mm., a few free proglottides; (7) 200 and over; (8) 8; (9) 1, length 20 mm. On 2 dates in October: (1) many with free proglottides; (2) 6, from 9 to 16 mm. in length.

(U. S. N. M., Helm. Coll. 7666.)

Carcharias taurus.

1905, August 8: 1 strobile with scolex, and easily separating, but mature, segments.

Galeocerdo arcticus.

1907, August 7: 5. The scoleces are in agreement with this species; the strobiles are rather longer, about 30 mm., in balsam, than is usual in this species; little change in the proportions made by the killing fluid.

1912, August 19: 2.

1915, July 31: Few.

Galeus glaucus.

1905, August 5: 20, very small; from spiral valve of young shark about 90 centimeters in length.

1923, July 23: 52, small, maximum 8 mm., from a 945-centimeter shark.

Vulpecula marina.

1914, July 23: 10, small, 7 to 10 mm. Dimensions of living specimen, in sea water: Length, 7.5; bothria, variable, length of one expanded and attached to slide, 0.52, breadth 0.45, diameter of acetabulum, 0.07; distance to first segment 3; first distinct segment, length, 0.19, breadth 0.18; last segment very variable, approximate length 0.70, breadth 0.45. The last segments separate from the strobile easily; length of free proglottis 2.65, breadth 0.78. The ova in this species are characteristically fusiform.

1922, August 23: 4. The bothria in this species, as I have usually seen them, are somewhat narrowed in the vicinity of the acetabula, especially while actively extending themselves. In this lot from the thrasher shark the bothria were rather oblong-elliptical, even

when they were actively contracting and extending. Length, 5.5, straightened in alcohol, in which they showed a tendency to contort: 4 free segments.

1923, August 28: 9, small, from a 173-centimeter shark.

CROSSOBOTHRUM LACINIATUM Linton.

1889*b*, pp. 469-474, pl. 3, figs. 4-18.

1890, pp. 799-802, pl. 7, fig. 4.

1897*a*, pp. 445-446.

1900, p. 273.

1901, p. 429.

1910*a*, p. 694.

1910*b*, p. 1200.

1911, p. 585.

Dr. W. C. Curtis, Biological Bulletin, vol. 5 (1903), pp. 125-142, figs. 1-8; vol. 11, (1906), pp. 202-228, pls. 4-7.

Following are records of this cestode not before published:

Carcharias taurus.

This cestode appears to be peculiar to the sand shark, from the spiral valve of which it is rarely absent.

Collected in 7 of the years from 1904 to 1922: On 4 dates in June: (1) 7 large, maximum 100 mm., a few small, and a few free proglottides; (2) very numerous, adult, young, and free proglottides; (3) 12, and numerous free proglottides, from a 150-centimeter shark; (4) few, no free proglottides, from a 105-centimeter shark. On 3 dates in July: (1) 108, large and small, from 2 sharks; (2) a few fragments of strobiles, and a few free proglottides; (3) 21, and a few free proglottides; among the strobiles were four with adult segments, beginning about 10 mm. back of the scolex. On 8 dates in August: (1) Numerous in each of 2 sharks; (2) 2 mature, 1 young; (3) few, large and small; (4) few, small; (5) 1 mature, free proglottis; (6) several, large and small; (7) numerous, some small, none with ripe proglottides; (8) 4, with many free proglottides, collected by Dr. G. A. MacCallum. On 8 dates in September: (1) very numerous, adult, young and free proglottides; (2) numerous in each of 2 sharks, adult, only 1 young noted, large numbers of free proglottides; (3) many, adult, young, and free proglottides; (4) numerous, a few young, many free proglottides; (5) numerous, a few young, many free proglottides; (6) 2 fragments; (7) 35 with scoleces, many without scoleces, and many fragments, great numbers of free proglottides, some of them unusually large, length 7 mm., breadth 3.5 mm.: young and adult, maximum length 120 mm., formalin material; (8) 1, from a 202-centimeter shark, and 91 from a 130-centimeter shark.

(U. S. N. M., Helm. Coll. 7667-7668.)

1923. On 4 dates in July and one in August; 3 to 40; few to great numbers of free proglottides; maximum length noted 100 mm.

NOTES ON CERTAIN GENERA BELONGING TO THE FAMILY PHYLLOBOTHRIIDAE.

In common with others who have attempted to classify Selachian Cestodes I have experienced much difficulty with those genera of the Phyllobothriidae which are characterized by having a scolex with four unarmed bothria, each provided with an auxiliary sucker at its anterior end, and without costae.

The generic names which I have used for members of this group are, *Anthocephalum* Linton, *Calyptrobothrium* Monticelli, *Crossobothrium* Linton, *Monorygma* Diesing, *Orygmatobothrium* Diesing, and *Phyllobothrium* Beneden.

As I have interpreted these genera they may be arranged according to the following scheme:

- | | |
|--|---------------------------|
| 1. Auxiliary acetabula relatively small, borders of bothria usually thin and flexible, often folded or crumpled..... | 3. |
| 2. Auxiliary acetabula more or less cup-shaped..... | 4. |
| 3. Bothria in pairs, leaf-like with crenulate borders..... | <i>Phyllobothrium</i> . |
| Bothria cruciform with crenulated borders..... | <i>Anthocephalum</i> . |
| Bothria cruciform, borders not crenulate..... | <i>Crossobothrium</i> . |
| 4. Bothria with sphincter muscle on border..... | <i>Orygmatobothrium</i> . |
| Bothria plain, acetabula cup-shaped..... | <i>Monorygma</i> . |
| Acetabula large, horseshoe shape..... | <i>Calyptrobothrium</i> . |

Consideration is not here given to two characters which are usually mentioned in descriptions of these genera, that is, the presence or absence of a myzorhynchus, and the pedicelled or sessile condition of the bothria.

As to these features it may be said that, whether the bothria are pedicelled or not, is often very difficult to determine in these strongly contractile forms, unless one has seen them when they were actively mobile. Furthermore, the presence or absence of a myzorhynchus, unless it is represented by a permanent sucker, as in *Echeneibothrium*, is of little importance, since it is an evanescent structure, found in a variety of larval forms, as for *Scolex polymorphus*, and may be retained more or less discernibly, in scoleces which have developed strobiles.

It is significant that Zschokke in his admirable monograph² gives evidence of the unsettled state of the systematic relations of such forms as are here being considered, as for example, *Orygmatobothrium* (*Phyllobothrium*) *dohrnii* Oerley, and *Anthobothrium* (*Orygmatobothrium*) *musteli* van Beneden; other examples could be cited.

² Recherch. sur Struct., etc., des Cestodes.

The material which I have does not warrant an attempt at the revision of these difficult forms. The foregoing observations are made in the hope that they may prove of assistance to future workers.

MONORYGMA PERFECTUM (van Beneden).

Plates 2 and 3, figs. 18-31.

Anthobothrium perfectum P. J. VAN BENEDEN, Mem. sur Les Vers Intestinaux, p. 125, pl. 17, figs. 11-14.

Diesing³ made the new generic name *Monobothrium* for this species. See Zschokke.⁴

For more complete bibliography, see Stiles and Hassall.⁵

The material here reported was obtained from the stomach of a sleeper shark (*Somniosus brevipinna*), Moser Bay, Alaska, June 3, 1903, and was sent to me by Dr. C. W. Stiles.

(U.S.N.M., Helm. Coll. 7669.)

There are three strobiles in the lot, measuring 55, 70, and 85 mm. in length, respectively. No free proglottides were present, but there were a few short chains of ripe segments. Following are measurements of the largest specimen: Length 85; breadth of scolex 3.50; length of bothrium 2.50; breadth of strobile behind scolex 2.50; length of segments 10 mm. back of scolex 0.07, breadth 3; 25 mm. back of scolex, length 0.21, breadth 3.50; 40 mm. back of scolex, length 0.28, breadth 5; 60 mm. back of scolex, length 0.56, breadth 5; average length of last 15 segments 0.86; breadth 4.50.

Five ripe proglottides, each with the uterus swollen with ova, and bulging out on the ventral side, were 4.75 in breadth, and of about uniform length, 1.6. The thickness through the projecting uterus hump was 2. When pricked, one of these proglottides liberated large numbers of fusiform ova, 0.09 by 0.03 in the two principal diameters.

Scolex.—As seen in alcoholic specimens the scolex is pyramidal, truncate in front. The bothria are pyriform, the posterior loculus deeply cup-shape, with rather thin, sharply defined borders. The anterior loculus (auxiliary acetabulum) is shallower, almost saucer shape. Transverse sections of the scolex show a central dense mass of deeply staining cells, marking the anterior termination of the axis of the scolex. This appears in five sections of the series, and represents a structure which is a little more than one-third the length of the anterior loculus of a bothrium, and is doubtless to be interpreted as the rudiment of a myzorhynchus (fig. 21).

³ Sitz. d. kais. Akad. d. Wissens., Wien, vol. 13, p. 583.

⁴ Recherch. sur la Structure Anatomique et Histologique des Cestodes, pp. 281-294; pl. 7, figs. 114-120.

⁵ Bulletin 85, Hygienic Laboratory, p. 276.

One conspicuous feature in scoleces of certain cestodes, as for example, *Calliobothrium*, mentioned by Zschokke⁶ as characteristic of *Monorygma perfectum*, that is the four muscular bands placed transversely at the level of the boundary between the accessory suckers and the bothria, seems to be entirely wanting.

Diesing makes the presence of a myzorhynchus a generic character of *Monorygma*. Zschokke does not mention this structure, although his admirable account of this species does not include a detailed description of the histology of the scolex. As stated above I find what I interpret as the rudiment of a myzorhynchus in the scolex of the Alaska material.

Strobile.—For a short distance back of the scolex there is no indication of segments, further than is shown by faint, transverse lines. About 4 mm. back of the scolex the lateral margins are minutely but regularly crenulate, and at a distance of 10 mm., definite segments can be distinguished, with a length of 0.07 and a breadth of 3 mm. For other dimensions, see foregoing measurements. The general habit is rather broad, and, especially in the region of ripe segments, thickish. Sections of proglottides, with uterus moderately filled with ova, show the thickness to be about one-third the breadth. The lateral margins of the proglottides are slightly rounded, and the posterior margin projects but little. The genital pores are irregularly alternate, and are placed near the anterior end of the proglottis, almost exactly on the lateral margin, but shown in sagittal sections to be situated a little toward the ventral side.

The cuticle consists of a dense inner layer, and a thicker outer layer which abrades easily. The outer layer is difficult to interpret. I find no trace of the stiff, slightly recurved bristles on the neck, nor of the dense covering of papillae on other parts of the strobile, such as are mentioned by Zschokke.⁷ The outer layer in longitudinal sections appears to be made up of short, blunt papillae, but these are but sections of the fine transverse corrugations on the surface of the strobile, which, it is true, simulate papillae.

The fibers of the longitudinal muscles are rather slender, and peculiar in that they are, for the most part, distinct, except at the lateral margins, and in the neck, where there is a slight indication of fascicles. The muscular layer is not sharply marked off from the vitellaria on the one hand, and its fibers interpenetrate the subcuticula on the other. Near the scolex the muscle fibers become larger and more numerous and they encroach on the surrounding tissue to

⁶ Recherch. sur la Structure Anatomique et Histologique des Cestodes, p. 285.

⁷ Idem, p. 284.

such a degree that the subcuticula is reduced, in transverse sections, to a narrow line. Next the cuticle the subcuticula is dense.

The longitudinal excretory vessels are rather remote from the lateral margins. In a transverse section, 4 mm. in the longer diameter, which represents the breadth of the strobile at that point, the longitudinal vessels were 0.86 from the lateral margins. In the same section the lateral nerve was 0.28 from the lateral margin. No trace of circular muscles was seen.

Reproductive organs.—The cirrus-pouch is long-pyriform, and lies near the anterior border of the proglottis. It opens by the common genital pore on the lateral margin near the anterior end of the proglottis. The cirrus is long and slender, and covered with very dense, hair-like spines. The vas deferens is voluminous, and lies between the median end of the cirrus-pouch and the uterus. The testes occupy the median portion of the parenchyma, extending laterally nearly to the nerve. They are continuous along the median axis of transverse sections of the anterior end of a proglottis, but are interrupted by the ovary, and, in ripe proglottides, by the uterus. In transverse sections they form a single slightly irregular row toward the margins, becoming irregularly two-ranked for a short distance near the middle of sections made in front of the uterus.

The vagina enters the common genital cloaca from the anterior side. In a series of sagittal sections the genital cloaca was estimated to be 0.2 mm. deep. The vagina is a thin walled tube at first lying along the anterior border of the cirrus-pouch, and the coils of the vas deferens. In its earlier portion it is lined with fine hair-like spines similar to those of the cirrus but shorter. It is compressed, at first dorso-ventrally, then antero-posteriorly (figs. 24-29). Toward the median axis of the proglottis it becomes tubular for a short distance, then, in most cases, it was compressed again in the vicinity of the uterus. At the median axis it turns toward the posterior and follows the uterus, being partly enclosed in the uterine walls, in a tortuous course on the dorsal side. Before joining the germ duct it enlarges to become the seminal receptacle, which lies, in about two close coils at right angles to the long axis of the proglottis. The complex formed by the ducts of the genitalia in the vicinity of the shell gland is compact, and difficult to reconstruct from the sections. A provisional interpretation is given in Figure 30. The ovary is at the posterior end of the proglottis and consists of two main divisions symmetrically placed, the one dorsal and the other ventral, each being distinctly lobulate.

The vitellaria make a distinct layer of the extra-parenchymatous region of the proglottis immediately within the layer of longitudinal

muscles. It is continuous at the lateral margins, thus surrounding the regions in which the longitudinal vessels and the lateral nerves lie.

The uterus is median in position, being nearly circular in its outline in sections of adult proglottides in both transverse and sagittal sections.

While there would seem to be no reason to doubt that these Alaska specimens belong to van Beneden's species, nevertheless, when one considers the details of the anatomy, given in Zschokke's excellent description of this cestode, differences appear which can not well be ignored.

1. Zschokke's figure of the scolex⁸ shows elongated bothria which, it is hard to see could contract into the shape which all of my specimens uniformly have.

2. The figure of the uterus⁹ shows a much more sacculated structure than I find in sections made at relatively the same stage of development.

3. In the plan of the reproductive system¹⁰ while my material is far from being all that could be desired, I find a distinct ootype, that is, a muscular, funnel-like beginning of the germ duct; also the oviduct enters the uterus a little above the posterior third, instead of at the anterior end.

4. Both Beneden and Zschokke speak of ripe proglottides becoming longer than broad. In my specimens, even those which have the uterus bulging with eggs, the breadth of the proglottides is more than four times the length.

5. In my sections I find no trace of the "stiff, slightly recurved bristles" on the neck, nor the "dense covering of villi" of the remainder of the body, mentioned by Zschokke. As already stated, the outer layer of the cuticle in longitudinal sections of the Alaska material appears to be composed of short, blunt papillae, but these are sections of fine transverse corrugations on the surface of the strobile.

I venture the suggestion that Zschokke's material from *Catulus stellaris* is specifically different from Beneden's material from *Somniosus brevipinna* (*Seymnus glacialis*, and *Laemargus borealis* of Beneden's papers are synonyms; see Jordan and Evermann, Fishes of North America (p. 57)).

⁸ Recherch. sur la Structure Anatomique et Histologique des Cestodes, fig. 114.

⁹ Idem, fig. 120.

¹⁰ Idem, fig. 119.

MONORYGMA, species.

Plate 1, fig. 6.

1900, p. 271.

1901, pp. 426, 429.

1911, p. 586.

Small cestodes of this genus are recorded in my notes on a few occasions, but the preserved material does not admit of satisfactory specific determination. Following are records not before published.

Squalus acanthias.

1910, July 29: 1. Length of specimen in balsam 3 mm.; length of bothrium 0.28, breadth of anterior loculus 0.14, posterior loculus 0.28; bothria with thick, muscular walls.

Raja stabuliformis.

1904, October 10: 1. Dimensions of alcoholic specimen: Length 7.7; bothrium, length 0.42, breadth 0.21; breadth of neck 0.14; distance to first segment 0.42; length of first segment 0.04, breadth 0.14; last segment, length 0.45, breadth 0.30; last segment fusiform, tapering at each end.

(U.S.N.M., Helm. Coll. 7670.)

ORYGMATOBOTHRIMUM FORTE, new species.

Plate 2, figs. 8-10.

Scolex.—Squarish in front view, bothria cup-shaped, with thick, muscular walls, directed forward. There is an anterior accessory sucker which, in contracted scoleces, is enclosed in the bothrial cup. This condition is brought about by the contraction of a sphincter muscle at the margins of the bothria. The sphincter is much weaker than in *O. paulum*. Back of the bothria the scolex contains a complex of vessels of the excretory system, together with many strong muscle fibers, which continue into the strobile. There is no trace of a myzorhynchus.

Strobile.—Unsegmented portion (neck) long, and crossed by fine transverse lines, which make a serrate outline on the lateral margins. In some cases of extreme flaccidity the strobiles become attenuated and lose the serrate character of the margins. The serrations may continue to the posterior end of the strobile. Adult and ripe proglottides do not appear in any of my material. The first indication of segments may be as much as 5 mm. from the scolex, where the breadth is many times the length. They gradually increase in length but remain about the same breadth. Toward the posterior end they become squarish, then longer than broad.

Reproductive organs.—Only the rudiments of genitalia had developed. The genital pores are irregularly alternate, and a little

in front of the middle of the length of the proglottis. The rudiment of the cirrus-pouch is at right angles to the margin. Rudiments of the vagina and uterus lie along the median region from the base of the cirrus-pouch is at right angles to the margin. Rudiments of transverse streak on the posterior border of the proglottis, thickening at the median line, the thickening probably representing the rudiment of the shell gland. A broad, granular marginal space represents the vitellaria which appear to form a continuous mass within the muscular layer. The rudiments of the testes are the most conspicuous feature of these immature proglottides. They lie on either side of the median space back of the level of the cirrus-pouch. In front of the cirrus-pouch they are continuous across the median line, and are continuous with lateral masses in the posterior portions of the proglottis, except where interrupted by the cirrus-pouch.

The average breadth of ten mounted scoleces is 0.65 mm.; the largest, which is considerably compressed, is 0.98, and the smallest 0.46 mm. broad.

Dimensions of a specimen mounted in balsam: Length 18; diameter of scolex 0.70; bothrium, length 0.35, breadth 0.31; breadth of neck 0.35; distance to first segment 4.9; first segment, length 0.07, breadth 0.32; last segment, length 0.28, breadth 0.43. In another: length about 25 mm., the maximum breadth is 0.72; penultimate segment, length 0.35, breadth 0.56. The last segment tapers to a bluntly rounded point. Diameter of auxiliary sucker, measured on a section, length, 0.075, breadth 0.090. In a strobile which has not been compressed the penultimate segment is 0.46 in length and 0.24 in breadth.

This species has been found in the hammerhead shark (*Cestracion zygaena*) on the following dates:

Type.—U.S.N.M., Helm. Coll. 7671.

1911, July 5: Number not ascertained; associated with large numbers of other small cestodes in the spiral valve.

1913, August 18: 9.

1915, July 19: A few specimens, collected by Dr. G. A. MacCallum.

Following are extracts from notes made on living material, collected July 5, 1911: This species was easily separated from the other small cestodes found in the spiral valve of a large hammerhead, on account of its stouter habit, and its tendency to throw the body into a close spiral. They also exhibited more vitality than the others. After lying over night in sea water they were still in good condition and active, rather more active than any of the other species. The bothria are cruciformly placed, and are characteristically thick and muscular. There is an acetabulum, and the border

of the remainder of the bothrium is thickened into a muscular sucker. While the shape of a bothrium at rest is circular, it assumes many shapes while actively contractile, becoming elongated, sometimes rather pointed in front, and, occasionally, there is a slight protuberance at the posterior edge. The scolex, with the exception of that part of the bothria which is enclosed by the larger sucker, is translucent, as is also the very short neck-like portion. The whole strobile is thickish, actively contractile, with a tendency to coil in a spiral. No ripe segments were observed.

Much confusion exists in the classification of the small cestodes belonging to the Phyllobothriidae largely on account of the great diversity of shapes which their soft and exceedingly contractile scoleces can assume. It is desirable that extensive collections be made from a large number of species of sharks and rays, and prepared, as far as possible, under the same conditions, and by the same technic.

ORYGMATOBOTHRIMUM PAULUM Linton.

Plate 2, figs. 11-13.

1897a, p. 444, pl. 33, figs. 7, 8.

1901, p. 426.

1911, p. 586.

Monorygma galeocerdonis MACCALLUM, Zoopath., N. Y. Zoolog. Soc., vol. 1, p. 237, fig. 122.

Records of this cestode not before published:

The maximum length of mounted specimens is 15 mm. The cirrus is long and slender with a bulbous base, which is armed with short spines. An interesting feature, observed in a number of these worms is that, while the genital pores are irregularly alternate, there is a tendency for many successive proglottides to have these pores on the same lateral margin. For example, in the specimen from which Figure 12 was made, the 10 posterior proglottides had the genital pores on the left side, then 1 on the right side, preceded by 12 on the left side. In another the last 14 pores were on the right side, preceded by 5 on the left side. In another, 9 on the right side were preceded by 10 on the left side, and these by 6 on the right side.

Galeocerdo arcticus.

Collected in 5 of the years from 1905 to 1915.

On 1 date in June, many, over 100, in spiral valve of a shark measuring 325 centimeters. On 4 dates in August: (1) 225, in spiral valve of a 150-centimeter shark, taken at Menemsha Bight. The small cestodes found in this shark were examined with care but no other species except young *Thysanocephalum thysanocephalum* was found; (2) about 100, maximum length 12 mm., bothria active; stro-

biles showed a tendency to coil in close, somewhat irregular spirals; (3), 3; (4), 23.

On 1 date in September, few.

(U.S.N.M., Helm. Coll. 7672.)

ANTHOCEPHALUM GRACILE Linton.

1890, pp. 794-796, pl. 7, figs. 1, 2.

1897a, p. 439.

1900, p. 275.

1901, p. 433.

1905, p. 347.

1907e, p. 113.

1908b, pp. 162, 169.

1910a, p. 10.

1911, p. 585.

Records of this cestode not before published:

Dasybatis centrura.

1906, September 20: 12 slender strobiles, only 1 with scolex; material not in good condition.

1913, August 29: 1, length 15 mm. in alcohol.

1920, September 1: 2.

1923, August 20: 2 in one of two rays.

(U.S.N.M., Helm. Coll. 7673.)

PHYLLOBOTHRIMUM FOLIATUM Linton.

1890, pp. 787-794, pl. 6, figs. 5-10.

1897a, p. 443, pl. 33, fig. 6.

1900, p. 275.

1901, p. 433.

1905, pp. 340, 347.

1910a, p. 695.

1911, p. 587.

Records of this cestode not before published:

Dasybatis centrura.

Collected in eight of the years from 1903 to 1922, inclusive: On three dates in June: (1) 8, with ripe proglottides, from a large sting ray; (2) 3 and 2 fragments; (3) 2, maximum length 60 mm., from 1 sting ray, and 5, young and adult, from another. On one date in July: 3, and a few fragments. On three dates in August: (1) 7, maximum length 60 mm.; (2) 1, length 45 mm., in alcohol; (3) 22; while attached to the mucous membrane of the spiral valve the anterior portion of the strobile stretches out into a long thread-like part; when placed in alcohol they have a tendency to plump up in the middle region, so that the strobile becomes long-fusiform. On

four dates in September: (1) numerous; (2) 2, length 15 mm.; (3) 29; (4) few. On one date in October: 10, length 30 mm.

(U.S.N.M., Helm. Coll. 7674.)

1923. Five rays examined on 4 dates, 2 in July and 2 in August: 1, 7, 10 with scoleces and a few strobiles with scoleces missing, 3, 6. Each pair of bothria pedicelled; bothria bordered with small loculi; auxiliary acetabulum small and not easily seen; it appears to be one of the loculi with thickened, muscular border; maximum length, in sea water, 100 mm.

Raja stabuliformis.

Cestodes collected by Mr. Edwards on different dates from the barn-door skate which appear to belong to this species are here recorded. Auxiliary suckers could not be made out in the formalin material, but were recognized in a series of transverse sections.

1906, April 20: 7 strobiles with scoleces, and 4 without; also numerous free segments. The habit of the strobile resembles that of typical specimens from the sting ray. Ova 0.034 by 0.027 in the two principal diameters.

1913, April 17: 3, and free proglottides, lengths 20, 31, and 50 mm.; maximum breadth 2 mm. April 23: 6, maximum length 80 mm. April 29: 6, maximum length 80 mm. May 1: 23, and many free segments. May 29: 6.

1916, May 19: 4, maximum length 70 mm.

CALYPTROBOTHRIUM MINUS Linton.

1900 (*C. occidentale*, in part), pp. 275, 298-299, figs. 92, 93, 96.

1901, p. 432.

1907c (*C. minus*), pp. 279-283, figs. 3-7.

1910a p. 694.

1911, p. 585.

Records of this cestode not before published:

The scoleces of this species are usually rather firmly embedded in the mucous membrane of the spiral valve, and are thus liable to be left fixed in the intestinal wall unless especial care is taken to remove them.

Narcacion nobilianus.

Collected in five of the years from 1908 to 1920: On seven dates in July: (1) free, ripe proglottides; (2) 1 with scolex, 5 with scolex missing, maximum length 20 mm.; (3) 4 young strobiles, longest about 12 mm.; (4) free proglottides, eggs dark, slender, fusiform; (5) 1; (6) 1 strobile and a few scoleces, from 1 of 4 torpedoes; (7) 2. On one date in August, 3. On one date in October, 17 strobiles, 3 with scoleces.

(U.S.N.M., Helm. Coll. 7675.)

CALYPTROBOTHRIUM OCCIDENTALE Linton.

1900, pp. 275, 298-299, figs. 94, 95, 97.

1901, p. 432.

1907a, pp. 155-157, fig. 2.

1907c, pp. 276-279, figs. 1, 2.

1911, p. 585.

Records of this cestode not before published:

Narcacion nobilianus.

Collected in 5 of the years from 1908 to 1920: On 3 dates in July: (1) 2, lengths 125 and 200 mm.; (2) 1 scolex and 2 fragments of strobiles; (3) 1, in 1 of 4 torpedoes. On 2 dates in August: (1) 1; (2) few, at lower end of spiral valve, in 2 of 3 torpedoes. On 1 date in October, 3 fragments of strobiles, 25, 75, and 120 mm. in length. (U.S.N.M., Helm. Coll. 7676.)

LECANICEPHALUM PELTATUM Linton.

1890, pp. 802-805, pl. 9, figs. 2-4.

1900, p. 275.

1901, p. 433.

1905, p. 347.

1910a, p. 695.

1911, p. 586.

Following are records of finds of this cestode not hitherto published:

Dasybatis centrura.

Collected in 3 of the years from 1903 to 1922: On 1 date in June, 2, and a few fragments. On 2 dates in July (1) 2, and a fragment; (2) a few fragments. On 1 date in August, many, collected by Dr. G. A. MacCallum. On 4 dates in September: (1) few; (2) 22; (3) 1; (4) 3, small, the only parasites found in the alimentary canal. The ray had been kept in the pool for a few days, stomach empty.

(U.S.N.M., Helm. Coll. 7677.)

1923. On two dates in July and one in August: 2 to many; in one case the scoleces were adhering firmly to the mucous membrane of the spiral valve; when placed in sea water the scoleces were very active, the anterior portion forming a vase-like organ which is evidently capable of acting as a sucker; maximum length 25 mm.

TRILOCULARIA GRACILIS Olsson.

Plate 2, figs. 14-17.

1911, p. 589.

Small cestodes found in the spiny dogfish are easily referable to the genus *Trilocularia*, and presumably belong to Olsson's species *T. gracilis*.

So far as I am acquainted with the literature of this species, ripe, or even adult, proglottides have not been found attached to the strobile of *Trilocularia*. Luehe's species, *Urogonoporus armatus*,¹¹ was rightly regarded, I think, to be a free cestode proglottis.¹² As to its being the free proglottis of *T. gracilis*, as Olsson argues, that is a point which does not seem to me to be satisfactorily established. The presence of spines on *U. armatus* is hard to account for, if it is from the strobile of *T. gracilis*, the strobiles of which are not represented as being armed. In cestodes which are characterized by the possession of cuticular spines, the spines are most strongly developed on the anterior portions of the strobile, and are usually absent, or lingering but sparingly, on the mature proglottides.

None of the strobiles in my collection have the slender proglottides, shown in Olsson's figure 27, but the resemblance to his figure 26¹³ is striking.

On one of my slides there are two ripe segments mounted along with scoleces of *T. gracilis*. One of these measures 2.8 mm. in length and 0.7 in breadth. It is fusiform and practically filled with ova, except for a small area at each end. The ova do not have sharp outlines, but appear to be from 0.015 to 0.018 mm. in diameter. The genital pore is near the middle, or a little in front of the middle of a lateral margin. These proglottides may or may not be the proglottides of *T. gracilis*.

This cestode is characterized by having the bothria divided by a transverse septum near the anterior end into two parts, the posterior, and larger of which, being divided by a median septum, so that the bothria become trilobulate.

Squalus acanthias.

Collected in 7 of the years from 1903 to 1914. On 4 dates in May: (1) Numerous young cestodes, resembling *Scolex polymorphus*, but with characteristic trilobulate bothria; strobiles taper to posterior end, which is frequently curved; length of longest 5 to 6 mm., diameter of scolex 0.9 mm.; (2) 6, maximum 16 mm., 9 dogfish examined; (3) 1 scolex found adhering to a free proglottis of *Anthobothrium pulvinatum*, in a lot of formalin material from the spiral valves of 40 spiny dogfish; breadth of bothrium 0.56 mm.; (4) 1, length 10 mm. On 1 date in June, 4, found adhering to specimens of *Phyllobothrium loliginis*; length 1.73; length of bothrium 0.31, breadth 0.30; diameter of neck 0.18; bothria in pairs on lateral margin, covered with minute, stout bristles. On 2 dates in September: (1) 10, from spiny dogfish taken by the steamer *Fish Hawk* on Crab Ledge, off Chatham, Mass., in 16 fathoms, 6 dogfish examined. The

¹¹ Archiv. de Parasit., vol. 5, 209-250.

¹² Lunds Univ. Arssk., vol. 3, pl. 2.

¹³ Idem, vol. 8, 465-471.

cestodes were small, longest 3.5 mm.; length of bothrium 0.48, breadth 0.45 mm.; (2) 1. On 5 dates in October: (1) A few small, slender segments; (2) to (5) 1 on each of 4 dates, 6 to 9 mm. in length. On 1 date in November, 12, all small, less than 10 mm. in length.

(U.S.N.M., Helm. Coll. 7678-7679.)

Family ONCHOBOTHRIIDAE.

Following are records of collections of cestodes belonging to this family made since the publication of my report on Parasites of Fishes of the Woods Hole Region (1901).

The genera represented are: *Acanthobothrium*, *Calliobothrium*, *Onchobothrium*, *Phoreiobothrium*, and *Platybothrium*, all of which bear structureless, chitinous hooks on the bothria. The genus *Thysanocephalum* does not belong in this group. The hooks in that genus, instead of being structureless, have a very dense striated structure, and appear to be a modification of the dense, muscular border of the bothria.

CALLIOBOTHRUM ESCHRICHTII van Beneden.

1890, pp. 812-816, pl. 7, figs. 5-12.

1897a, pp. 447, 448.

1910a, p. 9.

1911, p. 585.

Records of this cestode not before published:

Host; *Galeorhinus laevis*. Smooth Dog-fish; spiral valve.

July 9, 1904: 2.

July 31, 1905: 1.

August 4, 1905: 1.

August 5, 1905: Few, maximum 10 mm.

August 18, 1905: Few.

(U.S.N.M., Helm. Coll. 7680.)

CALLIOBOTHRUM VERTICILLATUM (Rudolphi).

1889b, pp. 476-479, pl. 4, figs. 1-8.

1890, pp. 810-812.

1897a, p. 447, pl. 34, figs. 6, 7.

1900, p. 270.

1901, p. 425.

1910a, p. 694.

1911, p. 585.

Records of this cestode not hitherto published.

Galeorhinus laevis.

Usually present in the spiral valve of the smooth dogfish. Collections made in 8 of the years from 1903 to 1922, inclusive. Free, ripe proglottides present in most instances. Thus, on August 18,

1903, 2 strobiles, with numerous free, ripe proglottides, were found in the spiral valve of a dogfish. The ova in the ripe segments soon became dark brown in sea water. The ova were in linear clusters, usually 5 or 6 in the same capsule, and contained six-hooked embryos.

On 2 dates in May, 9 dogfish examined; few, with ripe proglottides.

On 5 dates in June, 9 dogfish examined; 3 to 17, maximum length 135 mm.

On 6 dates in July, 9 dogfish examined; 4 to 40, ripe proglottides on one date.

On 11 dates in August, 12 dogfish examined; 2 to 50, ripe proglottides on 5 dates.

On 4 dates in September, 5 dogfish examined; 3 to 50, ripe proglottides on 2 dates.

1923, August 4: about 12 in each of 3 dogfish.

(U.S.N.M., Helm. Coll. 7681.)

Squalus acanthias.

Found in the spiral valve of the spiny dogfish, where it does not appear to be a frequent guest.

1904, June 6: 1, length 115 mm.

1910, July 29: 30, maximum length 76 mm., from one of nine dogfish examined.

1922, July 20: 31, collected by Dr. G. A. MacCallum.

ACANTHOBOTHRIMUM CORONATUM Rudolphi.

Plate 4, figs. 33-35.

1901, p. 431, fig. 293.

1911, p. 585.

Prof. T. Southwell, to whom I had sent specimens of this species, remarks on its resemblance to Yoshida's *A. ijimai*.¹⁴

It is a common parasite of the barndoor skate (*Raja stabuliformis*), only a few, or often only one, in the spiral valve.

Following are records of this cestode not before published:

Raja stabuliformis.

Collected in 10 of the years from 1903 to 1922, inclusive.

On 3 dates in April: 3 skates; 6 on each of two dates and 18, with many fragments, on the other; maximum length 66 mm.

On 5 dates in May: 5 skates; 1 strobile with scolex on each date, several fragments and scoleces with scolex missing; maximum length 48 mm.; length of last segment 1.20, breadth 1.12.

¹⁴ Parasitology, vol. 9, pp. 573-5, pl. 23, figs. 12, 13, text-fig. 1.

On 2 dates in June: 2 skates; 1 on one date; on the other date 4 with scoleces, and about 6 with scoleces missing; maximum length 60 mm.

On 1 date in July: 3 skates; 19 strobiles slender and filiform; scoleces adhered firmly to bottom of dish; maximum length 54 mm.

On 1 date in August: 1 skate; 1, length 60 mm.

On 1 date in September: 1 skate; 3, length 16 mm.

On 5 dates in October: 5 skates; 1 to 8, 19 in all; maximum length 66 mm.

On 1 date in November: 1 skate; 6 and a few fragments.

(U.S.M.N., Helm. Coll. 7682.)

The scolex is often firmly attached to the mucous membrane of the spiral valve, and, unless care is taken, may not be secured in collecting the strobiles.

Reja eglantheria.—While examining preserved material from this host, which had been identified at the time of collecting as *A. paulum*, a few individuals were found which differed from that species in the character of the hooks in a marked degree (see figs. 32 and 33). The scoleces were much contracted, and difficult to interpret; one, however, was seen in which three accessory suckers could be made out in that part of the bothrium which is anterior to the hooks. Length of bothrium 0.70, breadth 0.56; maximum length of hook 0.11.

1905, August 8: Few. August 21: 1.

Dasybatis centrura.

Several found in a vial which contained a considerable number of *A. paulum*, collected from a large sting ray, September 1, 1903. I find in my notes made at the time of collecting, that, on account of the large amount of material obtained on that date, the small forms were not separated carefully. Length, mounted in balsam, 15 mm.; length of hooks 0.12 mm.

ACANTHOBOTHRIMUM PAULUM Linton.

Plate 4, fig. 32.

1890, pp. 816–819, pl. 8, figs. 1–7.

1900, p. 275.

1901, pp. 433, 434.

1905, pp. 346, 348, 349, fig. 126.

1910a, p. 10.

1911, p. 585.

The cestode recorded in preliminary reports: 1907e (p. 113), and 1908b (p. 163), as *A. paulum* proved to be a new species, and was described under the name *A. brevissimum*, 1908b (pp. 173–4; pl. 4, figs. 26–29).

Following are records of finds of this species not hitherto published:

Raja eglanteria.

1905, August 8: 26, maximum length 10 mm.; length of bothrium 0.67, breadth 0.25; length of hooks 0.14. August 12: 1. August 21: 3. There were also free proglottides which appeared to belong to this species. All of them had small ova, with thin, collapsed shells.

1910, July 21: 12, length about 10 mm.

1916, September 11: 1, length 18 mm.

Dasybatis centrura.

1903, September 1: Few.

1914, August 1: 20, collected by Dr. G. A. MacCallum.

1922, June 22: One sting ray examined; many small strobiles and free proglottides in spiral valve. *A. paulum* noted. The anterior ends of the bothria, in front of the hooks, were very mobile, extending themselves into nearly linear prolongations.

1923, July 20: 2, 14 mm. August 15: 1, small.

(U.S.N.M., Helm. Coll. 7683.)

ONCHOBOTHRUM UNCINATUM Diesing.

1897a, p. 446, pl. 34, figs. 2-5.

1901, p. 433.

1905, p. 347, fig. 127.

1911, p. 586.

This cestode has been found in the northern sting ray at Woods Hole, and in the southern sting ray at Beaufort, N. C.; following are records not before published:

Dasybatis centrura.

1914, August 1: 3, found in a large sting ray examined by Dr. G. A. MacCallum.

1922, July 31: 1; length in sea water, 68 mm.; scolex white, neck pale, becoming pinkish posteriorly; posterior half of strobile salmon color: rather active. There were four strongly developed fascicles of longitudinal muscles in the neck, connected with the bothria, and traceable throughout the length of the strobile. Dimensions in balsam: Length of bothrium, 0.77; length of hooks, 0.135; distance to first segments, approximately, 2.8; length of posterior proglottis, 0.7, breadth 1.61.

(U.S.N.M., Helm. Coll. 7684.)

Genus PHOREIOBOTHRUM Linton.

This generic name was proposed to accommodate a cestode from the dusky shark (*Carcharhinus obscurus*), 1889 (p. 474). Type species, *P. lasium*.

The finding of another species in the dusky shark, and of two additional species in the hammerhead shark (*Cestracion zygaena*) makes a restatement of the generic characters desirable.

Characters of genus.—Four cruciformly placed bothria, each with an auxiliary acetabular space in front of a pair of compound hooks, and loculate at the posterior end.

In some contraction states the bothria appear to be tubular, thus suggesting, as was stated in the original description of the genus, Diesing's *Cylindrophorus typicus*, a name which he proposed for Wagener's *Tetrabothrium carchariae-rondoletti*. Further, in some contraction states of the strobile, especially noticeable in the species from the hammerhead shark, the neck bears a strong resemblance to Wagener's figure.¹⁵

PHOREIOBOTHRIUM LASIUM Linton.

Plates 4 and 5, figs. 36-40 and 54.

1889b, pp. 474-476, pl. 4, figs. 24-29.

1890, pp. 819-820.

1897a, p. 447.

1900, pp. 272-273.

1901, pp. 426, 427, 428.

1905, pp. 340-343.

1907e, p. 116.

1908a, p. 114.

1908b, pp. 163, 165, 174.

1911, p. 587.

The cestodes recorded as *P. lasium*, from *Cestracion zygaena* (1900, p. 273; 1901, p. 428) should be referred to *P. pectinatum*.

Scolex.—This is somewhat rectangular in outline; the bothria, being provided with a thick muscular border, are rather rigid; at rest they are parallel with the neck, or slightly flaring at the posterior end, in which case the scolex becomes somewhat hour-glass shape. There is a short lappet-like projection at the back of each bothrium near the posterior end, and the space thus formed is divided into a considerable number, 20 or more, loculi (figs. 36, 38).

The muscular borders of the bothria are carried forward and form a single acetabular space in front of the hooks. In some cases this space appears to have a faint trilocular structure. Each bothrium carries a pair of three-pronged hooks. Each hook is like a short-handled three-toothed rake, in which the oblong, bluntly rounded embedded portion is the handle, a transverse bar is the head, and the three prongs, which are nearly at right angles to the transverse bar and are strongly reflected, are the teeth. The middle prong is about twice as long as the inner and a little longer than the outer prong.

¹⁵ *Entwicklung der Cestoden*, fig. 270.

The inner end of the horizontal bar projects slightly beyond the inner prong and meets its fellow on the median line of the bothrium. Under favorable conditions a small papilla may be seen between the anterior ends of the bothria (fig. 37).

Strobile.—The neck, and sometimes the proglottides, are armed with spines. Seen in front view these spines are triangular. In some cases they are very abundant. They are, however, evanescent, and specimens may be encountered from which they have disappeared entirely. The neck is linear and usually rather straight, increasing in breadth gradually and uniformly. The first indication of proglottides appears from 2 to 3 mm. back of the scolex. The first proglottides are broader than long, or squarish, but soon become longer than broad, and adult proglottides are much longer than broad, and somewhat rectangular in outline.

Reproductive organs.—The genital apertures are irregularly alternate, and are situated at about the middle of the lateral margins. When an adult proglottis, in which ova have not yet made their appearance, is observed in dorso-ventral view the ovary is seen to occupy about the posterior fourth, the vitellaria forming a dense border along each lateral margin. The vagina lies close to the anterior border of the cirrus-pouch, runs at nearly right angles to the long axis of the proglottis to the median line, thence in a sinuous course to the ovary. The rudiment of the uterus lies along the median line and extends to near the anterior end of the proglottis. The cirrus-pouch is somewhat pyriform, and is nearly at right angles to the margin; its length is approximately equal to one-third the breadth of the proglottis. A little of the vas deferens is enclosed in the inner end of the cirrus-pouch, thence its rather voluminous coils extend forward along the median line. The most conspicuous organs are the testes, which fill the interior of the proglottis in front of the ovary within the layer of vitellaria. In horizontal sections the testes are circular in outline; in transverse sections they are elliptical, and lie in a single row.

Until the summer of 1922 the ova of this species were not certainly identified. Then I had the opportunity of examining a large number of sharks, and succeeded in demonstrating the presence of rod-shaped ova (fig. 54) in gravid proglottides of *P. lasium*. These were at first taken to be linear clusters of eggs, but they seem to be eggs which are undergoing segmentation. Of those observed the vast majority consisted of 4 cells, a few were seen with 3, many with 5, and one with 6 cells. In all cases the cells were in linear arrangement. When proglottides, plump with ova, are placed in sea water they soon burst and a chalky white mass of ova is discharged.

Three species of cestodes, of practically similar dimensions, and of superficially like appearance, were found often associated to-

gether; namely, *Anthobothrium laciniatum*, *Crossobothrium angustum*, and *Phoreiobothrium lasium*. These cestodes have a similar habit with respect to the ripening of the proglottides. In each species the proglottides separate from the strobile before maturity. They continue to grow after separation from the strobile. Often the chyle of the spiral valve was found to be swarming with free proglottides of these three species. The ova are very different, one species from the other. Thus, in *A. laciniatum* they are nearly circular in outline, in *C. angustum* they are fusiform, and in *P. lasium* they are as described above. Further details are given under *C. milberti* below.

Following are dimensions of four specimens mounted in balsam:

Length of strobile.....	40.00	15.00	25.00	18.00
Breadth of scolex, excluding projecting hooks..	0.39	0.34	0.38	0.25
Length of scolex.....	0.51	0.34	0.34	0.30
Length of longest hook.....	0.10	0.10	0.10	0.11
Length of spines on neck, maximum.....	0.015	0.015	0.018	0.018
Distance to first distinct segment.....	2.50	2.80	1.12	2.10
Length of posterior segment.....	2.20	1.20	0.77	0.50
Breadth of posterior segment.....	0.34	0.35	0.45	0.25

Following is a list of finds of this cestode not hitherto recorded. All are from the Woods Hole region, and all from the spiral valve of the host.

Carcharhinus commersonii.

1922, August 5: 6, associated with 1 *C. angustum*, in a 135-centimeter shark, brought to the laboratory by Otis Luce, and identified by Dr. H. M. Smith; menhaden in stomach, beak and lenses of squid in spiral valve, also a structure which appears to be decalcified and partly digested spines of a small sting ray. August 7: 17, associated with 2 *A. laciniatum* and 3 *C. angustum*; many free proglottides; in a 135-centimeter shark; menhaden in stomach.

1923. On 10 dates in August and 1 in September, in 16 sharks; many, few, 54, 10, 115, 134, 2, 7, 1, 30, 197, 9, 119, 164, 1, 3; maximum length 59 mm., usual length 25 to 30 mm.

Carcharhinus limbatus.

1915, August 6: 7, associated with 175 *C. angustum*.

1918, July 13: 4, associated with 14 *Discocephalum pileatum*; in 210-centimeter shark; lenses and otoliths of fish in spiral valve.

Carcharhinus milberti.

1915, August 12: Many in each of 5 sharks. August 18: Many.

1916, September 25: 2.

1922, July 3: 185, in one of two sharks; fragments of squid in spiral valve.

July 10: 149, in a 135-centimeter shark; menhaden in stomach. Another shark, length 150 centimeters, was examined by Dr. G. A. MacCallum, many small cestodes in spiral valve, the majority of which were *P. lasium*.

August 5: 6, in a shark measuring 215 centimeters; menhaden in stomach.

August 11: 248, associated with 51 *C. angustum*, and 3 *A. laciniatum*. There were enormous numbers of ripe proglottides in the chyle. Most of those examined were *P. lasium*; 135-centimeter shark; fish vertebrae in spiral valve.

August 12: 9, associated with 9 *A. laciniatum*, and 113 *C. angustum*; 135-centimeter shark; menhaden in stomach. Measurements of three 4-celled eggs, living, gave the following results: Lengths, 0.08, 0.11, 0.13; breadth of each, 0.02. Dimensions of eggs mounted in balsam: Lengths of 5-celled eggs, 0.156, and 0.159; of 4-celled eggs, lengths, 0.12 and 0.135; breadths about the same in each, 0.02.

August 15: The sharks which were examined on this date were brought to the laboratory by Otis Luce, who had taken them in his trap at Blackwoods, near Tarpaulin Cove, Vineyard Sound. They were all males, and ranged in length from 144 to 202 centimeters. The stomachs contained menhaden. Seven sharks were examined. *P. lasium* found in each of them.

No. 1. Large: 30, maximum length 28 mm.; associated with 5 *A. laciniatum*, and 9 *C. angustum*. Many ripe proglottides; most of the eggs 4-celled; length of 3-celled egg, 0.066, breadth, 0.021, another measured 0.084 in length; a 4-celled egg measured 0.106 in length; breadth of eggs rather uniform, from 0.015 to 0.021.

No. 2. Large: 1, length 30; a few free proglottides.

No. 3. Large: 4, length 28; a few free proglottides.

No. 4. Large: 70, associated with 1 *A. laciniatum*, and 4 *C. angustum*; very many free proglottides.

No. 5. Medium: 4, maximum length 22; very few free proglottides.

No. 6. Medium: 23, associated with 71 *C. angustum*; a few free proglottides.

No. 7. Small: 11, maximum length 36, associated with 7 *A. laciniatum*, 24 *C. angustum*, and 5 *P. triloculatum*.

August 23: 42, associated with 15 *A. laciniatum*, and 36 *C. angustum*, in a 210-centimeter shark; menhaden in stomach.

(U.S.N.M., Helm. Coll. 7685.)

Carcharhinus obscurus.

See page 7 for remarks on the species *C. milberti* and *C. obscurus*.

Collected in 11 of the years from 1905 to 1918. On 4 dates in July: (1) Few, maximum 12 mm. in 135-centimeter shark: (2) 96, in a 120-centimeter shark, associated with 30 *A. laciniatum*, 10 *P. triloculatum*, and 1 *O. crenacolle*; a few free proglottides: (3)

many, with many *A. laciniatum*, and *C. angustum*, and 3 *P. triloculatum*; (4) few, in 1 of 3 sharks. On 10 dates in August: (1) many in 150-centimeter shark; (2) few, in 325-centimeter shark; (3) many, in a 302-centimeter shark; (4) 8, with 3 *A. laciniatum*, and 2 *C. angustum*, with very few free proglottides in a 225-centimeter shark; (5) 45, with 29 *A. laciniatum* and 5 *O. crenacolle*, in a 150-centimeter shark; (6) 3 in one shark, with 18 *A. laciniatum*, and 63 in another with 4 *A. laciniatum* and 4 *C. angustum*, many free proglottides; (7) 1, length 23 mm., and a few free proglottides in 1 of 2 240-centimeter sharks; (8) 30, in 165-centimeter shark, no other parasites found; (9) three 165-centimeter sharks from Obed Dagett's trap in Buzzards Bay. No. 1:65, with 6 *A. laciniatum*, 33 *C. angustum*, and 19 *D. pileatum*. No. 2:36, with 7 *A. laciniatum*, 19 *C. angustum*. No. 3:40, with 1 *A. laciniatum*, 2 *C. angustum*; (10) 9, no other parasites in spiral valve. On 5 dates in September: (1) 5, from 10 to 28 mm. in length, from a 150-centimeter shark; (2) 12, with 12 *A. laciniatum*, and over 200 *C. angustum*; (3) 14, with 95 *C. angustum*, from 3 small sharks; (4) 185, with 2 *A. laciniatum*, 8 *C. angustum*, 1 *P. cervinum*, and many free proglottides, in a 210-centimeter shark; (5), 93, with 9 *A. laciniatum*, 14 *C. angustum*, and 1 *T. bisulcatus*, in a 240-centimeter shark.

Galeocerdo arcticus.

1915, August 2: 2, with 2 *O. paulum*, and large numbers of *T. thysanocephalum*.

Scoliodon tetrac-novae.

1914, August 20: 1, length 20 mm., with 40 *C. angustum*, 2 *P. cervinum*, and 1 *D. pileatum*, in a 150-centimeter shark.

1915, July 15: Many, with a few *A. laciniatum* and many *C. angustum*.

Vulpecula marina.

1923, July 30: 1, and 2 fragments; lengths, 12, 15, 18 mm.

August 28: 270 counted; many adhering firmly to mucous membrane of spiral valve; maximum length 32 mm.

PHOREIOBOTHRIUM TRILOCULATUM Linton.

Plate 5, Figs. 45-46.

1901, p. 427, pl. 26, fig. 292.

1905, pp. 340, 343.

1911, p. 587.

This species is readily recognized by the three loculi at the posterior ends of the bothria.

Scolex.—Length and breadth about equal; more robust than *P. lasium*; hooks same general plan as in that species, but much larger,

middle and outer prongs about equal, inner prong much reduced, inner end of transverse bar blunt.

Strobile.—General characters as in *P. lasium* but rather stouter; spines on neck rather more slender; adult proglottides somewhat rounded, so that the posterior end of the strobile may become moniliform; anatomy of proglottis, so far as observed, differs little from that of *P. lasium*; free, ripe proglottides not yet certainly identified.

Measurements of four specimens mounted in balsam gave the following results:

Length of strobile.....	20.00	27.00	23.00	22.00
Breadth of scolex, excluding hooks.....	0.70	0.70	0.56	0.63
Length of scolex.....	0.70	0.70	0.56	0.63
Length of longest hook.....	0.18	0.14	0.15	0.165
Length of spines on neck, maximum.....	0.015	0.015	0.012	0.012
Distance to first distinct segment.....	2.50	3.00	1.68	1.48
Length of posterior segments.....	1.05	1.96	1.12	0.98
Breadth of posterior segments.....	0.63	0.43	0.56	0.42

This species has been recorded from *Carcharhinus obscurus*, at Woods Hole, Mass., and Beaufort, N. C., and from *Scoliodon terrae-novae*, at Beaufort.

The following additional finds of this species were all made at Woods Hole.

Carcharhinus milberti.

1922, July 3: 4, with 69 *A. laciniatum*, 6, *C. angustum*, and 185 *P. lasium*. August 15: 5, maximum length, 30 mm.

(U.S.N.M., Helm. Coll. 7686.)

Carcharhinus obscurus.

1905, July 28: Few, longest, 25 mm. August 11: 1.

1910, July 25: 10.

1914, July 11: 3.

PHOREIOBOTHRIUM PECTINATUM, new species.

Plate 5, figs. 47-50.

Phoreiobothrium lasium, 1900, p. 273; 1901, p. 428.

Scolex.—Smaller and relatively shorter than in either of the foregoing species; about seven loculi at posterior end of bothrium; the costa in front of the loculi is bordered with about seventeen short, flat, rounded, and scale-like papillae. The hooks are much like those of *P. lasium*, but smaller; moreover, the hooks of a pair are not symmetrical, the inner prong of one hook being much shorter than the other two, while the inner prong of the other hook is of nearly the same length as the two others (fig. 48). The horizontal bar of the hooks is relatively broader than in *P. lasium*, and the inner end projects very little.

Strobile.—The spines on the neck are longer and larger than in either of the foregoing species. The necks in most of my specimens are very slender. This species shows more irregularities due to different contraction conditions than is the case in either of the preceding species. Adult proglottides are from two to two and a half times as long as broad, with the ends more or less rounded or tapering. The general plan of the anatomy agrees with that of *P. lasium*.

Length of strobile.....	20.00	30.00	28.00	11.00
Breadth of scolex, excluding books.....	0.20	0.16	0.14	0.15
Length of scolex, approximate.....	0.12	0.16	0.14	0.15
Length of hooks, maximum.....	0.06	0.054	0.054	0.054
Length of spines on neck, maximum.....	0.03	0.03	0.03	0.03
Distance to first distinct segment.....	5.60	3.90	3.20	2.57
Length of posterior segments.....	1.82	1.92	1.68	0.77
Breadth of posterior segments.....	0.70	0.71	0.63	0.44

Type.—U.S.N.M., Helm. Coll. 7687.

From spiral valve of *Cestracion zygaena*.

1914, August 6: Few. August 7: 32.

The spiral valves from which these cestodes were obtained were given me by Dr. H. B. Goodrich. The sharks from which they came measured 135 and 150 centimeters, respectively. The worms were rather firmly attached to the mucous membrane near the anterior end of the spiral valve. The following measurements were made of living specimens:

Length of strobiles.....	24.00	29.00
Breadth of scolex, slightly compressed.....	0.27	0.27
Length of bothrium.....	0.15	0.15
Breadth of bothrium.....	0.18	0.18
Length of spines on neck, maximum.....	0.35	0.035

The scolex is so short that it usually presents nearly a front view when placed under the cover-glass. The neck is long and slender and the whole worm more or less spinose. Spines evanescent, many of them becoming detached when the cover-glass was placed on the worm in sea water.

PHOREIOBOTHRIUM EXCEPTUM, new species.

Plate 4, figs. 41-44.

Scolex.—Bothria enlarging toward the posterior end, which bears six loculi. The hooks appear to be two pronged. These prongs spring from a conical, roughened base which is inclined at an angle of about 45 degrees with the axis of the scolex. The inner tips of the bases of a pair of hooks meet on the median line of a bothrium in the same manner as do the horizontal bars of the three-pronged hooks of the three preceding species. The basal support of the hook

is short, bluntly rounded, as in the other species, and is situated opposite the base of the inner of the two large prongs. The two prongs of these hooks correspond to the middle and outer prongs of the three-tined hooks of the three foregoing species. The rudiment of a third, inner prong may be made out on close examination (fig. 43).

Strobile.—The neck, in all specimens seen, is slightly enlarged next the scolex, the enlarged portion being free from spines. Back of this point the neck narrows for a short distance, then enlarges, and has a tendency to enlarge and narrow irregularly. It is densely covered with relatively large, straight spines with strong basal supports which are elliptical in optical section. The neck is relatively long, and the first segments to appear are squarish, but are quickly followed by long and slender segments. Mature proglottides were not seen. The posterior segments show a tendency to become relatively broad, and are more or less rounded at the extremities. The genital pore appears to be a little back of the middle of a margin.

Measurements of four specimens mounted in balsam:

Length of strobile.....	20.00	16.00	14.00	25.00
Breadth of scolex, excluding hooks.....	0.46	0.35	0.42	0.42
Length of scolex.....	0.46	0.39	0.42	0.42
Length of hook, maximum.....	0.11	0.12	0.10	0.12
Distance to first distinct segment.....	0.036	0.036	0.036	0.036
Length of posterior segments.....	0.77	1.29	0.76	1.33
Breadth of posterior segments.....	0.68	0.49	0.43	0.28

From spiral valve of *Cestracion zygæna*.

Type.—U.S.N.M., Helm. Coll. 7688.

1911, July 5: 5, with many examples of *Platybothrium parvum*.

1913, August 1: 1.

PLATYBOTHRIUM CERVINUM Linton.

Plate 5. fig. 51.

1890, pp. 820–823, pl. 8, figs. 8–10; 9, fig. 1.

1901, p. 427.

1911, p. 587.

Hosts: *Carcharhinus obscurus*, *C. commersonii*, *C. milberti*, *Galeus glaucus*, and *Scoliodon terræ-novæ*; spiral valve.

This genus was based on a single specimen from the spiral valve of the dusky shark (*Carcharhinus obscurus*), collected at Woods Hole, August 12, 1887. It has been found on but three occasions since that date, all at Woods Hole.

On September 12, 1912, I found a single specimen of this species in a dusky shark. Dimensions, in balsam: Length 61; breadth of scolex in front, 0.2, middle, 0.52, posterior end, 0.12; length of scolex, 0.40; length of hooks, 0.15; breadth of pair of hooks, 0.21; distance

to first segments, 25; length of first distinct segments, 0.08; breadth, 0.28; length of posterior segments, 1.05, breadth 0.54; length of spines on neck, 0.012.

On August 20, 1914, two of these cestodes were found in the Sharp-nosed Shark (*Scoliodon tærrae-novae*). They measured 45 and 50 millimeters, respectively, lying in sea water. The neck was armed with short, triangular spines, about 0.015 mm. in length; strobiles spinose, sparsely so on posterior proglottides, which were immature. Length of hooks, 0.14; breadth of pair of hooks 0.25; breadth of scolex, 0.50; length of posterior proglottides, 0.70, breadth, 0.53.

On August 12, 1915, a few of these cestodes were found in each of two blue sharks (*Carcharhinus milberti*). Two of them in balsam measure 24 and 36 mm, respectively. The necks are densely, and the strobiles sparsely, spinose.

C. commersonii.

1923, August 4: 1, length 36 mm., in alcohol. 30:1.

Galeus glaucus.

1923, July 23: 77, young strobiles, maximum length about 16 mm.; densely spinose, length of spines about 0.02 mm.

(U.S.N.M., Helm. Coll. 7689).

This cestode has many features in common with *Phoriobothrium*. The neck is elongated, and both neck and proglottides are spinose, a feature that was not noted in the original description. There is an elliptical auxiliary sucker at the anterior end of each bothrium in front of the hooks. The posterior proglottides were sufficiently developed to show the following characters: The genital pores are at about the middle point of the lateral margin and are irregularly alternate. The vagina lies in front of the cirrus-pouch, passes antero-medial to the median line, thence, posteriorly, to the ovary at the posterior end of the proglottis. The vitellaria are best seen along the lateral margins but can be seen to form a continuous layer within the body wall. The cirrus-pouch was still rudimentary; its course from the margin is at first postero-medial, then antero-medial, with indications that coils of the vas deferens are enclosed in the median portion. The most conspicuous organs are the testes which fill the proglottis from the ovary to near the anterior end which for a short space is free from genitalia.

PLATYBOTHRIUM PARVUM Linton.

Plate 5, figs. 52 and 53.

1900, *Platybothrium*, species, pp. 273, 300, pl. 42, figs. 98, 99.

1901, pp. 426, 428, 430.

1911, p. 587.

Since the above records were made this species has been found at Woods Hole on the following occasions.

Carcharhinus milberti.

1922, August 5: 1, in spiral valve of a 210-centimeter shark.

Cestracion zygaena.

1911, July 5: Numerous, in spiral valve of a hammerhead shark, measuring 305 centimeter in length.

1913, July 21: Few, in spiral valve of a 225-centimeter shark, collected by Dr. G. A. MacCallum. August 1: 62 found in spiral valve of a 195-centimeter shark, and 12 in a 225-centimeter shark; maximum length about 12 mm. August 18: Many, from spiral valve of a 285-centimeter shark.

1914, August 7: 1; not noted at time of collecting, but found later on a slide with specimens of *Phoreiobothrium pectinatum* collected on this date.

(U.S.N.M., Helm. Coll. 7690.)

This species is readily distinguished from *P. cervinum* by its smaller size, the two costae, instead of one, on the bothria, and the larger size of the spines on the neck. Dimensions of specimen mounted in balsam: Length, 12 mm.; breadth of scolex, 0.30; length of hooks, 0.10; breadth of pair of hooks, 0.21; maximum length of spines on neck, 0.03; length of posterior proglottides, 1, breadth, 0.5; free proglottides, length, 2.24, breadth, 0.84; length, 2.10, breadth, 0.48.

In the lot collected July 5, 1911, mature free proglottides were observed which supply some details of the anatomy not given in the descriptions of this species which have been published.

The free proglottides, while presenting a considerable variety of shapes, are in general more or less oval in outline, the anterior end being free from genitalia. The cirrus is relatively large and covered with rather stout hooks. The distal portion of the vas deferens is enclosed in the inner end of the cirrus-pouch, the inner coils lying on the median line a little in advance of the vagina. Testes fill practically all of the inner portion of the proglottis. The vagina opens in front, and a little to one side of the cirrus at the genital pore, which is a little back of the middle of the margin; it passes directly to the median line, where it turns posteriorad and continues as a relatively large vessel, the seminal receptacle, to about the anterior edge of the ovary where it narrows and becomes the germ duct, which is more or less coiled and can be traced, in whole mounts, to the shell gland. The ovary is at the posterior end of the proglottis and occupies about half of the space behind the genital pore. The vitellaria form a layer surrounding the testes and are conspicuous in whole mounts along the lateral margins.

THYSANOCEPHALUM THYSANOCEPHALUM (Linton).

Phyllobothrium thysanocephalum.

1889*b*, pp. 464-468, pl. 2, figs. 1-12.

Thysanocephalum crispum.

1890, pp. 823-824.

1891*b*.

1897*a*, p. 448.

1907*e*, pp. 113, 116.

1908*b*, pp. 162-163, 165, 174-175.

1910*a*, pp. 693-694.

1911, p. 589.

This cestode has been recorded hitherto only from the tiger shark (*Galeocerdo arcticus*), in which it has been found to be invariably present in the spiral valve, in large numbers, both young and mature strobiles, and large numbers of free, ripe proglottides.

Below will be found records of this cestode from a new host, the hammerhead shark (*Cestracion zygaena*).

Record of finds of this cestode not before published. Collections on the two 1908 dates were made in Tortugas, others at Woods Hole. *Galeocerdo arcticus*.

1905, August 26: Large numbers in spiral valve, adult to very small, with intermediate sizes, and many free proglottides; approximately 180, of which 30 were adult.

1907, August 7: 1 large specimen in stomach; 15 large, 13 medium, and 30 small specimens in spiral valve, with large numbers of free proglottides; largest 420 mm. in length.

1908, June 14: 200, approximately, small and medium. The spiral valve had been preserved in formalin at the Tortugas laboratory, and was examined by me on June 27. The shark had not been identified, but the character of the spiral valve, and the presence of large numbers of this cestode point to this host. June 24: Numerous, small and large, with free proglottides; from a shark 370 centimeters in length, Tortugas. The shark was taken before my arrival at the laboratory; the spiral valve had not been preserved, but some of the cestodes had been kept in formalin.

1910, September 3: 41, adult and young, longest about 220 mm.; one small specimen noted with forked posterior end. The gelatinous tissue plug, described in a former paper (1900, p. 271, fig. 102) as a tumor, is evidently normal, and is a structure whose function seems to be to prevent, or to render difficult, the passage of undigested pieces of food through the pylorus.

1912, August 19: 59 large, 494 medium and small, and large numbers of free, ripe proglottides, in spiral valve; maximum length about 600 mm.; from a 180 centimeter shark.

1913, August 13: Numerous, large and small, in spiral valve, largest 1 meter in length; shark examined by Dr. G. A. MacCallum. September 8: Numerous, large and small and free proglottides; from a 150 centimeter shark.

1914, August 12: Numerous, large, medium and small, and numerous free proglottides from spiral valve.

1915, July 31: Many different sizes, small to adult, numerous free proglottides, in spiral valve. August 5: Many, large and small, and great numbers of free proglottides in the chyle of the spiral valve.

1919, August 19: Large numbers, adult and young, and of free proglottides collected by George M. Gray.

(U.S.N.M., Helm. Coll. 7691.)

Cestracion zygaena.

1913, August 1: 1, in spiral valve. Dimensions, in balsam: Length 32; scolex, length 0.21, breadth 0.18; breadth of pseudoscolex 1.47; breadth of strobile behind pseudoscolex 1.05; posterior segment, length 1.40, breadth 1.90. Dimensions in alcohol before mounting: Length 40; diameter of scolex 0.22; diameter of pseudoscolex 1.82. The scolex agrees in details of structure with that of the form from the tiger shark, but is somewhat smaller. Thus, a scolex from the tiger shark, in balsam, measures 0.26 in diameter, and 0.30 in length. The chief difference between this example from the hammerhead and typical specimens from the tiger shark is that of size. While the posterior proglottides in the hammerhead specimen are not ripe, they are sufficiently developed to show all the genitalia except the uterus, the rudiment of which, however, can be distinguished in the posterior segment. Segments can be distinguished about 3 mm. back of the pseudoscolex, where their length is about 0.04, and their breadth 1.12. Ten mm. back of the pseudoscolex the proglottides are 0.32 in length and 1.54 in breadth. This is in sharp contrast with specimens from the tiger shark, which may be a meter or more in length, the first segments appearing at about one-third of the length of the strobile back of the pseudoscolex.

In spite of these differences, the details of structure are so similar in these cestodes that I do not feel justified in referring those from the hammerhead to a new species. It will be noted that while this cestode is very abundant in the tiger shark, it has been found on but three occasions in the hammerhead. It seems probable that the difference, which is mainly that of size, is due to the fact that the tiger shark furnishes a better physiological habitat for this particular species than does the hammerhead. Confirmation of this view is found in the condition of the material collected from a hammerhead in 1914, noted below.

The scolex was very active, projecting itself into an elongated, conical, proboscis-like tip, then retracting until it was hidden in the

folds of the pseudoscolex. It seemed to be more mobile than the forms from the tiger shark, while the borders of the bothria appeared to be less rigid.

1914, August 6: 1, measuring 115 mm., lying uncompressed in sea water. This specimen was badly macerated, as if affected by the digestive juices of the shark. The cestodes with which it was associated in the spiral valve, were living. Greatest breadth, near anterior end 5 mm.; breadth of posterior segments 3.5, length 2, compressed; breadth of pseudoscolex 6. When the specimen had been fixed in corrosive-alcohol-acetic, and straightened, it measured 147 mm.; in addition there were fragments aggregating 24 mm. Some of these were stained and mounted in balsam; although much macerated such of the anatomy as can be seen is in agreement with this species.

1915, July 19: 1, about 30 mm. in length, with medium sized pseudoscolex was collected from a hammerhead shark by Dr. G. A. MacCallam.

PARATAENIA MEDUSIA Linton.

1890, pp. 862-866. pl. 15, figs. 5-9.

1897a, p. 440.

1900, p. 275.

1901, p. 433; figs. 290, 291.

1905, p. 347.

1910a, p. 695.

1911, p. 587.

Records of this cestode not before published:—

Dasybatis centrura.

Collected in 6 of the years from 1903 to 1922 inclusive. On 1 date in July, 3 from small ray, 1 from large ray. On 3 dates in August: (1) Numerous; (2) 1, length 16 mm.; scolex, length 0.46, breadth 0.49; diameter behind scolex 0.17; distance to first distinct segments 0.14; first segments, length 0.14, breadth 0.19; median segments, length 0.58, breadth 0.22; last segment, length 1.12, breadth 0.29. Some free segments, much elongated, and crowded with minute thin-shelled eggs; (3) few. On 3 dates in September: (1) Few; (2) 2, length 4.5 mm.; (3) 2.

1923, July 7: many; August 15: 1; August 20: 4.

(U.S.N.M., Helm. Coll. 7692.)

ICHTHYOTAENIA ADHERENS, new species.

Plate 6, figs. 55-59.

Taenia, species 1901, p. 428; figs. 274-282.

1911, p. 589.

On July 31, 1899, a number of these cestodes were found attached to the mucous membrane of the spiral valve of a hammerhead shark at Woods Hole, Mass. About a dozen of them had their heads

deeply embedded within a space 10 mm. square. They were recorded as *Taenia*, species, with the comment that they suggested *Taenia gibbosa* Leidy, from a species of *Lamna* of the Pacific coast of North America. Since then I have examined hammerhead sharks at Woods Hole on nine different dates and have found these cestodes on two of those dates.

Type.—U.S.N.M., Helm. Coll. 7693.

Cestracion zygaena.

1903, August 3: 11, not in good condition, being in some cases partly macerated. The length of the longest specimen was 70 mm.; diameter of scolex 0.56, of bothrium 0.21; length of ripe proglottides 4.5, breadth 1.5; eggs large, smoky-brown, 0.21 by 0.14.

1914, August 7: On this date the spiral valve of a 180-centimeter hammerhead was examined; crystalline lenses and spermathecae of squid were found, and four species of cestodes, among them 10 specimens of this cestode. The maximum length was 75 mm. These worms were firmly attached to the mucous membrane. In many cases the scoleces were so deeply embedded that it was necessary to dissect them out in order to secure unbroken specimens. Around the point of attachment some infiltrated blood was noted. There seemed to be a faint patch of red pigment in the neck a short distance back of the scolex.

Galeus glaucus.

1923, July 23: 8, all firmly fixed to the mucous membrane of the spiral valve, which was slightly inflamed, and probably ulcerated at the points of attachment; length 41 mm., maximum breadth 1.4 mm.; densely beset with fine, short, evanescent spines, length about 0.024 mm.

Although several figures were published in the original report on this cestode, the written description was brief, and contained only data recorded at the time the collection was made. A more detailed description than that already published is therefore called for.

The Scolex is subglobular, with the bothria directed forward. The proglottides do not appear immediately behind the scolex. The general habit of the strobile is linear, but the breadth increases rather uniformly. Adult proglottides are longer than broad, and have the angles more or less rounded. Free, ripe proglottides may be three or more times as long as broad. The genital pores are irregularly alternate and situated at about the anterior third of the margin. A characteristic feature of ripe proglottides is the relatively large ova, which are nearly spherical and have thick shells. The dimensions which were given in the original description were of living material which had been washed in fresh water, and was consequently more or less turgid, hence the diameter of the scolex

there given is considerably larger than that given in measurements of material which has been obtained since.

The following dimensions are from measurements of material mounted in balsam, and belonging to the lot collected August 7, 1914.

Length 56; diameter of scolex 0.45, of bothrium 0.14; distance to first proglottis 0.70; length of first proglottis 0.14, breadth 0.42; length of proglottis 10 mm. from scolex 0.30, breadth 0.56; 20 mm. from scolex, length 0.70, breadth 0.84; 30 mm. from scolex, length 1.40, breadth 1.12; 40 mm. from scolex, length 1.40, breadth 1.20; length of last proglottides, average of three, 1.92, breadth 1.47. Another specimen of about the same length was in close agreement with this, the only difference being that the proglottides toward the posterior end were somewhat narrower. Thus, 40 mm. from the anterior end a proglottis measured 1.54 in length and 0.98 in breadth, while the average length of the last three was 1.86 and the breadth 1.12. The length of a free, ripe proglottis in the first lot, before placing in preservative, was 8.5, and the breadth 2.5.

Anatomy of a proglottis.—The cirrus is relatively long and is spinous, the spines measuring as much as 0.014 in length. In sagittal sections as many as seven sections of a retracted cirrus were noted in the same section of a cirrus-pouch. The coils of the vas deferens extend from the base of the cirrus-pouch anteriorly for a short distance near the median line and, in adolescent proglottides, lie beside the rudiment of the uterus. The testes are distributed throughout the interior of the proglottis inside the vitelline layer. In adult proglottides they are relatively large, and appear in sections as a single row of oval-elliptical bodies, from 0.14 to 0.16 mm. in the longer diameter. The vagina lies along the anterior border of the cirrus pouch and crosses the vas deferens near the median line. It then turns toward the posterior and follows the median line, along which its course is somewhat tortuous, to the shell gland which lies near the posterior end of the proglottis between the lobes of the ovary. The ovary lies near the posterior margin of the proglottis and is two-lobed, the lobes being united behind the shell gland. It occupies approximately two-thirds of the breadth and one-fourth of the length of an adolescent proglottis. The vitelline glands are widely distributed. In transverse sections they form a layer lying next within the muscular layer, its continuity being broken only in the vicinity of the genital pore. The uterus, before eggs have made their appearance, is tubular, and lies along the median line, extending from the vicinity of the shell gland near the base, nearly to the anterior end of the proglottis. In ripe proglottides it is much enlarged. In the proglottis sketched in Figure 56, the uterus communicated with the exterior through the ruptured wall of the

proglottis, on the median line, about on a level with the genital pore. The eggs are relatively large, for the most part nearly spherical, and are provided with very thick shells. In an egg measuring 0.18 mm. in diameter, the thickness of the shell was 0.012. All of the ova seen were segmenting. The largest number of nucleated cells noted in any section of an egg was 24.

DISCOCEPHALUM PILEATUM Linton.

Plate 1, fig. 7.

1890, pp. 781-787, pl. 10, figs. 1-7.

1900, p. 272.

1901, p. 427.

1907*d*, p. 97, pl. 5, fig. 31.

1907*e*, p. 116.

1908*b*, pp. 168-169, pl. 1, fig. 8.

1911, p. 586.

Hosts: *Carcharhinus commersonii*, Woods Hole, Mass.
limbatus, Woods Hole, Mass.
milberti, Woods Hole, Mass.
obscurus, Woods Hole, Mass.
platyodon, Bermuda and Tortugas.
Scoliodon terrae-novae, Woods Hole, Mass.

Following are records of this cestode not before published:

Carcharhinus commersonii.

1923, August 4: 1, length 410 mm.; maximum breadth, 8 mm.

Carcharhinus limbatus.

1918, July 13: 14, attached to anterior third of wall of spiral valve of a 210 centimeter shark; length of smallest, 65 mm., one of the largest measured 450 mm. in length.

Carcharhinus milberti.

1915, August 12: 4, large specimens with ripe proglottides, attached at anterior end of spiral valve, from one of six sharks examined on this date. The scoleces of these cestodes, in shape something like a mushroom-anchor, have invariably been found firmly attached to the wall of the intestine, the muscular disk penetrating the mucous membrane, and removable only by dissection. Length variable, in sea water about 500 mm., and 10 mm. broad at widest part; segments toward posterior end have a tendency to become narrower; no free segments were seen. Enormous numbers of eggs were discharged. In a short time the bottom of the dish in which the worms were lying, was covered with ova, which, at first, were white, but shortly became dark colored. These ova were segment-

ing, and were somewhat irregular in outline; shell thin; 0.10 by 0.08 in the two principal diameters. These worms were much broader than those obtained from the black-finned shark on July 13. In other particulars, including the character of the ova, they were in agreement.

(U.S.N.M., Helm. Coll. 7694.)

Carcharhinus obscurus.

1914, September 1: 2, lengths 60 and 130 mm. Attached firmly to intestinal wall, the disk embedded in the mucosa. It was necessary to dissect it out before it could be removed.

1916, July 26: 2, scoleces missing, in one of three sharks. The sharks had been dead for some time. The scoleces were searched for with some care, but were not found. The strobiles were slightly macerated. After lying in sea water for a short time large numbers of segmenting eggs were discharged. Length of strobiles, 245 and 430 mm. respectively.

1918, August 5: 19, from one of three 165 centimeter sharks. These were all firmly attached to the wall of the spiral valve; 15 were attached in a row, 36 mm. in length; length of largest 360 mm., with a maximum breadth of 8 mm.; 4 small, immature specimens, in a cluster, length of each 25 mm.

Scoliodon terrae-novae (fig. 7).

1914, August 20: 2, lengths 140 and 240 mm. respectively. These agree with *D. pileatum*, except that the terminal disk is smaller than the cervical mass. The disk was ivory white, with a diameter of 0.80; when extended it was separated from the cervical mass by a constricted portion, 0.22 in length, and 0.60 in diameter; length of cervical mass 0.75, diameter 0.90. The general appearance of the scolex when fixed without compression bears some resemblance to the genus *Tylocephalum*.

The scolex was rather actively contractile, and showed a considerable variety of contraction phases.

There is a marked difference between the scoleces of these cestodes from the sharp-nosed shark and those from the dusky shark; the ratio of anterior disk to cervical mass being 0.82 to 140 in the former, and 1.82 to 1.40 in the latter, measurements made on specimens mounted in balsam. A comparison of the strobiles, however, does not reveal differences sufficient to justify referring them to different species. The posterior, ripe proglottides in each become longer than broad. The ova agree in size and appearance, having in each rather thin shells, irregularly collapsed, brownish, with a maximum size of about 0.11 by 0.07 mm.

OTOBOTHRIUM CRENACOLLE Linton.

Plate 13.

IN FINAL HOST, ADULT.

- 1890, pp. 849-853, pl. 13, figs. 9-15; pl. 14, figs. 1-4.
 1900, p. 273.
 1901, p. 428.
 1905, p. 344.
 1907*b*, p. 122.
 1907*e*, p. 116.
 1908*b*, pp. 163, 185.

ENCYSTED, LARVAL.

- 1897*b*, *Tetrarhynchus*, pt. pp. 807-809, pl. 16, figs. 6-9.
 1901, *Rhynchobothrium*, pp. 453-454, pl. 23, figs. 255-256*a*; pl. 24, fig. 265.
Octobothrium crenacolle.
 1905, pp. 331, 340, 350, 363, 369, 372, 377, 381, 384, 386, 388, 395, 409, 413, figs. 110-115.
 1907*b*, pp. 113-132, pls. 1, 2.
 1907*d*, pp. 99, 100.
 1910*a*, pp. 692, 694-5.
 1910*b*, pp. 1201-1207.
 1911, p. 586.
 1912, pp. 5-9.
 1914, pp. 53-56.
 1915, pp. 19-28.

The adult stage of this cestode has been found in the spiral valve of *Carcharhinus obscurus*, at Beaufort, North Carolina, and Woods Hole, Massachusetts; *C. platyodon*, at Tortugas; *Scoliodon terrae-novae*, at Beaufort; *Cestracion zygaena*, at Woods Hole.

In the encysted stage it has been found, in Bermuda, in *Balistes carolinensis*, *Diplodus sargus*, *Ocyurus chrysurus*; at Beaufort, in *Bairdiella chrysurus*, *Carcharhinus obscurus*, *Coryphaena hippurus*, *Cynoscion nebulosus*, *Galeichthys milberti*, *Lagodon rhomboides*, *Micropogon undulatus*, *Opsanus tau*, *Orthopristes chrysopterus*, *Pomatomus saltatrix*, *Scoliodon terrae-novae*, *Scomberomorus regalis*; at Woods Hole, in *Carcharhinus limbatus*, *C. commersonii*, *C. obscurus*, *Caranx chrysos*, *Ceratocanthus schoepfii*, *Cynoscion regalis*, *Fundulus heteroclitus*, *Galeorhinus laevis*, *Lobotes suranensis*, *Paralichthys dentatus*, *Peprilus alepidotus*, *Pomatomus saltatrix*, *Poronotus triacanthus*, *Sarda sarda*, *Scomberomorus cavalla*, *Squalis acanthias*, *Trichiurus lepturus*, *Xiphias gladius*.

The encysted stage was found in the flesh of these species of fish: *Ceratocanthus schoepfii*, *Peprilus alepidotus*, and *Poronotus triacanthus*. In other hosts it was found in the submucosa of the stomach wall, in the mesentery, and on the viscera.

Following are records of finds of this cestode not hitherto published:

Adult stage. All at Woods Hole, Mass.

Carcharhinus obscurus.

1910, July 25: 1.

1913, August 6: 5.

Cestracion zygaena.

1908, August 27: 3, and numerous ripe proglottides free in the chyle of the spiral valve.

1912, August 9: Few, with free, ripe proglottides. The shark had been harpooned by Mr. Charles Grinnell on the 8th, and was not examined until the next day. The cestodes were somewhat macerated, but some of the ripe segments were still active.

1913, August 1: 2.

1914, August 7: Many, and large numbers of free, ripe proglottides, which were slender, wormlike, and active, even after lying for some time in sea water.

(U.S.N.M., Helm. Coll. 7695.)

Larval stage.*Caranx chrysos.*

1910, September 22: 1, from small piece of stomach in vial.

Carcharhinus limbatus.

1915, August 6: Encysted in large numbers in submucosa of stomach.

1918, July 13: Very numerous in submucosa of stomach.

1923, July 28: Numerous, in submucosa of stomach.

Carcharhinus obscurus. (See p. 7.)

1907, August 3: Few, in amber colored cysts in stomach wall.

1911, August 3: Rather numerous, in submucous coat of stomach, most abundant near posterior end of cardiac portion. Some of the cysts were yellow. on account of the presence of degenerate tissue.

1912, September 12: Large numbers of cysts in submucosa of stomach; oval-elliptical, 1 to 1.5 mm. in diameter; submucosa of entire stomach thickly covered with these cysts, estimated to average 50 to the square inch.

1914, September 1: Cysts in stomach wall in enormous numbers. The stomach was examined in several places and these cysts were found in great numbers in all of them, most numerous at pyloric end. It was estimated that there were 12 cysts to every square centimeter of surface. The cysts were mostly yellowish, some were yellowish brown, and contained only degenerate tissue. Cysts which contain the characteristic scoleces of this cestode are from 1 to 2 mm. in the longer diameter. What was at first taken to be a cyst, 6 mm. in diameter, on the intestine of this shark, proved to be a small outfolding of the mucous membrane, filled with chyle. Its communication with the lumen of the intestine was nearly occluded.

1918, August 20: Cysts in submucosa of stomach. not numerous.

C. commersonii.

1923, August 25: Great numbers of cysts in mucous membrane of stomach of 184-centimeter shark, 100 cysts of *O. crenacolle* and one

Synbothrium filicollis in a piece of submucosa 12 by 8 mm., a large part of the stomach similarly infected; typical cyst 1.4 by 0.8 mm., largest 2 by 1.25 mm.

August 29: Very numerous in submucosa of stomach.

August 30: 1 cyst seen in submucosa, a few portions only of the stomach examined.

Ceratacanthus schoepfi.

1909, August 17: Numerous cysts in the flesh, most abundant near the back bone, associated with larvae of *Dibothrium*, species. Dimensions of one: Cyst 1.12 by 0.70; plerocercus 0.90 by 0.50; length of scolex 0.33.

Cynoscion regalis.

1903, August 20: Cysts in stomach wall; 1 fish examined.

1904, July 8: Cysts in stomach wall; 4 fish examined. August 6: 2 cysts, one of which contained 3 plerocerci.

1905, July 8 to 27: Cysts in stomach wall, few to many, in some cases associated with *T. bisulcatus*; on six dates; 29 fish examined.

Fundulus heteroclitus.

1904, August 26: 1 scolex, in dish in which viscera of 104 fish had been lying.

Lobotes surinamensis.

1908, August 15: Numerous, encysted in stomach wall.

Paralichthys dentatus.

1910, July 28: Encysted in stomach wall; 1 fish examined.

1920, August 25: Cysts in stomach wall, associated with *R. bulbifer*, 1 fish examined.

Peprilus alepidotus.

1908, July 24: Three fish, 11.5, 12.5, and 13.5 centimeters in length examined on this date. Each had numerous cysts in the flesh. Diameter of cyst, 0.7 by 0.5; plerocercus active, contracting between the lengths, 0.5 and 0.8; scolex, compressed, length, 0.8, diameter, 0.35, diameter of neck, 0.16, of scolex, 0.35, length of bothrium, 0.35; bulbs, length 0.07, breadth, 0.04.

July 29: Five fish, 13.5 centimeters in length, all had cysts in the flesh, 3 numerous, 2 many. Fish from Menemsha Bight trap. Cysts distributed as in the common butterfish, viz. above and below the vertebrae, most abundant ventral to the vertebrae above the posterior end of the body cavity, and between the body cavity and the caudal fin.

August 7: Two fish from Nantucket, J. H. Barrett, collector. These fish, 13 and 14 centimeters in length respectively, each had

numerous cysts in the flesh distributed both above and below the vertebrae, and through the muscles to the dorsal and ventral limits, mainly in the dorso-ventral median plane. Two fish on the same date, from Menemsha Bight, Daniel West, collector, and measuring 14 centimeters in length, each had numerous cysts in the flesh, also in the walls of the stomach.

October 10: Seven fish, examined by Vinal N. Edwards, all had cysts in the flesh.

1918, July 9: One fish from trap at Lamberts Cove. Cysts numerous in flesh.

Pomatomus saltatrix.

1910, July 1: Many on submucosa of 14-pound fish; most of the cysts amber color; a cyst, uncompressed, measured 1.82 by 0.70 mm.; a plerocercus, compressed, 2.38 by 1.05; length of scolex, 0.42.

1911, July 17: Small cysts in submucosa in each of 10 stomachs, very numerous. Some of these cysts contained typical scoleces of this species; others contained scoleces with somewhat longer necks, and of a yellowish color.

1912, August 16: Encysted in large numbers in submucosa of stomachs of 3 fish.

Poronotus triacanthus.

Occasionally found on viscera, but more often in the flesh; see special reports. Examinations of butterfish for flesh parasites have been made over a series of years. Following is a summary of the results of these examinations since 1908:

Year.	Length in centimeters.	Number of fish examined.	Number with many cysts in flesh.	Number with few cysts in flesh.	Number with no cysts in flesh.
1909	20 centimeters and over.....	282	175	83	24
	15 to 20 centimeters.....	131	82	31	18
	10 to 15 centimeters.....	43	15	16	12
	Less than 10 centimeters.....				
	Total for 1909.....	456	272	120	54
1910	20 centimeters and over.....	297	114	109	74
	15 to 20 centimeters.....	111	43	30	28
	10 to 15 centimeters.....	8	8		
	Less than 10 centimeters.....				
	Total for 1910.....	416	165	139	102
1911	20 centimeters and over.....	183	73	55	55
	15 to 20 centimeters.....	154	87	43	24
	10 to 15 centimeters.....	66	26	31	9
	Less than 10 centimeters.....	263	200	60	3
	Total for 1911.....	666	386	189	91
1912	20 centimeters and over.....	300	115	99	86
	15 to 20 centimeters.....	182	50	65	67
	10 to 15 centimeters.....	247	41	67	139
	Less than 10 centimeters.....	217		3	214
	Total for 1912.....	946	206	234	506

¹ On September 9, 1911, 36 butterfish, less than 10 centimeters in length, were all found to have cysts in the flesh, 12 with few, 24 with many. On September 15 of the same year, 220 butterfish, less than 10 centimeters in length, were also all found to have cysts in the flesh, 43 with few, 177 with many. These were exceptional cases. I have found butterfish which are less than 10 centimeters in length, as a rule, to be practically free from cysts in the flesh.

Year.	Length in centimeters.	Number of fish examined.	Number with many cysts in flesh.	Number with few cysts in flesh.	Number with no cysts in flesh.
1913	20 centimeters and over.....	412	135	147	130
	15 to 20 centimeters.....	264	29	136	99
	10 to 15 centimeters.....	396	24	262	110
	Less than 10 centimeters.....				
	Total for 1913.....	1,072	188	545	339
1914	20 centimeters and over.....	80	25	26	29
	15 to 20 centimeters.....	210	22	67	121
	10 to 15 centimeters.....	404	114	125	165
	Less than 10 centimeters.....	96		3	93
	Total for 1914.....	790	161	221	408
1915	20 centimeters and over.....	222	18	72	132
	15 to 20 centimeters.....	394	29	145	221
	10 to 15 centimeters.....	104	3	29	72
	Less than 10 centimeters.....	5			5
	Total for 1915.....	725	50	246	430
1916	20 centimeters and over.....	295	9	98	188
	15 to 20 centimeters.....	327	49	174	103
	10 to 15 centimeters.....	27	5	15	7
	Less than 10 centimeters.....	40			40
	Total for 1916.....	689	63	287	338
1917	20 centimeters and over.....	18	1	8	9
	15 to 20 centimeters.....	36	9	16	11
	10 to 15 centimeters.....	26	1	1	24
	Less than 10 centimeters.....	38			38
	Total for 1917.....	118	11	17	82
1918	20 centimeters and over.....	26	1	8	17
	15 to 20 centimeters.....	48	19	22	7
	10 to 15 centimeters.....	8		6	2
	Less than 10 centimeters.....	2			2
	Total for 1918.....	84	20	36	36
1919	20 centimeters and over.....	53	5	22	26
	15 to 20 centimeters.....	33	4	11	18
	10 to 15 centimeters.....	2	1		1
	Less than 10 centimeters.....				
	Total for 1919.....	88	10	33	45
1920	20 centimeters and over.....	11		5	6
	15 to 20 centimeters.....	6		4	2
	10 to 15 centimeters.....	21			21
	Less than 10 centimeters.....	80		1	79
	Total for 1920.....	117		9	108
1922	15 to 20 centimeters.....	6		2	4
	10 to 15 centimeters.....	5		3	2
	Less than 10 centimeters.....				
	Total for 1922.....	11		5	6

(U.S.N.M., Helm Coll. 7696.)

Scomberomorus cavalla.

1920, August 2: Numerous cysts in submucosa of stomach; 1 fish examined.

Squalus acanthias.

1907, August 15: Few, yellow, in wall of stomach. One was crushed, and proved to be a degenerated tetrarhynch with hooks agreeing with *O. crenacolle*.

Trichiurus lepturus.

1903, July 6: Several clusters of cysts on viscera, some with black pigment; 212 large, 28 small fish examined.

Xiphias gladius.

1904, July 15: A few cysts from peritoneal coat of pyloric caeca, associated with small waxy cysts; length of larva 0.67 mm.; 4 fish examined.

OTOBOTHRIMUM DIPSACUM Linton.

1897b, pp. 806-7, pl. 66, figs. 1-5

1901, p. 451.

1905, p. 375.

1911, p. 586.

Only the encysted stage of this cestode has been found; in *Pomotomus saltatrix*, in the Woods Hole region, and in *Centropristes striatus*, at Beaufort, N. C. Following are records not before published:

Ceratacanthus schoepfi.

1915, August 21: 7 large cysts from body cavity, maximum 17 by 7, minimum 7.5 by 3.25. A cyst, 9 by 6 mm. when opened, released a plerocercus, length 5.25, diameter 3 mm. Under pressure a scolex with the characteristic proboscides of this species was seen; 1 fish examined.

1920, July 28. Large cysts, for the most part rather triangular in outline, from viscera; maximum 20 by 10 mm.

(U.S.N.M., Helm, Coll. 7697.)

Mycteroperca falcata.

1911, June 5; Cysts from serous coat of intestine. long-clavate, bluish black, for about half the length from the smaller end; one measured 24 mm. in length, and 6 mm. in diameter at larger end, tapering to 2 mm. at the smaller end; another 17 by 5; larva, length 2.5, breadth of head 1.5. Collected by Dr. F. A. Brink, State board of health of Florida, Pensacola, Florida.

Pomotomus saltatrix.

1904, July 22: 1, plerocercus about 12 mm. in length, and 6 mm. in diameter; length of larva 3.68, of head and neck, scolex, 3.45, of bothrium, at rest, 1.35; diameter of head, in front, 0.60, at base of flaring bothria, 1.65 to 3.15, very variable, contracting and expanding; diameter of neck, behind head, 0.75, at base of bulbs, 1.20; length of bulbs 1.50, diameter 0.22; diameter of proboscis, including hooks, 0.22.

Xiphias gladius.

1920, July 27: 1 cyst from viscera, oval, 12 by 6 mm.; 2 fish examined.

OTOBOTHRIMUM PENETRANS Linton.

Plate 7, figs. 60-70.

1905, *Otobothrium*, species, pp. 357-358, figs. 102-109.

1907d, *O. penetrans*, p. 100, pl. 6, figs. 39-48.

1908a, p. 114.

1910b, p. 1202.

This specific name was first used to designate certain larval cestodes found encysted in the flesh of the gar, *Tylosurus acus* in Bermuda

in July, 1903. The same forms had been found in the flesh of the needle-fish, *T. raphidoma*, at Beaufort, N. C., in August, 1901, and recorded as *Otobothrium*, species.

I have found the adult stage of this tetrarhynch in the hammerhead shark, *Uestracion zygaena*, on two occasions, at Woods Hole, Massachusetts.

On the evening of August 2, 1908, a hammerhead shark, taken off Nomansland by Captain J. W. Fuller, of Provincetown, was brought to the laboratory of the United States Bureau of Fisheries. It was not opened until the following morning. The stomach contained fragments of fish and squid, large numbers of lenses, both of fish and squid, and a few "pens" of squid.

The cestodes, of which two species were found in the spiral valve, were somewhat macerated, especially at the anterior ends. Six of the larger cestodes, with free, ripe proglottides, were recognized as the adult stage of *O. penetrans*. The longest of the strobiles measured 160 mm. before, and 130 mm. after having been placed in alcohol. Length of scolex, 5 mm., breadth, in front, and at posterior end, near base of contractile bulbs, 3.25, breadth in middle, 2; free proglottides, length 8, breadth 4.5; eggs, 0.036 by 0.027.

The scoleces were not in good condition, the bothria were much crumpled, and the pits, characteristic of this genus, could not be made out, but all features present were in agreement with the genus *Otobothrium*, and the hooks on the proboscides, so far as seen, agreed with the species *O. penetrans*.

On August 18, 1913, a single specimen of this cestode was obtained from the spiral valve of a hammerhead shark. The shark measured 285 centimeters in length. The stomach contained numerous lenses of large fish, and a considerable quantity of oil.

The following measurements were made of material before it had been placed in preservative: Length of strobile, 103 mm.; scolex, length 4, breadth, anterior, 2.5, posterior, 3.5; last proglottis, length 5.5, breadth, 3.5; largest free proglottis, length, 8.5, breadth 3.5. There were also found twelve free proglottides, one short fragment of three segments, and a fragment of the posterior end of a strobile measuring 55 mm. in length. The strobile was flat and thin, the scolex subcylindrical. The bothrial pits were not made out at the time of collecting, but can be seen in the stained and mounted scolex.

A specimen of this species was collected by Dr. Davenport Hooker from *Carcharhinus commersonii*, at Tortugas, on July 26, 1907, and brought to me at Woods Hole by Dr. A. G. Mayor.

(U.S.N.M., Helm. Coll. 7698.)

In the original description of the species the statement that the bothria are marginal is misleading. It was probably written from the appearance of cross sections of the scolex made through the

bothria. The bothria are really placed on the sides of the scolex which coincide with the flat surfaces of the strobile.

Following are measurements of a specimen mounted in balsam: Length, 115 mm.; scolex, length, 4.5, breadth, near anterior end, 1.33, middle, 0.93, posterior, at base of widely flaring bulbs, 2.24; breadth of strobile at junction with scolex, 1.28, quickly increasing to 1.68; distance to first proglottides, 1.54; length of first proglottides, 0.07, breadth, 1.96; length of proglottis, 10 mm. from scolex, 0.52, breadth, 1.90; 20 mm. from scolex, length 1.12, breadth 1.88; 40 mm. from scolex, length 2.10, breadth 1.96; length of posterior proglottis 5.5, breadth, 1.96.

Scolex.—The bothria, in alcoholic specimens, are little, if any, wider than the axial portion of the scolex; in some of the mounted specimens they are contracted until they are not as broad as the portion of the axis which they enclose. There seems to be a tendency on the part of the bothria to contract strongly. The surface of the scoleces between the bothria and the contractile bulbs is roughly papillate. This is in agreement with the description of the scoleces from *Tylosurus raphidoma*. This character was not noted in the scoleces from *T. acus*, but, upon reexamining a mounted scolex from that host, I find the same character exhibited. The proboscides are rather stout, and are armed with hooks of a variety of shapes and sizes. The proboscis sheathes are slightly tortuous, and the retractile muscle is attached near the proximal ends of the bulbs, which, as is usually the case in this genus, are widely flaring. The scolex, as a whole, is somewhat hour-glass shape, and the posterior end slightly overlaps the beginning of the strobile. Transverse sections of the scolex of the adult and of larval forms show similar structure.

Strobile.—The strobile is flat and thin, and does not vary much in width throughout its length. The proglottides begin near the scolex, are at first very much broader than long, soon become squarish and ultimately become much longer than broad. The genital apertures are marginal, irregularly alternate, and are placed at about the posterior third of the length. Each is marked by a shallow notch with vertical walls.

Reproductive organs.—The sectioned material is not entirely satisfactory, but the following points were made out: The common genital pore opens into a shallow marginal notch. The vagina lies behind the cirrus-pouch, and enters the common duct near the marginal aperture. The cirrus-pouch is small, oval-elliptical, and horizontally placed. The vas deferens is voluminous. The testes occupy the entire median axial region, in sagittal sections being interrupted only by the cirrus-pouch and ovary. In a series of sagittal sections, 80 in all, the vagina joins the cirrus at the 6th section from the marginal genital notch. The cirrus-pouch continues

for about ten sections, that is to about the 16th section from the margin. Sagittal sections show that the proglottis thins a little in the vicinity of the cirrus-pouch. For example, in a sagittal section with maximum breadth, representing the thickness of the proglottis, of 0.25, the thickness at the level of the cirrus-pouch was 0.18, and the diameter of the pouch at this point was 0.14.

The vagina turns posteriorly near the median line, and enlarges into a relatively spacious seminal receptacle which occupies a median axial position. A slender sperm duct, which lies in a somewhat close and irregular spiral, leads from the seminal receptacle to the germ duct, which is joined later by a single yolk duct. The shell gland appears in the sections as a very compact structurē, granular in its central portion. The anterior border of the two-lobed ovary is about on a level with the posterior angle of the marginal genital notch. Its breadth is about half that of the proglottis, the length about equal to the breadth, and the distance between its posterior border and the posterior end of the proglottis equals approximately the breadth of the ovary. The vitellaria are distributed throughout the proglottis, showing in sections as a layer lying within the muscular layer of the body wall, and continuous, in adult proglottides, in which eggs have just begun to appear, except in the immediate vicinity of the cirrus-pouch. The uterus begins as a slender duct leading from the shell gland, quickly expands into a capacious pouch, is, in earlier proglottides, somewhat sacculate on its lateral margins, but in ripe proglottides comes to fill practically all the interior in front of the cirrus pouch.

In mounted material the ova are for the most part collapsed and boat shaped, with length up to 0.04 mm. Two, not collapsed, measured 0.039 by 0.028, and 0.042 by 0.028 in the two principal diameters.

RHYNCHOBOTHRUM ATTENUATUM Diesing.

1897*b*, pp. 805-806, pl. 5, figs. 8-11.

1900, p. 278.

1901, p. 448.

1911, p. 587.

Records of this species not heretofore published:

Larval stage.

Carcharhinus milberti.

1922, August 5: 1, from serous coat of viscera.

Vulpecula marina.

1912, August 7: 2, from serous coat of liver of a 510-centimeter shark, taken at Menemsha Bight, stomach and intestine brought to laboratory by Vinal N. Edwards. The stomach contained only a few vertebrae, lenses and otoliths of fish. These larvae were placed in

sea water, when each of them immediately turned and thrust its proboscides through its own body; length 35 mm., breadth 5.

Xiphias gladius.

1904, July 15: Many, in body cavity on viscera and peritoneum, in each of 3 swordfish. When placed in sea water they contracted to 30 mm., or less, and elongated to 100 mm., or more. These larvae are not encysted, but are wandering under the serous membrane of the viscera and body wall. One of the fish had many of the copepod parasite, *Penella plumosa*, burrowing into the flesh, some of them penetrating into the body cavity, where their heads were encysted. More internal parasites were found in this fish than in either of the others.

July 20: Many, in body cavity of each of 3 swordfish.

July 28: Many, on peritoneum of 1 swordfish.

1911, July 13: 40 from one swordfish, 8 from another; on viscera and peritoneum; probably not all collected; most of them white, one decidedly yellow; very contractile.

1912, July 20: 2, from viscera of 1 swordfish.

1913, July 7: Many, on viscera and peritoneum of 1 swordfish.

1920, July 27: About 10, from each of 2 swordfish; viscera and peritoneum. After lying in sea water for some hours they became much elongated, one of them measuring 150 mm.

(U.S.N.M., Helm. Coll. 7732.)

RHYNCHOBOTHRIMUM BULBIFER Linton.

1889b, *R. tenuicolle* RUDOLPHI, pp. 486-488, pl. 5, figs. 17, 18.

1890, *R. bulbifer* LINTON, S25-S29, pl. 10, figs. 8, 9, pl. 11, figs. 1, 2.

1897a, p. 448.

1900, p. 270.

1901, pp. 425, 436, 445, 447, 451, 460, 464, 482.

1910a, pp. 1201, 1202.

Adult stage.

The length of the hooks near the base of the proboscis greater than that given in the original description, being about 0.03 mm.

Galeorhinus laevis.

Collected in 7 of the years from 1903 to 1915, inclusive: On 5 dates in May, 5 to 75 strobiles, with from few to many free proglottides, 8 dogfish examined; 6 dates in June, 4 to 80 strobiles, free proglottides found on some of the dates, 24 dogfish examined; 7 dates in July, 4 to 100 strobiles, 9 dogfish examined; 9 dates in August, 2 to 6 strobiles, 9 dogfish examined; 2 dates in September, 1 and free proglottides from 1 dogfish on 1 date, 2 in 1 of 2 dogfish on the other.

(U.S.N.M., Helm. Coll. 7699.)

Squalus acanthias.

1904, June 6: 32, and free proglottides, from 4 dogfish.

1910, July 29: 3.

1914, October 13: 1, in spiral valve, still in cyst; sand eels in stomach. Cysts of this cestode are not uncommon in the flesh of the sand eel.

1922, August 29: 2, from 1 of 3 young spiny dogfish. Collected by Dr. G. A. MacCallum.

1923, July 23: 1.

August 4: about 12 in each of 3 dogfish.

Vulpecula marina.

1923, August 27: 5 in spiral valve.

Larval stage.

The cysts and plerocerci of this species are often club-shaped, or gourd-shaped, the larger end being subglobular, the remainder, which is of much smaller diameter and cylindrical, may be either straight or curved. Usually encysted on viscera, and in intestinal wall, but common in the flesh of sand eels, silverside, and young herring.

Acanthocottus octodecimspinosus.

1904, October 28: 1 cyst.

1910, October 14: A few cysts, some with degenerate tissue; 8 fish examined.

Ammodytes americanus.

Collected in 4 of the years from 1905 to 1914, inclusive: On 1 date in July, 2 cysts found by Dr. C. W. Hahn in the flesh near the tail fin. On the same date 25 fish were examined and 1 cyst found on the viscera; 4 dates in August—(1) 1 thin-walled cyst on viscera; (2) numerous characteristic plerocerci in thin-walled cysts on mesentery, 19 fish from stomach of squeteague; on same date in a lot of 16 sand-eels from the stomach of a bonito 2 cysts were found; (3) numerous, encysted in muscles of most of about 40 sand-eels from the stomach of a bonito; (4) many, in muscles, most abundant near caudal fin, 2 fish; 1 date in October, cysts, presumably from viscera, 12 fish; 1 date in November, a few cysts clustered in flesh under backbone; another record on same date, many cysts in flesh. Mr. Edwards reported that 7 out of 100 fish had cysts in the flesh.

Anguilla rostrata.

Collected in 7 of the years from 1904 to 1914, inclusive: On 1 date in April, 1 cyst; 1 date in May, 2 cysts, length 4 mm., 1 eel examined; 3 dates in July—(1) few small, pedicelled cysts on viscera, 7 eels; (2) characteristic gourd-shaped cysts and plerocerci on mesentery, 5 eels; (3) 20 cysts in walls of stomach and intestine of 2 eels; 4 dates in August—(1) few, characteristic cysts on viscera in 3 of 7 eels; (2) numerous cysts in intestinal wall, 1 eel; (3)

1 small, typical cyst, 3 eels; (4) many in intestinal wall of 2 out of 25 eels; 1 date in September, 16 cysts on intestine of 1 of 10 eels; 1 date in November, cysts of diverse shapes, elongated, cylindrical, claviform, reniform, etc., 6 eels.

Caranx chrysos.

1908, August 31: 1 cyst in intestine, introduced with food.

Clupea harengus.

Collected in 5 of the years from 1910 to 1920, inclusive: On 1 date in February, encysted in fragments of flesh of young herring from stomach of a gar; 6 dates in August, encysted in the flesh, on the viscera, and in the intestine (introduced with food), 15 fish, ranging in length from 52 to 74 mm.

Cynoscion regalis.

1904, August 6: A few small plerocerci, in intestine, probably recently introduced with food, 3 fish examined.

Elops saurus.

1905, October 17: 1 cyst, rather larger than usual, length 5.74 mm.; hooks typical.

Gadus callarias.

Collected in 3 of the years from 1904 to 1915: On 2 dates in January—(1) piece of intestine in bottle, with many cysts in its walls, 10 fish examined; (2) 1 cyst, 12 fish; 2 dates in November—(1) 1 small cyst, 20 fish; (2) 1 small cyst.

Gasterosteus bispinosus.

Collected on 1 date in July, few small, characteristic cysts in flesh, 10 fish examined; 2 dates in August—(1) 12 cysts in flesh of 1 fish, 6 in flesh of another, near backbone, 1 near caudal fin; (2) numerous cysts in flesh of sides from middle to near caudal fin, plerocerci globular with long slender appendage, 1 fish examined.

(U.S.N.M., Helm. Coll., 7700.)

Gymnosarda alleterata.

1905, August 12: Several characteristic cysts and plerocerci, from intestine, evidently recently introduced with sand eels, with which the stomach was filled.

Lophopsetta maculata.

1910, July 21: 1 cyst, typical plerocercus and scolex, collected by Dr. C. W. Hahn.

Menidia notata.

Collected in 4 of the years from 1906 to 1913: On 5 dates in August—(1) few characteristic cysts from viscera of a large number of silversides, brought to me by Dr. I. A. Field, who was experi-

menting with this species in the manufacture of sardines; (2) 1, from flesh, dorso-lateral region, 38 fish examined; (3) 1 cyst from viscera, 21 fish examined; (4) 1 cyst from viscera, 35 fish examined; (5) 4 cysts, typical. Dr. C. W. Hahn, to whom I am indebted for these specimens, said that about 1 out of 8 of the silversides which he had been examining for sporozoa, had these cysts in the flesh. The cysts were not numerous, 6 or 7 at most, usually near the tail, and easily seen when the fish is held up to the light.

Menticirrhus saxatilis.

Collected in 3 of the years from 1909 to 1912: On 2 dates in July—(1) 4 plerocerci in intestine, evidently introduced with the sand eels in the stomach, 1 fish examined; (2) cysts in intestine, evidently recently introduced with food, sand-eels in stomach, 9 fish examined; 1 date in October, 1 plerocercus in intestine, 10 fish examined.

Merluccius bilinearis.

Collected in 3 of the years from 1907 to 1916: On 3 dates in August—(1) 1 slender, but characteristic cyst, 16 fish examined; (2) 1 cyst on viscera, 5 fish examined; (3) cysts in intestine, probably introduced with young herring, 12 fish examined; 1 date in October, 1, typical, in intestine, round herring in stomach, 3 fish examined.

Microgadus tomcod.

Collected on 2 dates in July: Few cysts on viscera, 13 fish examined on each date.

Myoxocephalus aeneus.

1905, July 28: 2 small cysts, 1 fish examined.

Narcacion nobilianus.

Collected on 1 date in August, 1 cyst, with characteristic plerocercus, and larva in spiral valve, evidently recently introduced; 1 date in October, 1 cyst with larva; proboscides retracted, but characteristic hooks of the species seen; length of bothrium 0.45, breadth 0.37; length of contractile bulb 0.42.

Palinurichthys perciformis.

1910, August 20: 1 small cyst on viscera, 1 fish examined.

Paralichthys dentatus.

Collected on 2 dates in August—(1) numerous cysts in intestine, lately introduced with food, 2 fish examined; (2) small cysts in stomach wall, associated with *O. crenacolle*, 1 fish examined; 1 date in September, 3 plerocerceri, recently introduced with food.

Pomatomus saltatrix.

Collected on 3 dates in August—(1) 1 cyst from serous coat of intestine, 3 fish examined; (2) 1 plerocercus in intestine, introduced with food, 1 fish on each of 2 dates.

Poronotus triacanthus.

Collected in 5 of the years from 1904 to 1913: On 3 dates in July—(1) several small, gourd-shaped cysts, clear faint amber yellow, on viscera, 2 fish examined; (2) 1 cyst from viscera, collected by Dr. C. W. Hahn; (3) 1 cyst from viscera, 1 fish examined; 1 date in August, a few small cysts, mostly elongated, cylindrical, 2 fish examined.

Prionotus carolinus.

1913, August 3: A few pleurocerci in intestine, evidently introduced with sand eels, with which the stomach was filled. Dr. G. A. MacCallum.

Pseudopleuronectes americanus.

1908, August 20: 1, encysted in flesh, dorso-lateral region.

1913, December 29: Encysted on pyloric caeca.

Raja erinacea.

1905, August 23: Small, pyriform cyst, evidently recently introduced with food; scolex resembles this species; bothria emarginate, length 0.31, breadth about the same; length of contractile bulbs 0.22, breadth 0.14; diameter of proboscis, excluding hooks, 0.33; only base of proboscis everted, which bore a few slender hooks, longest 0.024.

1906, July 30: Small white cysts in wall of spiral valve near rectum; some had degenerated and contained carbonate of lime; one cyst was found with living larva, the hooks agreeing with this species.

Raja diaphanes.

1914, November 4: 1 cyst in spiral valve, evidently recently introduced with food; sand eels in stomach.

Roccus lineatus.

1912, September 11: Typical plerocerci in intestine, evidently introduced with sand eels, with which the stomach was filled, 1 fish examined.

Sarda sarda.

Collected on 2 dates in August—(1) 1 cyst from viscera, 1 fish examined; (2) cysts in intestine, evidently introduced with sand eels, of which there were 16 in the stomach.

Scomber scombrus.

Collected in 4 of the years from 1895 to 1914: On 2 dates in July—(1) few cysts on pyloric caeca, 12 fish examined; (2) a few

cysts on viscera, typical, some oval, 12 fish examined, 1 date in August, 12 cysts on mesentery and serous coat of viscera; 1 date in September, 1 cyst, 1 fish examined; 3 dates in October, a few small cysts on viscera on each date, number of fish examined 6, 14, and 12.

Selar crumenophthalmus.

1913, August 29: 3 typical cysts, plerocerci and larvae, 14 fish examined.

Spheroides maculatus.

Collected on 3 dates in August—(1) 15 characteristic cysts, 2 fish examined; (2) small cysts, serous coat of intestine, 2 fish examined, (3) 1 cyst, 1 fish examined.

Tautoga onitis.

Collected on 2 dates in August—(1) several cysts in walls of stomach and intestine, some degenerate; (2) 3 cysts on viscera, 2 small with some waxy, degenerate tissue, the other larger with calcified material in the cyst, 1 fish examined.

Tautogolabrus adspersus.

Collected on 1 date in July, 1 scolex attached to its plerocercus, introduced with food (pipefish), 6 fish examined; 3 dates in August—(1) few cysts, 2 fish examined; (2) 1 cyst, 1 fish examined; (3) 2 small, yellow cysts, 3 fish examined.

Thunnus thynnus.

1914, July 31: 1 small cyst from intestinal wall, typical hooks seen; diameter of cyst about 1.5 mm., associated with *Koellikeria*, species.

Urophycis chuss.

On 1 date in August, few cysts, 6 fish examined; 1 date in October, 1 cyst from intestine, introduced with food, alewife, and sand eels recorded in food, 12 fish examined; 2 dates in November, 1 cyst on one date, 2 on the other.

Urophycis tenuis.

1913, October 29: 1 cyst.

RHYNCHOBOTHRIMUM EXILE Linton.

Plate 9, figs. 85-90.

1908b, pp. 180-181, pl. 7, figs. 48-54.

Scolex as broad as long, slightly emarginate on posterior border; proboscides relatively long, with two stout and strongly recurved hooks at outer side of base, and about three stoutish, smaller hooks behind them; inner side of base slightly tumid, with numerous minute spines, remainder of proboscis armed with rather slender

spines, more or less recurved at the tip; sheathes spiral; bulbs elliptical-oblong, rather short.

Strobile very slender; segments beginning near the scolex, soon becoming as long as broad, and lengthening rapidly; last proglottis, immature, length, 2.60 mm., breadth, 0.26.

Only immature proglottides were seen. These are exceptional in that the cirrus and cirrus-pouch are so poorly developed as to be barely distinguishable, what were interpreted as their rudiments being made out only in the two last proglottides. In a proglottis measuring 2.6 mm. in length, the rudiment of the genital pore was situated at the posterior third, i. e. 0.84 from the posterior end, but a short distance in front of the ovaries. A similar rudiment, similarly placed was seen in another proglottis. In these proglottides the testes were well developed, and occupied practically all the interior, both in front of the ovary and behind it. The ovary could be distinguished in the two posterior proglottides. It is two lobed, the lobes lying opposite each other on either side of the median line. In a proglottis which measured 2.52 mm. in length, the posterior margin of the ovary was 0.5 mm. from the posterior end of the proglottis.

Dimensions of specimen in balsam: Length of strobile, 24.5; scolex, length 1.09, length of bothrium 0.34, breadth 0.36, diameter of neck at bulbs 0.32; contractile bulbs, length 0.24, diameter 0.06; length of posterior proglottis 2.60, breadth 0.40; diameter of proboscis, excluding hooks, 0.030, including hooks, 0.054; length of large stout basal hooks 0.024; length of longer hooks, middle of proboscis, 0.018.

Galeocерdo arcticus.

1914, August 12: 1, strobile active, length 26 mm., Woods Hole.

This cestode appears to belong to this species, which was founded in material from the tiger shark, collected at the Dry Tortugas, Florida.

(U.S.N.M., Helm. Coll. 7701.)

RHYNCHOBOTHRUM HETEROSPINE Linton.

1890, pp. 839-840, pl. 12, figs. 3-5.

1897b, p. 799; pl. 64, figs. 3-8.

1900, p. 283.

1901, pp. 425, 436, 443, 482.

Squalus acanthias.

1907, August 15: 2; scoleces attached to plerocerci.

RHYNCHOBOTHRIMUM HISPIDUM Linton.

1890, pp. 833-835, pl. 11, figs. 12-17.

1900, p. 275.

1901, p. 433.

1905, pp. 345, 348; fig. 146.

1908*b*, p. 184.

1910*a*, p. 695.

1911, p. 587.

Adult stage.

Dasybatis centrura.

1903, September 1: Noted, but number not recorded. September 20: 6, length 4 mm., with 4 free proglottides.

1904, August 20: Numerous.

1914, August 1: Few, collected by Dr. G. A. MacCallum.

1922, July 15: 1. July 31: 1, from each of two small sting rays. Also on same date, 1, from large sting ray, 270 centimeters in length, collected by Dr. G. A. MacCallum.

1923, July 20: 2; August 15: 2; August 20: 3 in each of 2 sting rays. (U.S.N.M., Helm. Coll. 7702.)

Encysted stage.

Tautoga onitis.

1904, August 12: 1, from cyst.

1910, July 9: 1, scolex with red pigment blotch in neck, escaped from plerocercus. August 6: 1, similar to foregoing; sucker-like organ at base of plerocercus. August 30: 1, like specimen collected on preceding date.

RHYNCHOBOTHRIMUM IMPARISPINE Linton.

ADULT STAGE.	LARVAL STAGE.
1890, pp. 840-843, pl. 12, figs. 6-9.	1897 <i>b</i> , pp. 788, 799-801, pl. 64, figs. 9-12.
1897 <i>a</i> , p. 450.	1890, p. 276.
1900, p. 275.	1891, pp. 436, 437, 445, 456, 458, 475, 476, 482, 484, 485, 488.
1901, pp. 431, 432, 434, figs. 251-254.	1910 <i>a</i> , p. 694.
1910 <i>a</i> , p. 694.	1910 <i>b</i> , p. 1201.
1911, p. 588.	1911, p. 588.
	1912, p. 2 (of reprint).
	1914, p. 53.

This cestode is a common parasite of skates belonging to the genus *Raja*. It has been found in the adult stage, with ripe proglottides, in *Narcacion nobilianus*, *Raja eglanteria*, *R. erinacea*, *R. stabuliformis*, and *Squalis acanthias*. In the encysted stage it has been found in a large number of species of teliosts.

Following are records of *R. imparispine* not before published.

Collections on dates other than those occurring between June 27 and September 3 were made by the late Vinal N. Edwards.

Adult stage.

Carcharhinus obscurus.

1916, July 26: 1 scolex; probably lately introduced with food.

Dasybatis centrura.

1903, October 5: 2 scoleces with strobile beginning on one of them; length of scolex, 6 mm.; length of young strobile, 13 mm.

1914, August 1: 1.

Narcacion nobilianus.

1905, August 7: 1; length 52 mm.; posterior segments, length 3.5, breadth, 1. August 12: 1, scolex only.

1914, July 13: 1. scolex only.

Raja diaphanes.

April: 1 to 17, in 38 skates, 13 dates, 3 different years; ripe joints on 7 dates.

May: Recorded on 27 dates, in 7 different years, 74 skates examined; largest number from one skate, 35; not found in all skates examined, but record does not indicate the number in which no cestodes were found; ripe joints noted on 10 dates.

June: 1 to 16, in 13 skates, on 9 dates, in 6 different years; ripe joints noted on 6 dates.

1905, August 9 to 25: 1 to 14, from 7 skates on 7 dates; ripe joints noted on 2 dates.

1907, August 30: 5 skates examined; many cestodes in 3, few in 2, 160 in all.

September: 4 dates, 3 different years, 54 skates examined; ripe joints noted on 2 dates; record does not always show the number of skates in which cestodes were found. Thus, the record for September 27, 1911, is 27, and numerous free segments from 43 skates.

October: 21 dates, 8 different years, 84 skates examined; ripe joints noted on 10 dates. The record usually gives the number of skates examined on a given date with, sometimes, the number of cestodes found in particular individuals. As a rule the label with the specimens bore only the name of the host, the number of fish examined, and the date. Mr. Edwards also kept a journal in which the character of the food of the fish examined for parasites was noted. The smallest number of cestodes noted for one skate in this month was 1, the largest, 108. On one date 40 skates were examined, and cestodes found in 10; on another date cestodes were found in 15 out of 20 skates examined.

November: 3 to 45, from 13 skates, on 8 dates, in 2 different years; ripe joints noted on 7 dates.

Raja eglanteria.

Collected in six of the years from 1905 to 1916, inclusive: On one date in May, 3 and a few free proglottides; on one date in June, 2 strobiles, length 36 mm., 1 ripe proglottis; on one date in July, 8; on two dates in August, 1 to 2, and a few free proglottides in each of 4 skates; on one date in September, 2, with free proglottides.

Raja erinacea.

April: 1 from each of two skates, two dates in different years; ripe proglottides.

May: 1 on one date and 2 on another, in different years; ripe proglottides.

July: 1 to 5, in 5 skates, on four dates in three different years; ripe proglottides in some.

1903, August 21: 4.

1904, August 29: 1 with scolex, and fragments of 2 others.

October: 1 to 26 in 11 skates, on 11 dates in 6 different years; free, ripe proglottides on most of the dates; maximum length noted 60 mm.

November: 5 to 21 in 8 skates, on 8 dates in 4 different years; many ripe segments.

(U.S.N.M., Helm. Coll. 7703.)

Raja stabuliforis.

April: 1 to 21, 10 skates on 5 dates, 2 different years; ripe proglottides on 1 date.

May: 1 to 8, in 15 skates, 15 dates, 8 different years.

June: 1 and 2, in 2 skates, in different years; ripe proglottides in each.

1912, July 30: 24, with many ripe proglottides, ivory white, very active. Some of the larger proglottides collapsed soon after they were placed in sea water, leaving a white mass of ova on the bottom of the dish.

August: 4 and 20, in 2 skates, different years: maximum length in sea water, 100 mm.

September: 3 and 4, in 2 skates, different years, maximum, 52 mm., ripe proglottides in one.

October: 1 to 15, in 18 skates, on 15 dates, 7 different years; ripe segments on 8 dates.

November: 3, with ripe proglottides, from 1 skate on each of two dates, same year; 3 skates examined on each date.

Squalus acanthias.

Collected in 7 of the years from 1903 to 1914: Strobiles with mature segments, and free proglottides found only on the dates in May. On 2 dates in May, 4 to 7, adult strobiles and free proglottides;

on 1 date in July, 5, scoleces only; on 3 dates in August, 1 to 3. Record for August 15, 1907: Scoleces with plerocerci attached. Inasmuch as cysts containing larvae of this species were found in large numbers on the viscera of whiting taken on the same date along with the dogfish in the fish-trap at Menemsha Bight, it is likely that whiting had been the intermediate host of these cestodes found in the stomachs of the dogfish. On 1 date in September, 4, from spiral valve, but only scoleces present, length about 7 mm.; on 5 dates in October, 1 to 20, maximum length 12 mm.; on 4 dates in November, 2 to 6, maximum length 12 mm. Record for November 9, 1914: 2 scoleces, maximum length 8 mm.. 50 dogfish examined.

Larval stage.

Usually encysted on viscera, and in wall of intestine, but found in flesh of sand-eel, scup, and pipefish.

Acanthocottus octodecimspinosus.

Collections made in 8 of the years from 1905 to 1914, inclusive; Cysts usually pyriform, 3 by 2 mm. to 7 by 3.5 mm.; on viscera, and embedded in intestinal wall; 1 date in April, 1 cyst, 2 fish examined; 3 dates in May, 3 to 6 cysts on each date, 40 fish examined; 1 date in August, 6 cysts, 1 fish examined; 7 dates in October, 1 to 6 cysts on each date, 152 fish examined; 8 dates in November, 6 or more cysts on each date, 247 fish examined; 1 date in December, 5 cysts.

Ammodytes americanus.

Collections made in 8 of the years from 1903 to 1914, inclusive: Cysts usually pyriform, on viscera, and embedded in wall of intestine, in flesh on one date; recorded sizes, from 5 to 9 mm. in length and 3 to 4.5 mm. in diameter; 2 dates in May, 20 cysts on 1 date, 50 fish examined, 1 on the other date, number of fish not given; 2 dates in July, 2 cysts on each date, 25 fish examined on each date; 3 dates in August, 1 cyst on each of 2 dates, 5 in flesh on 1 date, 75 fish examined; 3 dates in October, 6 to 10 cysts on each date; one record is a few cysts in 2 of the 30 fish examined; number of fish examined 280; 5 dates in November, 1 to 7 cysts on each date, 531 fish examined.

Anguilla rostrata.

1904, July 30: Few encysted in intestinal wall, 7 fish examined.

1910, July 27: 3 cysts from surface of stomach, Dr. C. W. Hahn, 1 fish examined.

Centropristes striatus.

1903, October 8: 1 cyst, scolex immature.

1910, July 8: 1 cyst, hooks of larva rudimentary, 9 fish examined, July 16: 1 cyst, 3 fish examined.

Clupea harengus.

1904, November 12: 1 cyst, 3 fish examined.

Gadus callarius.

Collections made in 10 of the years from 1903 to 1915, inclusive: Cysts many, with brown, waxy degenerate tissue, from serous coat of viscera and mesentery, mostly pyriform, some oval-elliptical, sometimes pedicelled, occasionally in clusters, about 5 mm. in greatest diameter. On 9 dates in January, 1 to 20 cysts on each date, 126 fish examined; 2 dates in May, 1 to 24 cysts on each date, 3 fish examined; 6 dates in November, 1 to 24 cysts on each date, 29 fish examined; 19 dates in December, 1 to 50 cysts on each date, 297 fish examined.

Hemitripteris americanus.

1904, December 9: 1 pyriform cyst, with some dark pigment, 1 fish examined.

1907, November 5: 18, encysted in piece of intestine 8.5 centimeters in length; much black pigment.

1911, November 27: Pyriform cysts of various sizes and shapes, about 5 by 2 mm., 4 fish examined.

1913, February 18: 2 cysts, 5 fish examined.

1914, January 10: 50 or more cysts, oval with dark brown pigment, and degenerate tissue, 2 to 3 mm. in diameter and of variable length, 6 fish examined.

Leiostomus xanthurus.

1913, September 29: 1, 3 fish examined.

Leptocephalus conger.

1903, August 24: Small oval cysts free in the intestine; evidently recently introduced with food (scup in stomach), number of fish examined 1.

1904, July 22: 1 scolex; evidently recently introduced with food, number of fish examined 1.

Lophius piscatorius.

Collections made in 13 of the years from 1899 to 1920, inclusive: In general the encysted stage of this species in the goosefish is represented by globular and pyriform cysts, few to many on the viscera. These cysts are often tense, translucent, often pedicelled, 3 to 13 mm. in diameter, some with degenerate tissue, larger. On 1 date in May, 2 large, pyriform, pedicelled cysts, 11 by 6.5, and 13 by 7; larger end of the cysts translucent, and filled with fluid, larva at smaller end with some degenerate tissue, 10 fish examined. On 1 date in June, cysts on viscera. On 5 dates in July. Record for July 29, 1910: Numerous pyriform cysts on stomach, intestine and mesentery, and embedded in walls of intestine of each of 4

goosefish; much degenerate tissue with the larger cysts; scoleces from the larger cysts were no larger than those from the smaller; larvae from some of the larger cysts had degenerated. On 6 dates in August. Record for August 3, 1910: Many cysts in wall of intestine and on mesentery of 1 goosefish. One unusually large cyst was irregularly oval and pedicelled, with blotches of dark pigment, and ivory-white material showing through the walls of the cyst; dimensions, 22 by 15 by 8 mm. When this cyst was opened it was found to be filled, with the exception of the small space occupied by the plerocercus, with white, cheesy material, in which there were calcified masses and some dark-brown, waxy degenerate tissue. The plerocercus was subglobular, 7 by 5 mm., with thin wall and clear fluid contents, except at one end where there was a small ivory-white spot, the scolex. This plerocercus did not differ either in appearance or size from many which were enclosed in the wall of the intestine. Many cysts were found in the intestinal wall which were completely calcified; when opened they liberated a solid calcified mass, resembling a grain of rice, about 4 by 2 mm. The scolex from the large cyst had the following dimensions: Length 4.2; breadth of head 0.70, of neck just behind head 0.35, at bulbs 0.72. On 1 date in September, cysts on viscera. On 6 dates in October, cysts on viscera as usual. On 4 dates in November. Record for November 12, 1909: 10 pyriform and subglobular cysts from 3 goosefish; smallest cyst about 9 by 6 mm., largest 22 by 11 by 8 mm., with a large amount of dark-brown degenerate tissue; smallest cyst translucent, larger cysts with increasing amount of degenerate tissue; scoleces typical. It is to be understood that the number of cysts collected by Mr. Edwards does not necessarily represent all the cysts seen. On 1 date in December, 1 cyst in vial; record shows that 3 fish were examined.

1923, August 17: Many encysted on viscera.

Lophopsetta maculata.

Collections made in 7 of the years from 1903 to 1910, inclusive: Cysts, usually pyriform, on viscera, or embedded in the intestinal wall, in many cases in clusters in wall of rectum. For example, on August 20, 1910, 27 sand dabs were examined; cysts were found in the interstitial wall of nearly all of them; five or six of the fish had each a cluster of from 10 to 20 cysts in a space of from 20 to 30 mm. in length; the cysts were most common in the wall of the rectum. On 3 dates in July, 1 to 18 cysts on each date, 3 fish examined; 7 dates in August, 9 to many cysts on each date, 36 fish examined; 1 date in September, 14 cysts, 1 fish examined; 2 dates in October, 5 to many cysts, 2 fish examined; 1 date in November, few cysts on each date, 3 fish examined.

Melanogrammus aeglefinus.

1895, October 31: 1 cyst.

1903, September 3: 1 cyst on viscera, 5 fish examined.

1906, May 7: 1 cyst, 1 fish examined.

1909, August 12: 36 collected, more could have been got, encysted on intestine, 16 fish examined.

1913, April 29: Encysted on, and in intestinal wall; 139 cysts were counted on a piece of intestine 35 mm. in length.

Menidia notata.

1906, August 25: 2 from large number of fish, brought to me by Dr. I. A. Field, who was experimenting with these fish in the manufacture of sardines.

1910, August 30: 1 cyst, 24 fish examined.

Menticirrhus saxatilis.

1909, September 8: 1 scolex, evidently recently introduced with the food.

Merluccius bilinearis.

Collected in 12 of the years from 1894 to 1914, inclusive: Cysts often in large numbers, on viscera, in mesentery, and in intestinal wall, usually pyriform, often with dark brown pigment, in many cases associated with immature nematodes; of varying sizes, but usually about 5 mm. in greatest diameter. A typical record is that of August 19, 1910: Numerous cysts on intestine and liver, and in intestinal wall, 6 fish examined. These cysts associated with immature nematodes, have usually been present on the viscera of whiting which I have examined. It was noted that these cysts and the contained scoleces agree with those recorded as *Rhynchobothrium*, species (1901, p. 474, figs. 251-254). On 3 dates in May, 1 to 9 cysts on each date, 17 fish examined; 1 date in June, few cysts, 1 fish examined; 8 dates in August, 1 on one date, many on others, 57 fish examined; 9 dates in October, 1 to numerous on each date, 103 fish examined; 17 dates in November, few to numerous, 144 fish examined.

Microgadus tomcod.

Collected in 5 of the years from 1904 to 1914, inclusive: Cysts on viscera. On 1 date in July, 1 cyst, 13 fish examined; 1 date in August, 1 cyst, 9 fish examined; 2 dates in October, 1 scolex, 12 fish examined.

1923, July 22: A few black-pigmented cysts on stomach walls of 2 fish.

Morone americana.

1906, August 8: 2 irregularly oval cysts, brownish yellow, 6 fish examined.

Myoxocephalus aeneus.

1906, January 3: 1 pyriform cyst, 50 fish examined.

Osmerus mordax.

Collected in 3 of the years from 1903 to 1909, inclusive: Cysts on viscera; on 5 dates in August, 2 to 6 cysts on each date, 81 fish examined; 2 dates in October, 2 cysts on each date, 41 fish examined; 2 dates in November, 1 cyst on each date, 41 fish examined.

Palinurichthys perciformis.

1912, September 19: 2 plerocerci, 35 fish examined.

Paralichthys dentatus.

1903, October 19: 1 cyst from stomach wall, 1 fish examined.

1906, August 16: 1 cyst, 1 fish examined. November 9: 1 cyst, 1 fish examined.

Paralichthys oblongus.

1912, June 7: 7 pyriform cysts, 6 by 3 mm., some of them with long pedicels.

Pollachias virens.

Collected in 6 of the years from 1903 to 1914, inclusive: Cysts of various shapes, but usually pyriform, 2.5 to 6 mm. in length; on viscera, most numerous on pyloric caeca. On 1 date in May, 1 cyst, 8 fish examined; 3 dates in June, 1 to many cysts, 21 fish examined; 2 dates in July, many on each date, 21 fish examined; 2 dates in October, 1 to 30, 2 fish examined. Typical record: June 30. Cysts in practically all of the 14 fish examined, mostly under the serous coat of the pyloric caeca; a small number under the caeca next the stomach wall; a few in the stomach wall; elliptical and pyriform.

Pomolobus pseudoharengus.

Collected in 6 of the years from 1907 to 1915, inclusive: On 1 date in April, 1 cyst, 2 fish examined; 2 dates in May; on one date, 1 cyst, 40 fish examined, on the other, few cysts, one 8 by 4 mm., 6 fish examined; 3 dates in June, 1 to 7 cysts, some pyriform, about 5 mm. in length, 19 fish examined; 2 dates in July, 1 cyst from testis of one fish, few from 2 fish; 1 date in August, 20 or more encysted on viscera of 3 fish, not noted in others, but about 10 found in dish in which viscera of 10 other fish had been lying; most of cysts pyriform, and about 4 mm. in length.

Poronotus triacanthus.

Collected in the years 1903, 1910, and 1911: On 1 date in June, 2 cysts from 1 fish; 3 dates in July, few cysts on viscera, on one of the dates found mostly on the pyloric caeca, 33 fish examined; cysts found in but few of the fish. On one of the dates a scolex was noted which came from a cyst resembling a form common in *R. bulbifer*.

This scolex was abnormal, in that it had only two perfect proboscides. The other proboscides were represented by the rudiment of a sheath, and a bulb near the bothria.

Prionotus carolinus.

1910, July 8: 1 cyst on viscera, 12 fish examined.
(U.S.N.M., Helm. Coll. 7704.)

Prionotus strigatus.

1905, August 23: Few cysts between submucous and muscular layers of stomach wall, 1 on mesentery, 1 fish examined.

Pseudopleuronectes americanus.

Collected in 5 of the years from 1905 to 1913, inclusive: One date in May, 11 cysts, 4 to 8 mm. in diameter, 10 fish examined; 1 date in August, few cysts in wall of intestine, 4 fish examined; 1 date in September, 5 cysts, 9 mm. or more in length, scoleces usual size, from 1 fish; 1 date in October, 9 large cysts, the largest 12.5 by 5 by 3.5 mm., 20 fish examined; 1 date in November, 1 cyst, 1 fish examined.

Sarda sarda.

1904, August 18: 1 cyst from intestine of small bonito, evidently recently introduced with food; 28 small, and 1 large fish examined.

1906, August 14: Cysts in intestine, evidently lately introduced with food, 2 fish examined, 20 sand eels in stomachs of each.

Scomber scombrus.

Collected in 5 of the years from 1903 to 1922 inclusive; cysts usually small, yellowish-brown, and seed-like in appearance, many degenerate; in most cases 2 mm., or less, in diameter; occasionally larger maximum 5 mm., seen on only 1 date; characteristic hooks of this species found in some of the degenerate cysts. On 1 date in May, few degenerate cysts on viscera, 6 fish examined; 3 dates in June, few on one of the dates, numerous on the others, on viscera, in mesentery, and embedded in submucosa of stomach and intestine, 23 fish examined; 2 dates in July, few on serous coat of stomach, and many on pyloric caeca, all small, 13 fish examined; 3 dates in October, small, degenerate cysts, on viscera, 32 fish examined. Record for June 22, 1922: Viscera of a mackerel, 40 centimeters in length, thickly covered with cysts, from 1 mm. and less, to 5 mm. in diameter, many of them yellowish-brown. Submucosa of stomach and intestine crowded with cysts. A scolex, in fresh water, somewhat compressed, measured 7 mm. in length.¹⁶

Siphostoma fuscum.

1921, July 14: 10 cysts in muscle tissue of abdominal wall, 3 to 5 mm. in length; collected by Dr. P. Okkelberg.

¹⁶ For more detailed report, see *Journal of Parasitology*, vol. 9, pp. 176-177, figs. 1, 2 (March, 1923). Note on Degenerating Cystode Cysts in Mackerel.

Stenotomus chrysops.

1904, August 11: 1 cyst on viscera, 6 fish examined.

1909, July 26: 4 cysts from muscles back of head, near back-bone; plerocerci, in sea water, 8 to 12 mm. in length, and 3 to 4 mm. in diameter, ivory-white, enclosed in very thin cysts; general outline pyriform with scolex protruding from larger end; scolex moderately active, plerocercus slightly contractile; contractile bulbs 0.9 by 0.4 mm. compressed, retractile muscle attached to base of bulb. Collected by Dr. C. W. Hahn.

Tautoga onitis.

1911, August 15: 1 cyst on viscera, 1 fish examined.

Tautogolabrus adspersus.

Collected in 5 of the years from 1902 to 1910: 1 to 4 cysts on each date, on viscera. On 1 date in July, 1 cyst, collected by Dr. C. W. Hahn; 3 dates in August, 1 on each of two dates, 4 on the other, on viscera, 35 fish examined; 1 date in September, 2 cysts, on viscera, 4 fish examined; 1 date in October, 2 cysts on viscera, 5 fish examined.

Urophycis chuss.

Collected in 10 of the years from 1901 to 1915: Cysts usually pyriform, most of them small, 2 mm., more or less, in greatest diameter, occasionally one as much as 5 mm. in diameter; on viscera and in intestinal wall; in some cases degenerated. For example the record of November 3, 1911, is: A few cysts, among them clusters of very small cysts, 0.5 mm., or less, in diameter, with yellowish, waxy degenerate tissue; in some the contents were in part calcified. In one of these degenerate cysts, the hooks of *R. imparispine* were identified.

On 4 dates in May, 1 to few cysts on each date, 22 fish examined; 1 date in June, 3 scoleces and 1 small cyst, 10 fish examined; 3 dates in August, numerous cysts, 10 fish examined; 5 dates in October, 1 to 5 cysts on each date, 50 fish examined; 18 dates in November, 1 to few cysts on each date, 288 fish examined.

Urophycis regius.

1911, November 6: 1 pyriform cyst, 3.5 by 2 mm., 1 fish examined. November 8: 2 small cysts, 3 by 1.5 mm., 1 fish examined.

Urophycis tenuis.

Collected in 8 of the years from 1907 to 1916, inclusive: Cysts, usually pyriform, on viscera, and in intestinal wall, often numerous, in some cases degenerate; usually about 5 mm. in greatest diameter, but occasionally larger, and not rarely smaller. On 1 date in April, 8 cysts, 1 fish examined; 2 dates in May, 3 on one date, few on the other, 4 fish examined; 2 dates in June, 3 on one date, few on the other, 3 fish examined; 1 date in August, few cysts, 3 fish examined; 13 dates in October, 1 to numerous cysts on each date, 34 fish ex-

amed; 13 dates in November, 1 to 27 cysts on each date, 65 fish examined.

Following are typical records, the first, of a piece of intestine, the second, of a portion of the pyloric caeca:

1913, October 29: Numerous pyriform cysts on serous coat of intestine, some embedded in wall of intestine, the latter, in many cases with cheesy degenerate tissue; cysts of various sizes, largest about 5 mm. in length. The bottle contained a piece of intestine, 7 centimeters in length, which was thickly beset with cysts.

1914, October 28: Numerous cysts on pyloric caeca; a small piece of pyloric caeca in the vial contained 50 cysts, surface count, in a space 20 mm. square; 114 cysts were removed from the piece.

Xiphias gladius.

1904, July 15: Few, from peritoneum, cysts, with plerocerci and scoleces, 4 fish examined. July 21: Cysts on viscera, also in intestine, probably recently introduced with food.

RHYNCHOBOTHRUM INSIGNE, new species.

Plate 11, fig. 99-107.

Bothria emarginate, as broad, or a little broader than long, lateral, rather thick in contracted condition, and widely divergent. Neck of scolex very long, subcylindrical, and linear to near the base, where it increases in breadth rather abruptly, but is still narrower than the anterior end of the strobile. Hooks on the proboscides of a great variety of shapes and sizes. There is a cluster of very small, scale-like hooks on one side of the base. This side of the proboscis carries small, slender spines of varying length, and rather sparsely set toward the middle of the area. In the middle of this area is the most characteristic feature of the armature, in the shape of a linear row of very closely crowded hooks with broad bases (figs. 105-7). These hooks become so much crowded, about one millimeter above the base of the proboscis, as to have the appearance of being made up of two rows of hooks (fig. 106). The nature of the overlapping which gives rise to this appearance is shown in the figure. At $1\frac{1}{2}$ mm. from the base, which was as much as the proboscis was everted, the hooks in this linear row are still closely crowded together, but the appearance of being made up of two rows is almost wholly lost (fig. 107). On either side of the area, of which this linear row of closely crowded hooks is the center, there are larger hooks, which are long and slender, with a tendency to have rather abruptly recurved tips. The hooks on the two sides of the small-hook area are not quite symmetrical. They are separated on the opposite side of the proboscis by two longitudinal rows of relatively large, strongly recurved hooks, with elongated basal supports, and with the tips of one row inclined

towards the tips of the other (figs. 103, 104). These rows of stout hooks are flanked on either side with the slender hooks already mentioned. Those of one side have broad bases, when seen in outline (fig. 103). The contractile bulbs are slender, and about one-third the length of the neck of the scolex.

The strobile, in general, is somewhat linear, and rather thin in its dorso-ventral diameter. Its breadth at the junction with the scolex is about 3.5 mm. At a distance of less than 10 mm. from the scolex the breadth has increased to 5 mm. This breadth is maintained to the middle of the length of the strobile. With the formation of adult proglottides the breadth diminishes slightly, the posterior proglottides having a maximum breadth of about 3.5 mm. The last five proglottides have a uniform length of 6 mm., and maximum breadth of 3.5 mm.

First indications of proglottides, in the shape of closely crowded transverse lines, are seen near the scolex, and, at a distance of 8 mm., the segments are distinct with a length of 0.25 mm. The first adult proglottides appear about 70 mm. back of the scolex, where they are a little broader than long. They increase in length gradually, the posterior proglottides being longer than broad, somewhat constricted at their anterior end, and increasing in breadth to near the posterior end.

The genital apertures are irregularly alternate, and are situated at about the posterior third of the lateral margin. None of the cirri were everted. In each case the genital pore was at the center of a depression in the form of a notch with vertical walls. The cirrus-pouch is small, oval, nearly transversely placed. The vas deferens lies at the anterior border of the inner end of the cirrus-pouch and extends a little anteriorly to the median line. In many of the proglottides a globular body lay near the inner end of the cirrus-pouch which appears to be a seminal vesicle. Testes could be seen in the earlier adult proglottides, although somewhat masked by the vitellaria. They fill the interior of the proglottis, are most abundant in front and in the median region bounded by the lateral excretory vessels, although a few could be seen lying lateral to the excretory vessels, and lateral to the ovary at the posterior end of the proglottis.

The vagina lies on the posterior border of the cirrus-pouch, and passes toward the median line, thence back to the ovary, which is many lobed, and situated near the posterior end of the proglottis on the median line.

Sections were not made, and details of structure of shell gland and the complex of vitelline, germ and sperm ducts could not be made out from the mounted segments. The uterus opens on the median line near the anterior end of the proglottis. In earlier adult

segments the aperture is circular, in later, ripe proglottides it is more or less elongated.

The longitudinal excretory vessels are conspicuous, as are also transverse vessels, of which one lay near the base of each proglottis. The specimen had been placed in fresh water for a short time, which fact may account for the enlargement of these vessels.

A curious abnormality in the development of the proglottides was noted about 50 mm. back of the scolex. A sketch of this region is shown in Figure 102.

One specimen of this cestode was found, on August 5, 1922, in the spiral valve of a 210-centimeter shark, *Carcharhinus milberti*. The stomach of the shark contained fragments of menhaden and a considerable quantity of oil.

Dimensions of the cestode in life: Length 250 mm.; length of scolex 25, breadth 3.5; length of posterior segments, average of last five, 6.6, breadth 3.8. Length, in balsam, 210; length of scolex 21; breadth of scolex, through divergent bases of bothria, 3, immediately behind bothria, 2, which breadth is maintained to near the base, where it increases to about 3.25. Bothria emarginate, length 2 mm., breadth about the same, or a little more. The ova measure about 0.045 by 0.036 in the two principal diameters.

Type.—U.S.N.M., Helm. Coll. 7705.

Four large cestodes belonging to this species were found August 6, 1923, in the spiral valve of a shark, *Carcharhinus commersonii*: Maximum length 420 mm., maximum breadth 6 mm.; pinkish in median region when strongly contracted, scolex and anterior portion yellowish white, posterior yellowish.

Associated with these strobiles was a slender strobile, length 210 mm., linear, breadth 2 mm.; scolex ivory white, strobile translucent white. The books agree with *R. insigne*.

RHYNCHOBOTHRIMUM LOMENTACIUM Diesing.

1890, pp. 845-847, pl. 13, figs. 1-3.

1911, p. 588.

Adult stage.

Galeorhinus laevis.

1905, July 31: Fragments of strobile, referred to this species.

RHYNCHOBOTHRIMUM LONGICORNE Linton.

1890, pp. 847-849, pl. 13, figs. 4-8.

1897a, p. 450.

1901, p. 429.

1911, p. 588.

Adult stage.

Garcharias taurus.

1904, July 19: 2 scoleces, and a few free proglottides.

(U.S.N.M., Helm. Coll. 7706.)

RHYNCHOBOTHRUM LONGISPINE Linton.

Plate 12, figs. 110-114.

1890, pp. 835-837, pl. 11, figs. 18-20.

1901, p. 433.

1911, p. 588.

Adult stage.*Dasybatis centrura.*

1903, September 1: Many small Rhynchobothria were present in the chyle of the spiral valve; a few of them separated from the lot after they had been lying over night in formalin, were referred to this species.

Larval stage.

The encysted stage referred provisionally to this species, and found in various intermediate hosts is the same as that from *Stenotomus chrysops* (1897b, pl. 63, figs. 10-13). At the base of the proboscis the hooks, for a short distance, are rather straighter than they are elsewhere on the proboscis, and are somewhat appressed. They then become longer and more divergent (figs. 110, 111, 113), diminishing towards the tip. In the basal and middle regions there is not a great diversity in shape, the longer hooks being rather slender, tapering and arcuate. Towards the tip the hooks on one side of the proboscis are short, broad, and abruptly recurved, on the other side of the proboscis they are slender and arcuate (figs. 112, 114). This is in agreement with forms found in *Centropristes striatus* (1897b, p. 793; pl. 62, fig. 12).

Leptocephalus conger.

1903, August 24: Small oval cysts in intestine: doubtless recently introduced with food; stomach contained partly digested scup.

Microgadus tomcod.

1910, July 13: 2 small cysts. Figures 110-112 shows views of different regions of the proboscis of a larva from one of these cysts.

(U.S.N.M., Hehn. Coll. 7707.)

Paralichthys dentatus (figs. 113, 114).

Collected in 4 of the years from 1903 to 1910, inclusive: Small oval cysts, on viscera, in mesentery, and in wall of stomach and intestine. On 1 date in July, several small, oval cysts on mesentery, 1 fish examined; 4 dates in August, several cysts, on each date, on viscera and in wall of stomach and rectum. 11 fish examined; 1 date in October, several cysts in stomach wall.

(U.S.N.M., Helm. Coll. 7718.)

Prionotus carolinus.

1905, July 17: 1 cyst on viscera, 17 fish examined.

Prionotus carolinus.

1907, August 10: Amber colored cysts on viscera, 2 fish examined.

Prionotus strigatus.

1905, August 23: Several cysts between submucous and muscular coats of stomach; associated with cysts of *R. imparispine* and *T. bisulcatus*, 3 fish examined.

Scomber scombrus.

1905, August 18: Cysts in stomach wall, 3 fish examined.

1906, August 10: 1 cyst, with immature larva, 8 fish examined.

Scomberomorus maculatus.

1904, August 20: 3 cysts on viscera, 3 fish examined.

Stenotomus chrysops.

Collected in 8 of the years from 1904 to 1920, inclusive: Small, usually oval cysts on viscera. Dimensions of specimen, life, collected August 17, 1904: Plerocercus, compressed, length 2.25, breadth 1.47; larva, length 1.57, breadth 0.45; length of bulb 0.75; diameter of proboscis, including hooks, 0.07; length of longest hooks 0.03; 16 fish examined. On 5 dates in July, 2 to 20 cysts, on viscera, and in intestine, where probably introduced with food; 10 dates in August, 1 to numerous, on viscera, 93 fish examined; 1 date in September, 1 oval cyst, 2 fish examined.

Urophycis chuss.

Collected in 3 of the years from 1903 to 1910, inclusive: Small cysts of various shapes on viscera. On 1 date in May, small cysts on the intestine; on 1 date in September, a few small cysts on viscera, 3 fish examined; 4 dates in October, cysts of different shapes, in one case associated with immature nematodes, on viscera and mesentery, 26 fish examined; 3 dates in November, numerous on one date, 1 fish examined, few on one date, 3 fish examined, 1 on one date, 12 fish examined.

Urophycis tenuis.

1911, August 4: Few small cysts in submucosa of stomach, 3 fish examined.

RHYNCHOBOTHRIMUM SPECIOSUM Linton.

1887, *Rhynchobothrium*, species, p. 195, pl. 10, figs. 1-6.

1897b, pp. 801-805, pl. 64, figs. 13-14; pl. 65, figs. 1-7.

1900, p. 278.

1901, pp. 413, 443, 447, 451, 455, 458, 460, 463, 473, 482, 488.

1905, pp. 332, 369, 373, 384.

1907d, p. 98, pl. 5, figs. 32-35.

1908b, pp. 176-177, pl. 2, figs. 78, 79.

1921, pp. 30, 31.

The adult of this species has not yet been noted. The larval cestodes which I have recorded under this species are southern forms,

and probably represent different species. A revision of the species is deferred until more material from southern fishes is available. Those here recorded appear to belong to the species represented by the forms originally described from the blue fish.

Carana chrysos.

1910, September 13: 1 cyst from viscera. Dimensions of larva in glycerin: Length 7.42; length of scolex 4.62; bothrium, length 0.56, breadth 0.56; diameter behind bothria 0.49, at bulbs 0.77; bulbs, length 0.90, diameter 0.21, 1 fish examined.

Ceratacanthus schoepfi.

1920, July 28: Large, and for the most part, elongated cysts from viscera; maximum length 65, diameter 2 to 6 mm., and length 40, diameter 5 mm., 1 fish examined.

Cynoscion regalis.

1904, August 9: 1 larva in thin cyst, no plerocercus, on viscera, 6 fish examined. August 13: 1 cyst on viscera, 1 fish examined.

1905, July 17: 1 cyst from serous coat of viscera, 6 fish examined. July 18: 1 cyst on viscera, 12 fish examined.

1908, July 28: 1 scolex from intestine, probably recently introduced with food, 2 fish examined.

Pomatomus saltatrix.

1904, July 22: 1 cyst on viscera, 6 fish examined.

1910, July 1: A large cyst, 24 by 8 mm., embedded in the pyloric caeca, with plerocercus, but no scolex yet developed; resembled cysts of this species, 1 fish examined. July 5: 1 cyst on intestine, 1 fish examined. August 22: 2 long pyriform cysts on intestine, 2 fish examined.

1911, July 17: Cysts with immature plerocerci, 10 fish examined.

(U.S.N.M., Helm. Coll. 7708.)

Remora remora.

1912, November 7: 1 cyst from viscera, length 30 mm., diameter in middle 5 mm., thickening a little toward one end, where there was an accumulation of waxy, degenerate tissue; length of plerocercus 30, of larva 20.5, 1 fish examined.

Thunnus thynnus.

1914, July 29: 1 cyst from serous coat of intestine; 5 by 3 mm.; hooks agree with this species, but scolex smaller than in typical specimens, 1 fish examined.

Trichiurus lepturus.

1903, July 6: 1 cyst, body cavity associated with *O. crenacolle*, and immature nematodes; scolex agrees in detail with this species, 1 fish examined.

RHYNCHOBOTHRUM TUMIDULUM Linton.

1890, pp. 829-832, pl. 11, figs. 3-11.

1897a, p. 448.

1900, p. 270.

1901, pp. 425, 431, 468.

1905, pp. 348, 409.

1911, p. 588.

Adult stage.*Carcharhinus obscurus.*

1907, July 31: 2, in spiral valve.

Galeorhinus laevis.

Collected in 4 of the years from 1903 to 1907: On 2 dates in July, 1 on one date, 30 on the other; on 6 dates in August, 6 to numerous, with ripe segments which were brown almost black; ova conical, with bristles; on 2 dates in September, 3, with ripe segments, in 1 of 15 dogfish, on one date, and 28 in one dogfish, and 26 in another on the other date.

(U.S.N.M., Helm. Coll. 7709.)

Larval stage.*Lophius piscatorius.*

1903, October 29: 1, scolex attached to plerocercus. Dimensions, life: Length of larva, 5; maximum diameter, 1; diameter at bulbs, 0.63; length of bulbs, 0.27; hooks not satisfactorily shown, but largest about 0.03 in length. In balsam the length of the scolex to base of bulbs is 0.67; breadth at base, 0.56; behind bothria, 0.35; bothria, length, 0.33; breadth, 0.40; length of bulbs, 0.21; proboscides retracted and hooks not clearly shown; length, about 0.021.

Opsanus tau.

1910, October 5: 1 cyst, 4 by 1.5 mm.; proboscides of scolex retracted; referred provisionally to this species. Dimensions of a scolex mounted in balsam of date already reported (1901, p. 468): Length, much contracted, 0.98, breadth at base of bulbs 0.77, at anterior end behind bothria 0.35; length of bothrium 0.22, breadth 0.26; length of bulbs 0.35, breadth 0.08; diameter of proboscis, excluding hooks, 0.024; hooks slender, and, so far as seen, arcuate, maximum length about 0.009.

Spheroides maculatus.

1907, August 10: 2 scoleces attached to plerocerci, in intestine, red pigment in neck. Dimensions in balsam: Length of scolex, 0.70, breadth at base, 0.53, at anterior end 0.25; length of bothrium 0.22, breadth 0.21; length of bulbs 0.28; plerocercus, length 1.26, a little broader than scolex at anterior end, tapering to 0.21 at posterior end; hooks very small.

RHYNCHOBOTHRUM UNCINATUM, new species.

Plates 7-8, figs. 74-78.

Scolex with slender, cylindrical neck, and bothria rather widely separated and deeply notched on the posterior border; proboscides long, when fully extended there is a basal, naked portion, succeeded by a few large hooks, 0.075 to 0.12 mm. in length, which are at the base of the hook-bearing portion of the proboscis; next is an interval of about 0.11 mm., densely covered with minute hooks, 0.016 mm., more or less, in length, some of them slender and bristle-like, others short and broad; then hooks, similar in shape to the large basal hooks, but not quite so long, appear and continue to the apex of the proboscis. These hooks are, for the most part, nearly uniform in size and shape. They are rather slender and graceful, with a tendency to be rather abruptly recurved at the tip, length about 0.05 mm. Sheathes spiral, bulbs long-elliptical with thickish walls, retractor muscle attached at base. In a mounted scolex, measuring 3.22 mm. in length, a contractile bulb measured 0.56 mm. in length, and 0.14 in breadth.

Strobile slender, segments beginning very close to the scolex, at first very short, but soon as long as broad, later becoming much longer than broad. In mature segments the length may be as much as five times the breadth.

Reproductive organs.—Genital pores irregularly alternate at about the anterior fourth, or a little back of that point. Cirrus long and slender; cirrus-pouch short, fusiform, with a relatively large seminal vesicle on its anteromedian border; vas deferens unusually voluminous, apparently occupying the median axial region from near the anterior border of the ovary to the seminal vesicle; testes distributed throughout the proglottis inside the vitelline layer.

The vagina was not satisfactorily made out in the whole mounts, and no sections were made. From what is shown in a ripe proglottis, in which the uterus occupies the greater part of the interior between the ovary and cirrus-pouch, it would appear that a part of the complex which comprises the folds of the vas deferens may be the vagina filled with sperm, and functioning as a seminal receptacle. What was interpreted to be the distal portion of the vagina was seen lying close to the posterior margin of the cirrus-pouch, but it could be traced for only a short distance. The ovary is bilobed, the lobes being symmetrically placed with respect to the median line. In adult, but unripe segments the lobes of the ovary are longer than broad, in one case, length 0.39, breadth 0.14; in a ripe proglottis, length 0.30, breadth 0.18; uterus in ripe proglottides spacious, occupying practically all the interior of the segment between the ovary and cirrus-pouch and seminal vesicle. The vitellaria have the usual

distribution, seen in whole mounts as a dense glandular mass along the lateral margins, but also constituting a layer surrounding the inner core of the segment which contains the testes.

Type.—U.S.N.M., Helm. Coll. 7710.

Adult stage.

Vulpecula marina.

1912, August 7: 4 strobiles with scoleces, and 5 free proglottides; longest 33 mm.; length of scolex, 6, breadth through bothria 2; posterior proglottis, length 2.5, breadth 1; posterior segments rectangular, contracting when placed in killing fluid; ova subglobular, with very thin shells, diameter about 0.048. Diameter of proboscis, in balsam, basal hookless portion 0.072, portion near base bearing minute hooks, including hooks, 0.066, a short distance in front of portion bearing minute hooks, excluding hooks, 0.051, including hooks, 0.12.

Larval stage.

Xiphias gladius.

1911, July 10: Collected by Vinal N. Edwards, who, noticing the presence of parasites in flesh attached to a piece of backbone of a swordfish at the fish market, brought them to the laboratory. There was one scolex with an elongated plerocercus still attached, 40 mm. in length, increasing to 50 mm. when transferred to a slide. Beside this there were two fragments 27 and 12 mm. in length respectively. They were all embedded in muscular tissue near the vertebrae. Upon pressure the scolex with its short neck separated from the plerocercus. It was fixed under pressure with the proboscides in greater part extruded.

Upon comparing the scolex with that of the adult form from the thrasher shark, the agreement in detail in the peculiar character of the hooks was found to be so close that there seemed to be no room for doubt concerning their specific identity.

Dimensions of scolex, adult from Vulpecula marina, larva from Xiphias gladius; specimens mounted in balsam, and more or less flattened.

	Adult.	Larva.
Length of bothrium.....	0.63	0.77
Breadth, bothrium.....	0.72	0.84
Diameter of neck.....	0.49	0.67
Length of contractile bulb.....	0.56	0.56
Diameter, contractile bulb.....	0.14	0.21
Length of proboscis, approx.....	2.80	2.00
Diameter of unarmed basal portion.....	0.075	0.066
Diameter, median, including hooks.....	0.12	0.12
Diameter, median, excluding hooks.....	0.054	0.054
Length of large basal hooks.....	0.12	0.105
Length of smallest hooks, in front of large basal hooks.....	0.006	0.006
Maximum length of most abundant slender hooks.....	0.075	0.075

RHYNCHOBOTHRIMUM TENUISPINE Linton.

1890, pp. 837-838, pl. 12, figs. 1, 2.

1897a, pp. 448-449, pl. 34, fig. 8.

1905, p. 348 (adult), p. 395 (larva), fig. 101.

1910a, p. 695.

1911, p. 588.

Adult stage.

Dasybatis centrura.

Collected in 6 of the years from 1903 to 1920: On 2 dates in August, many on one date, 1, length 4 mm. on the other; on 4 dates in September, 1 to very numerous. There was a conspicuous red blotch in the neck, in specimens collected on one of these dates, which, in some cases involved the bulbs, and was easily visible to the unaided eye, ova with bristles. On one date in October, 1, length 15 mm., length of posterior segment 4 mm., number of segments 7.

1923, July 7, many; August 15, 20; August 20, 5.

This species is characterized by the relatively long proboscides, which are thickly beset with minute, spinose hooks.

(U.S.N.M., Helm. Coll. 7711.)

Raja erinacea.

1906, August 27: 1, scolex with plerocercus attached.

RHYNCHOBOTHRIMUM, species.

A *Rhynchobothrium* (figs. 91-94) which is near *R. tenuispine*, but differing from typical representatives of that species in the relatively coarser and more sparsely set spines is recorded here for the present.

This form was found on two occasions, September 22, 1906, and September 1, 1920, one specimen on each date, and associated with typical representatives of *R. tenuispine*.

The bothria are rather widely separated; proboscides long and slender; hooks small, of about uniform size, somewhat sparsely set, except at the base of the proboscis, where they are close set on a slight enlargement, as in *R. tenuispine*. Strobile slender, immature; proglottides begin near the scolex, and increase in length rapidly. There were about nine segments in all, the last one making up nearly half the length of the strobile back of the scolex. Dimensions of specimen in balsam: Length 5; length of scolex, 1.06, of bothrium 0.29; breadth of bothrium 0.35; diameter of scolex at contractile bulbs 0.22; length of bulbs 0.43, diameter 0.07; diameter of proboscis, excluding hooks, 0.015, including hooks 0.021; length of hooks 0.006; length of last segment 1.91, breadth 0.21.

Again on July 7, 1923, 1 similar form was found among many typical *R. tenuispine*. In some particulars these forms suggest *R. hispidum*.

Carcharhinus commersonii.

1923, August 4: Record is here made of three small cestodes with red pigment spots in the neck, and in other recognizable features agreeing with *R. tenuispine*, but with slightly coarser hooks.

(U.S.N.M., Helm. Coll. 7712.)

Larval stage.

Scomber scombrus.

1905, August 18: Cysts in stomach wall, associated with cysts of *R. longispine*, scoleces with minute, and moderately regular hooks, 3 fish examined.

RHYNCHOBOTHRIMUM WAGENERI Linton.

1890, pp. 843-845, pl. 12, figs. 10-12.

1901, p. 433.

1911, p. 588.

Dasybatis centrura.

1911, September 14: 75. This is the only record I have of this species since it was first described. Measurements of specimens from this lot were in agreement with those given in the original description. The most characteristic feature of this species is the single, relatively large hook at the base of each proboscis; all the other hooks being very small, and not differing greatly, either in size or shape. The following measurements are from a specimen mounted in balsam: Diameter of proboscis, exclusive of hooks, 0.066, including hooks 0.075; length of a small hook 0.015, breadth at base 0.004; length of the solitary large hook at the base of a proboscis 0.045; breadth at base 0.024.

(U.S.N.M., Helm. Coll. 7713.)

RHYNCHOBOTHRIMUM, species.

Plate 7, figs. 71-73.

Record is here made of scoleces from the torpedo, 1 from cyst on spiral valve, 4 scoleces, probably liberated from cysts which had been recently introduced with food.

Narcacion nobilianus.

1911, July 21: 4 scoleces, all small. The mounted specimens are from 1.64 to 2.24 mm. in length, from anterior end to base of contractile bulbs; length behind the bulbs varies from 0.28 to 0.56 mm.

Dimensions of specimen showing front view of bothrium; length to base of bulbs, 2.22, behind bulbs, 0.56; bothrium, length 0.42, breadth 0.56; diameter at bulbs 0.49; bulbs, length from 0.45 to 0.52, diameter 0.08.

Dimensions of specimen showing lateral view of bothria: Length to base of bulbs, 1.75, length behind bulbs 0.56; length of bothrium 0.38; diameter of scolex through bothria 0.56, at bulbs 0.34; bulbs,

length 0.42 to 0.45, diameter 0.07; diameter of proboscis, excluding hooks 0.03, including hooks 0.07; length of longest hooks 0.036.

(U.S.N.M., Helm. Coll. 7714.)

1914, July 7: 1, from small cyst on spiral valve. The mounted specimen is not in satisfactory condition for study. It was noted at the time of collecting that the hooks resembled those figured in my notes on larval cestode parasites of fishes (pl. 63, fig. 6, 1897b). The proboscides in this specimen are retracted. The hooks are smaller than in the former lot, one of the largest, resembling the stout, recurved hooks of lot 1, was 0.021 in length.

The hooks differ considerably both in size and shape, especially in lot 1 (figs. 71-72). The hooks of the specimen collected on the later date indicate a form that is specifically different from those of the first date.

LARVAL CESTODES BELONGING TO THE GENUS RHYNCIOBOTHRIUM.

Carana chrysos.

1911, September 22: 1 oval-elliptical cyst, 1.96 by 0.77, larva coiled at one end; hooks on the retracted proboscides appear to agree with those figured for species from *Carana chrysos* (1897b, pl. 62, figs. 13-15).

Ceratacanthus schoepfi.

1908, August 19: 1 elongated cyst, plerocercus with globular enlargement at one end which contained the larva; scolex slender; bothria deeply emarginate. Dimensions in balsam: Length of scolex 3, diameter, middle of neck, 0.28, at bulbs 0.37; length of bothrium 0.60, breadth 0.50; length of bulbs 0.60; length of longest hooks 0.04 (figs. 108, 109).

1909, October 6: 1 plerocercus, length 25 mm., no scolex.

1920, July 28: 2 cysts from wall of intestine. Dimensions in balsam: Length of pyriform cyst 0.98, greatest breadth 0.77; larva elongate, length of scolex 1.08, diameter at bulbs 0.12; length of bulbs 0.15; diameter of proboscis, excluding hooks, 0.018; length of longest hooks 0.015; hooks smaller and more densely placed than in species figured above.

(U.S.N.M., Helm. Coll. 7715-7716.)

Cynoscion regalis.

1907, August 24: 1, in flesh, collected by Charles R. Knight (figs. 115, 116). This cestode was found embedded in the flesh near the back-bone, and at about the middle of the length of the fish. The plerocercus was enveloped in a very thin, hyaline cyst, enlarged at one end, where the larva was enclosed, posterior two-thirds slender, cylindrical. Length 18 mm.; anterior, enlarged portion, length 5, diameter 3.5; diameter of slender portion 1.25. Length of larva

about 18 mm.; length of scolex 3.5; bothrium, length 1.43, breadth 1.14; contractile bulbs, length 1.08; proboscides, only base everted, diameter, excluding hooks, 0.18; length of longer hooks 0.06 to 0.08, of slender hooks on opposite side of proboscis 0.018 to 0.03.

1908, July 27: 2 cestodes found in the flesh of one out of 6 fish examined for parasites in the flesh. The fish measured about 500 mm. in length. One cestode, 75 mm. in length, and 1 mm. in diameter, lay in the muscles of the right side, near the anal aperture, color yellowish white; another, length 25 mm., diameter 2 mm., was found on the left side near the dorsal fin. The bothria were broader than long; hooks not yet developed.

1919, August —: In a lot of cestodes from a "salt water trout," presumably *C. regalis*, sent by S. S. Fay, State board of health, Miami, Fla., to the Bureau of Fisheries, and received by me August 12, plerocerci of a *Rhynchobothrium* were found, which probably came from the flesh. One proboscis of one of the scoleces is partly everted. The following dimensions are from a specimen mounted in balsam: Length of scolex 3.20, of bothrium 0.98; diameter at bulbs 0.91; length of bulb 1.12; diameter of proboscis, excluding hooks, 0.21; length of longer hooks 0.09, of slender hooks on opposite side of proboscis 0.018 to 0.03.

(U.S.N.M., Helm. Coll. 7717.)

These cestodes from the flesh of *C. regalis* appear to be the larval stage of *Rhynchobothrium*, species from *Scoliodon terrae-novae* (1905, p. 343, figs. 129–130c).

SYNBOTHRIUM FILICOLLE (Linton).

- 1887, *Tetrarhynchobothrium*, larva, p. 195, pl. 10, figs. 7–11.
 1890, *Syndesmobothrium filicolle*, pp. 861–862, pl. 15, figs. 2–4.
 1897b, *Synbothrium filicolle*, pp. 815–820, pl. 68, figs. 7–12.
 1900, pp. 277, 278.
 1901, pp. 425, 440, 451, 457, 460, 482.
 1905, pp. 341, 344, 349, 362, 363, 369, 396, 413, 415.
 1907e, p. 113.
 1908b, pp. 185–186.
 1910a, p. 693.
 1911, p. 589.

Used as a type, without specific name, in an article entitled: "Notes on two forms of cestode embryos."¹⁷

Larval stage.

Brevoortia tyrannis.

- 1905, July 27: 1, encysted, on viscera.
 1906, August 1: 1, length of plerocercus 10 mm., 3 fish examined.
 August 7: 1, 2 fish examined.
 1908, August 1: 1 plerocercus in thin hyalin cyst.

¹⁷ American Naturalist, February, 1887, pp. 1–6 (author's reprint), pl. 10, figs. 7–11.

Carcharhinus commersonii.

1923, August 25: About 50 cysts collected from the submucosa of the stomach of a 202-centimeter shark, associated with large numbers of cysts of *O. crenacolle*, all rather small, 10 by 5 mm.

1923, August 29: 150 cysts from submucosa of stomach of a 230-centimeter shark, associated with very numerous cysts of *O. crenacolle*.

Carcharhinus limbatus.

1915, August 6: Several, associated with *Otobothrium crenacolle*, encysted in submucosa of stomach; one cyst measured 8 by 3.5 mm. in the two principal diameters.

1918, July 13: Many cysts in submucosa of stomach; 8 by 3 mm., and smaller; one plerocercus when liberated from its cyst assumed the shape characteristic of the species, in which the end in which the scolex is lodged, became globular, 2 mm. in diameter, while the remainder of the plerocercus was very variable, sometimes forming a linear extension as much as 28 mm. in length.

Carcharhinus milberti.

1922, July 3: 1 cyst on serous coat of stomach; scolex, when placed in fresh water everted the proboscides.

(U.S.N.M., Helm. Coll. 7719.)

Carcharhinus obscurus.

1905, August 11: 2, between submucous and muscular coats of stomach; characteristic cysts and plerocerci.

1911, August 3: 4, encysted in submucosa at posterior end of cardiac portion of stomach; dimensions of largest plerocercus, diameter of globular portion, 3 mm., length of remaining portion, when fully extended, 38, diameter, 0.5.

1912, September 12: Several transparent, oval-elliptical cysts in serous coat of stomach, and on spleen; one cyst measured 6 by 4.5 mm; plerocerci of usual character, scolex contained in dense, ivory-white, globular portion. remaining portion variable, usually more or less linear.

Cynoscion regalis.

1905, July 14: 1 elongated cyst, on mesentery, 5 fish examined. July 15. 1; length of plerocercus 94 mm.; globular portion active, lengthening to 5 or 6 mm., and contracting to sphere, 2.5 mm. in diameter.

Galeocerdo arcticus.

1907, August 7: 1, encysted in stomach wall near esophagus.

Paralichthys dentatus.

1904, August 8: 2 plerocerci, no scoleces.

Pomatomus saltatrix.

1904, July 22: 1 plerocercus on viscera; proboscides partly everted, showing the smallish, recurved hooks at the base, followed by longer recurved hooks on one side, and straightish hooks with notch at the extremity, on the other.

1906, August 27: 1, cyst, with plerocercus and scolex.

1912, August 16: 1 cyst from pyloric caeca.

Poronotus triacanthus.

1913, July 3: 1 cyst, 4.5 by 2.5 mm., in flesh, about 50 mm. in front of the caudal fin, of a fish 22.2 centimeters in length. The wall of the cyst was thin, and loosely surrounded an ivory-white plerocercus, which was moderately active when liberated in sea water, and measuring, at rest, 3.5 by 2 mm. The plerocercus was oblong, and did not show the differentiation into globular and elongated portions usual in this species. A typical scolex was obtained.

Scomberomorus cavalla.

1920, August 2: 3 cysts with characteristic plerocerci and scoleces. These were found in a dish containing material which had been scraped from the gills of the fish. The cysts were not seen in place.

Seriola dumerili.

1905, October 30: 1 plerocercus of usual type in vial, location in host not stated.

SYNBOTHRIMUM MALLEUM, new species.

Plate 10, figs. 95-98.

Tetrarhynchus crinaceus BENEDEN, 1897b, pp. 811-812, pl. 57, figs. 1-8.

1900, p. 281.

1901, pp. 451, 454, 460.

Synbothrium species 1905, pp. 350, 369, 377, 385, figs. 116-118.

Cestodes found on two occasions at Woods Hole agree in essential characters with the species recorded in my report on the parasites of fishes of Beaufort, N. C., as *Synbothrium*, species.

Scolex.—Elongate, bothria nearly at right angles to axis, giving a hammer-like effect to the scolex; bulbs slender, one-third the length of the entire scolex or more; sheathes sinuous or spiral, depending on the state of contraction; proboscides armed with hooks of a great variety of shapes and sizes, many of them large and strongly recurved; in a mounted scolex they are seen to vary in length from 0.012 to 0.126 mm.

Dimensions of a scolex, in balsam, somewhat contracted: Length, 4.48; length of bothrial portion, 0.84, breadth, 1.54; length of neck, 3.64, diameter, 0.77; length of contractile bulb, 1.54, diameter, 0.21. Dimensions of another scolex, in balsam, not contracted: Length,

5.18; length of bothrial portion, 0.84, breadth, 1.82; length of neck, 4.34, diameter, 0.77; length of contractile bulb, 2.30, diameter, 0.21.

In the specimens collected in 1914 the hooks were not quite so large as in the first lot, the maximum being about 0.10; moreover, one side of the proboscis is densely covered with small hooks, 0.012 to 0.024 in length. It should be remarked that the proboscides were almost entirely everted. The proboscides in the first lot were only partly everted; hooks as small as those in the first lot were found, but they were not seen to cover any part of the proboscis as densely as in the second lot.

Strobile.—Length of longest specimen, in balsam, 26 mm. The first distinct segments are broader than long, soon squarish, then longer than broad; last segment, with ova, length 2.34, breadth 1.54; distance of middle of notch at genital pore from posterior end of proglottis, 0.91. The outline of the proglottides is, in general, rectangular; the last proglottis in the longest strobile is bluntly rounded at the posterior end (fig. 97).

Reproductive organs.—The genital pores are irregularly alternate, situated but little in advance of the posterior third, and are characterized, in adult segments, by having thick, rounded, and slightly projecting lips. The cirrus was not seen everted, but is evidently short and smooth. The cirrus-pouch is oval-elliptical, at right angles to the margin, its length approximately one-third the breadth of the proglottis; vas deferens rather voluminous, at base of pouch, along median region of proglottis from the anterior border of the ovary to about the middle of the length of the proglottis; testes occupy the median area of the proglottis within the layer of longitudinal muscles. The vagina was not seen very satisfactorily. It appears to enter the cirrus-pouch on the ventral side and is, therefore, difficult to see in whole mounts. In sections it was seen lying on the ventral side of the pouch, and taking a diagonal course in the direction of the ovary. The ovary is two-lobed, somewhat dumb-bell shaped, and is situated near the posterior end of the proglottis about midway between the posterior border of the pouch and the posterior end of the proglottis. The uterus, as seen in horizontal sections, lies along the median line, and is more or less sacculated. It was seen to open by a definite pore on the median line near the anterior end of the ventral face of the proglottis; ova, 0.030 by 0.015, in specimen mounted in balsam.

Type.—U.S.N.M., Helm. Coll. 7720.

Dasybatis centrura.

1911, September 14: A single strobile, attached to the mucous membrane near the anterior end of the spiral valve, and a few free proglottides, which discharged white masses of ova soon after they had

been placed in sea water. In an hour or two these eggs had become a dark brown color. There appeared to be some variation in the size of the ova, one of the larger measured 0.040 by 0.027.

1914, August 1: 6, collected by Dr. G. A. MacCallum.

TETRARHYNCHUS BICOLOR Bartels.

Plate 8, figs. 79-80.

1897*b*, pp. 813-815, pl. 68, figs. 1-6.

1900, pp. 271, 277.

1901, pp. 426, 427, 446, 448, 452, 482.

1905, p. 373.

1911, p. 589.

Following are records of this species not heretofore published :

Carcharhinus milberti.

1922, July 10: 1; attached to wall of spiral valve, near anterior end; inflamed patch of mucous membrane at point of attachment about 15 mm. in diameter. The color of the scolex was deep purplish red; length of strobile, 50 mm., diameter of scolex, 3 mm.; greatest breadth of strobile, 2 mm.; collected by Dr. G. A. MacCallum.

Carcharhinus obscurus.

1905, August 14: 2; head and neck, including collar, of one, deep, purplish red; head and neck of the other the same, collar a lighter shade; strobiles, 30 and 45 mm. respectively, a fragment of strobile measured 110 mm. in length; largest proglottides, length 1.2, breadth 3; length of head and neck, 6.5 and 9.

1907, July 31: 2, in shark measuring 183 centimeters; one of the worms was firmly attached to the mucous membrane. Length of longer, in sea water, 200 mm. Head not much differentiated from neck; head and neck cylindrical, longitudinally ribbed, except collar, which is smooth, red (shade 1, Milton-Bradley Co.); deepest color about the vicinity of the bulbs. The pigment in the head and neck was not dissolved, either by the fixing fluid (chr.-acet.-form.), or the alcohol in which it was preserved. The color still persisted when this note was written, November 4, 1921, but disappeared as the specimen was dehydrated before mounting in balsam.

Length of scolex at rest, 11 mm., stretching to 20 mm., or more; diameter 1.75. The larger specimen was active, and contracted strongly, becoming sinuously crumpled posteriorly, and spiral anteriorly. The scolex was also very active, contraction waves beginning at the anterior end and passing posteriorly to about the middle of the length, thus showing admirable fitness for the penetration of mucous membranes. Color of strobile, cream, with a blotch of white in the center of the face of ripe segments, where ova are clustered.

The face of the strobile on which ova lie is convex, the opposite side is concave; ova somewhat variable, but the larger ones measured about 0.031 by 0.024; shells of ova very thin. After the larger specimen was straightened by wrapping it around the handle of a needle-holder and immersing it in the killing fluid, it measured 212 mm.

Galeocерdo arcticus.

1905, August 26: 3 scoleces, adhering to mucous membrane of stomach; ivory white.

1913, August 13: 1, attached to mucous membrane of stomach; length of scolex 5 mm., of strobile, 6 mm., segments beginning, short and much narrower than the scolex; collected by Dr. G. A. MacCallum.

1914, August 12: 6 scoleces from the mucous membrane of the stomach; at one point where some of these were attached there was considerable suppuration; color white, yellowish behind the bulbs. All short, but one showed the beginnings of a strobile. This one measured 18 mm. in length; no segments.

1915, August 6: Associated with *T. bisulcatus*, a number of them being attached together near the anterior end of the stomach in a pit of the mucous membrane which was abraded and inflamed.

(U.S.N.M., Helm. Coll. 7721.)

Larval stage.

Echeneis naucrates.

1920, August 31: 5, white globular cysts, 3 mm. in diameter, from serous coat of stomach and intestine; ivory white.

Lophius piscatorius.

1910, July 29: 1, length 7 mm., white; from viscera.

Sarda sarda.

1910, June 27: 2, under peritoneum; one white, the other yellow.

Xiphias gladius.

1904, July 15: Many, on viscera, in each of four swordfish; mostly yellowish white, some ivory white; active; 6 to 12 mm.

1911, July 13: 10, in globular cysts on viscera.

1912, July 20: 1, from viscera, yellowish.

TETRARHYNCHUS BISULCATUS (Linton).

Adult stage.

1899, *Rhynchobothrium bisulcatum*, pp. 479-484, pl. 4, figs. 9-23.

1890, *Tetrarhynchus bisulcatus*, pp. 857-862, pl. 14, figs. 10-12; pl. 15, fig. 1.

1897a, p. 452.

1900, p. 272.

1901, p. 427.

1905, pp. 340, 341, 344.

1910b, p. 1201.

1911, p. 589.

Encysted stage.

1897b, pp. 810-811, pl. 66, figs. 11-15.

1900, pp. 280-283.

1901, pp. 432, 448, 449, 451, 458, 460, 471, 472, 482, 484, 486, figs. 243, 261-264.

1905, pp. 359, 362, 363, 365, 366, 369, 371, 377, 381, 385, 386, 388, 393, 395, 399, 402, 404, 405, 409, 413, 415, 416.

1911, p. 589.

Records of this species not heretofore published:

Adult stage.*Carcharhinus milberti.*

1915, August 18: In large numbers, the scoleces embedded in the mucous membrane of the pyloric division of the stomach throughout its entire length of 585 mm. They were not found in the stomach proper, and only chains of proglottides without scoleces occurred in the spiral valve. Enormous numbers of eggs were discharged when the strobiles were placed in sea water.

Carcharhinus obscurus.

1907, August 3: 1, at the beginning of the spiral valve, an unusual position; length, fixed, 112 mm.

1918, September 6: 1 strobile, scolex missing; pyloric division of stomach.

(U.S.N.M., Helm. Coll. 7722.)

Galococerdo arcticus.

1915, August 5: 5, stomach near esophagus; 1 attached alone, the others in a deep and highly inflamed pit of the mucous membrane. August 6: Several attached to the wall of the stomach, near its anterior end; a number of them together in an inflamed and abraded pit of the mucous membrane. Measurements of specimen in balsam: Diameter of proboscis, excluding hooks, 0.045, including hooks, 0.072; length of longest hooks, 0.021; bulbs, length 0.59 to 0.63, diameter, 0.15 to 0.18.

(U.S.N.M., Helm. Coll. 7723.)

Squalus acanthias.

1910, August 3: 1 scolex found in stomach, not attached.

1911, May 25: Fragments of strobiles, 6, 9, and 14 mm. in length; largest proglottides 3 mm. long, and 2 mm. broad; appear to belong to this species.

Larval stage.

Found encysted in many species of fish, on the viscera, but especially in the wall of the stomach and intestine, where its favorite lodgment is the submucosa; in flesh of the sea robin (*Prionotus carolinus*) on two occasions.

Anguilla rostrata.

1912, July 31: Cysts in stomach wall, 9 fish examined.

Cynoscion regalis.

Collected in five of the years from 1903 to 1910, inclusive. In all cases encysted on or in the submucous coat of the stomach, often in the submucosa of the intestine. Found in 54 of the 59 fish examined. On 8 dates in July, few to numerous cysts, 37 fish examined; 5 dates in August, few to numerous cysts, 22 fish examined.

Lophius piscatorius.

1905, August 23: Whitish, thick-walled cysts found in the stomach wall on this date resemble this species, but are much larger. Scolex, length 4, breadth 3; diameter of proboscis, with hooks 0.21, excluding hooks 0.14; length of longest hooks 0.056.

1910, July 29: Few cysts in stomach wall. Scolex, length 2, breadth 1.30; diameter of proboscis, including hooks, 0.08, excluding hooks, 0.05; length of longest hooks, 0.02.

Lophopsetta maculata.

1910, July 25: 1, encysted in mesentery; collected by Dr. C. W. Hahn.

Merluccius bilinearis.

1910, July 2: Several cysts in wall of intestine, 12 fish examined. August 16: Several cysts in wall of stomach, 12 fish examined.

Microgadus tomcod.

1910, July 13: 1, encysted on viscera; collected by Dr. C. W. Hahn.

Paralichthys dentatus.

Collected in 8 of the years from 1903 to 1920, inclusive: Usually encysted in submucosa of stomach and intestine, found also under serous coat of stomach, on gills, in post-branchial cavity and throat. Found in 54 of the 60 fish examined. On 1 date in June, many cysts; 9 dates in July, few to many cysts, 12 fish examined; 13 dates in August, few to many cysts, 44 fish examined; 1 date in September, several cysts, 1 fish examined; 2 dates in October, several to many cysts, 2 fish examined.

(U.S.N.M., Helm. Coll. 7724.)

Pollachias virens.

1913, June 30: Few cysts in stomach wall, 14 fish examined.

Pomatomus saltatrix.

1904, July 15: Numerous, encysted in submucosa of stomach.

Poronotus triacanthus.

1904, August 11: 1 cyst, from viscera.

Prionotus carolinus.

Collected in 4 of the years from 1905 to 1911: On 2 dates in July, 1 cyst in wall of esophagus on each date, 3 fish examined; 2 dates in August—(1) few cysts in stomach wall, more or less degenerated; (2) 3 cysts in flesh, beside anal fin, and 1 cyst on serous coat of intestine; 1 date in September, 3 cysts in flesh, above, and lateral to backbone, about middle of body.

Prionotus strigatus.

1905, August 23: Few cysts between muscular and submucous coats of stomach.

Raja erinacea.

1911, July 21: 1 cyst from wall of intestine; scolex large with faint pinkish tinge.

Remora remora.

1910, July 28: About 12 cysts at beginning of stomach.

Scomber scombrus.

1905, August 18: Associated with *Rhynchobothrium* cysts between coats of stomach.

1912, July 5: 2 cysts which appeared to be a young stage of this species, on pyloric caeca.

Spheroides maculatus.

Collected in 4 of the years from 1905 to 1910: On 2 dates in July—(1) few cysts on intestinal wall; (2) 1 cyst in stomach wall; 5 dates in August, few cysts on each date, from serous coat of intestine on 1 date, from wall of stomach and intestine on the others.

Urophycis chuss.

1910, August 12: 1 cyst in wall of esophagus; scolex resembles this species, but hooks appear to be smaller than usual, 3 fish examined.

Xiphias gladius.

1904, July 15: Several cysts on viscera. July 20. Few scoleces in alimentary canal; introduced with food.

TETRARHYNCHUS ELONGATUS Wagener.

1890, pp. 812-813, pl. 67, figs. 9-12.

1900, p. 282.

1901, p. 466, pl. 23, figs. 257-260.

1911, p. 589.

Mola mola.

1914, July 20: About 25 in liver, under serous coat, but with slender elongated portions penetrating the substance of the liver; still very active in sea water on July 21.

(U.S.M.N., Helm. Coll. 7725.)

There is a singularly close agreement between the plan of hooks on the proboscides of this species and that found in *Rhynchobothrium uncinatum* from *Vulpecula marina*. In each there is a basal portion which is devoid of hooks. This is followed by a collar-like cluster of relatively long hooks. This cluster does not completely surround the proboscis, but is on the side which corresponds with the periphery of the scolex. This is the position in which the hooks would be most serviceable as hold-fast organs. These large hooks are followed by very small, closely set hooks, which, in turn, are soon followed by longer, for the most part, slender hooks. Two vertical rows of stouter hooks lie on the peripheral side of the proboscis (1901, figs. 257-260). One proboscis was seen which was more than two-thirds of its length everted. It maintained a practically uniform diameter throughout.

Dimensions in balsam: Length of bothria, 2.80, breadth 2.03; diameter of neck, 2.03; length of proboscis, 5.32; diameter of unarmed, basal portion, 0.17; diameter of median region, including hooks, 0.28, excluding hooks, 0.17; length of large basal hooks, 0.14, of small hooks, in front of basal hooks, 0.03, of slender hooks, most abundant kind, 0.10; length of contractile bulb 2.10, diameter 0.56.

TETRARHYNCHUS PALLIATUS, new species.

Plate 8, Figs. 81-84.

Tetrarhynchus bisulcatus LINTON, MacCallum, Studies in Helminthology, vol. 1, No. 6 (1921), p. 206, fig. 105.

Scolex.—Concave in front; bothria long oval, bluntly pointed; neck portion short, subcylindrical; collar ample, flaring at posterior border; bulbs reaching almost to beginning of strobile; proboscis sheathes with about one spiral at junction with bulb, then nearly straight; retracted proboscides reach nearly to bulb; proboscides cylindrical, hooks of nearly uniform size and shape, increasing in size slightly toward tip, relatively stout, strongly recurved, about six showing in single spiral on one side, apparently about twelve vertical rows; collar of scolex more than one-third length of entire scolex, considerably wider than anterior portion of strobile, especially in specimens which have been more or less compressed.

The concavity at the anterior end, and the ample, flaring collar are distinct specific characters.

Strobile.—In uncompressed specimens, the strobile is nearly linear, under pressure, increasing in breadth slightly but uniformly toward the posterior end; free, ripe proglottides not seen. The first proglottides are enclosed in the collar of the scolex and are very short. They increase in length very slowly; posterior margins slightly projecting, thus giving to the lateral margins of the strobile a more or

less serrate outline; last proglottides thus far seen still broader than long. Thus, in a strobile, 30 mm. in length, the proglottides near the posterior end measured 0.56 in length, and 0.91 in breadth; in a strobile 20 mm. in length, the length of the posterior proglottides was 0.56; breadth, 0.70; in another which had been considerably flattened in mounting, length 30 mm., length of last proglottides, 0.63; breadth, 2.27.

Reproductive organs.—The genital pores are irregularly alternate, nearly symmetrical with respect to the dorso-ventral faces, and near the middle of the length; the cirrus is smooth, slender, with a bulbous base; the cirrus-pouch is cylindrical and extends from the genital pore, first forward to near the anterior margin of the proglottis, then transversely toward the median line; in an immature proglottis, 0.27 mm. in length and 1.33 in breadth, the inner end of the pouch is 0.49 from the margin; it is 0.56 in diameter, and has coils of the vas deferens, here quite slender, enclosed in the inner end. Voluminous folds of the vas deferens lie between the inner end of the bulb and the median line, on the dorsal side as far back as the level of the ovary. The testes appear in sections as two layers, and fill all the interior of the proglottis within the layer of vitellaria not occupied by other genitalia. The vagina lies close to the cirrus-pouch, on or near the posterior border; from the level of the inner end of the pouch to the middle line it is somewhat convoluted and lies beside the folds of the vas deferens; at the median line it turns posteriorad and, still more or less convoluted or sinuous, proceeds to its junction with the germ duct. The ovary is about one-third the breadth and one-half the length of a proglottis; in median sagittal sections it shows as two divisions, one ventral and the other dorsal, both lobulated. The shell gland, and the complex of germ duct, sperm duct, vitelline ducts, and beginning of the uterus lie between the dorsal and ventral lobes of the ovary. The vitellaria form an almost continuous layer immediately adjacent to the body wall, being interrupted only in the vicinity of the genital pores and the ovary. The uterus passes from the shell gland as a comparatively slender tube along the median line to near the anterior end of the proglottis, where it enlarges, becomes subglobular, and opens to the exterior by rupture of the walls of the ventral side of the proglottis at about the anterior third of the length. In sections studied, the uterus was filled with a rather heterogeneous mass of ova, germ, and yolk cells, from the vicinity of the shell gland to the point of discharge of contents (fig. 84).

Type.—U.S.N.M., Helm. Coll. 7726.

Cestracion zygaena.

On July 19, 1915, I examined the stomach of a hammerhead shark; the spiral valve of the same shark was examined by Dr. G. A. MacCallum.

A few specimens of an *Orygmatobothrium* and one *Thysanocephalum thysanocephalum* were found in the spiral valve.

In the stomach I found 41 examples of a *Tetrarhynchus* which, upon superficial examination, suggested both *T. bisulcatus*, and *T. robustus*.

Most of them were adhering to the stomach wall. When removed they still showed a tendency to fasten themselves again to the stomach wall and to each other.

Following are a few measurements of examples of four species of *Tetrarhynchus*. While there is much variation in the dimensions of these soft bodied worms, especially in preserved material, a record of dimensions is not devoid of value for purposes of comparison. Measurements made from material mounted in balsam.

Dimensions.	<i>T. robustus.</i>	<i>T. robustus.</i>	<i>T. bisulcatus.</i>	<i>T. bisulcatus, compressed.</i>	<i>T. palliatus.</i>	<i>T. palliatus.</i>	<i>T. tenuis.</i>	<i>T. tenuis.</i>
Length of strobile.....	15.00	15.00	76.00	100.00	30.00	20.00	10.00	22.00
Length of scolex.....	1.00	0.91	1.28	1.68	1.82	1.93	0.67	0.49
Length of bothrium.....	0.56	0.49	0.70	0.84	0.76	0.77	0.38	0.32
Diameter of scolex through bothria.....	0.63	0.51	0.81	1.29	0.93	0.70	0.26	0.22
Diameter of neck behind bothria.....	0.45	0.35	0.52	1.05	0.84	0.53	0.15	0.15
Diameter of neck (collar), posterior end.....	0.40	0.39	0.39	0.80	1.28	1.19	0.15	0.14
Length of collar.....	0.19	0.30	0.18	0.42	0.70	0.70	0.07	0.08
Length of contractile bulb.....	0.30	0.27	0.31	0.46	0.39	0.35	0.12	0.09
Diameter of contractile bulb.....	0.10	0.10	0.10	0.22	0.14	0.14	0.03	0.04
Length of proboscis.....	0.64	0.50	0.70	.....	0.50	0.53	0.32	.....
Diameter of proboscis, base, including hooks.....	0.03	0.045	0.06	0.06	0.06	0.06	0.02	.....
Length of hooks, maximum.....	0.006	0.015	0.02	0.018	0.021	0.019	.....	.....
Length of posterior proglottis.....	.....	0.70	0.46	0.98	0.60	0.49	0.50	0.77
Breadth of posterior proglottis.....	.....	1.12	1.42	2.10	2.36	1.33	0.28	0.53

The proboscis of *T. robustus* tapers from the base to the tip. For example in a proboscis measuring 0.37 mm. in length, the diameter at base, exclusive of hooks, was 0.027, at the tip 0.015; maximum length of hooks 0.009.

The proboscis of *T. bisulcatus* remains practically the same diameter from base to tip. Thus, in a proboscis 0.70 mm. in length, the diameter at base, exclusive of hooks, was 0.048, at tip 0.045; length of hooks near base of proboscis, 0.015, near tip 0.024.

In *T. palliatus* the proboscides are of the same type as those of *T. bisulcatus*. In a proboscis 0.53 in length, the diameter at base, exclusive of hooks, was 0.030, at tip, 0.027; length of hooks near base 0.015, at tip 0.021. No proboscis in this species was seen fully extended.

TETRARHYNCHUS ROBUSTUS Linton.

1890, pp. 855-857, pl. 14, figs. 7-9.

1900, p. 276.

1901, pp. 430, 431, 433, 434, fig. 242.

1905, p. 341.

1911, p. 589.

Record of this species not heretofore published:

Adult stage.*Dasybatis centrura.*

1905, August 20: 1, with several fragments.

(U.S.N.M., Helm. Coll. 7727.)

Larval stage.*Echeneis naucrates.*

1920, August 21: 2 globular cysts, 1 mm. in diameter, from serous coat of stomach; 1 fish examined.

SCOLEX POLYMORPHUS Rudolphi.

Larval Tetrabothria, 1889*b*, pp. 453, 454, pl. 6, figs. 6-9.

Larval Echeneibothria, 1897*b*., pp. 789-792, pl. 61, figs. 4-15.

Larval cestodes, 1900, pp. 276, 277, 279-284.

Scolex polymorphus RUDOLPHI, 1901, p. 413 (page references to 28 hosts).

1905, pp. 326, 332-333 (page references to 34 hosts).

1907*d*, p. 101.

1908*b*, pp. 162, 175.

1911, p. 588 (39 hosts named).

This name is retained for convenience, although it is to be interpreted, not as an ordinary specific designation, but rather as the name of a group of larval cestodes, in which many species, and even genera, are represented.

The complete life history of these forms has not been made out. They appear to be scoleces which have passed the encysted stage in some other, probably Arthropod, host, and are free in the alimentary canals of their hosts, as sojourners, for a short time in teliosts, as potential adults in such selachian as may be adapted to be a final host.

See the admirable paper by Dr. W. C. Curtis.¹⁸

Following are records of finds of these cestodes, details of which have not hitherto been published. Collections in the months, September to June, inclusive, for the most part made by Vinal N. Edwards.

¹⁸ Journal of Morphology, vol. 22, pp. 819-853, pls. 1 and 2 (September, 1911).

Acanthocottus octodecimspinosus.

1912, November 9: 30, 6 fish examined. December 27: 1, 2 fish examined.

1913, February 15: 1, 6 fish examined.

Alosa sapidissima.

1910, July 13: 2, two red pigment spots in neck, 1 fish examined.

1911, July 7: Few, two red pigment spots in neck, length of bothrium 0.2 mm., rudimentary costae, 1 fish examined.

1923, July 5: 40, length 1.26, breadth 0.56 mm.

(U.S.N.M., Helm. Coll. 7728.)

Ammodytes americanus.

1914, October 20: 16, 100 fish examined.

Anchovia argyrophana.

Collected in 1905, 1906 and 1911: On 4 dates in October, numerous on 1 date, very numerous on others, several hundred in the vials, length about 1.23 mm., breadth 0.5, outline long-oval, 2 fish examined on 1 date, 10 on 1 date, and 50 on each of 2 dates; 1 date in November, 5, length 2 mm., 3 fish examined.

Anchovia brownii.

1906, August 15: Many, 2 red pigment spots, rudiments of costae, 12 fish examined.

Anguilla rostrata.

1911, January 28: 10, length in formalin 3 mm., 61 fish examined.

1914, July 10: 3, one with distinct loculi on bothria, 9 fish examined.

Brevoortia tyrannis.

Collected in 6 of the years from 1903 to 1913, inclusive: red pigment spots noted on 7 of the 12 dates; lengths recorded on one date 0.09 to 0.12 mm. On 1 date in June, 1, six fish examined; 7 dates in July, 1 to numerous, 26 fish examined; 4 dates in August, 1 to few, 10 fish examined.

Caranx chrysos.

1911, October 13: 20, length 1.5 mm., myzorhynchus with trumpet-shaped border, 15 fish examined.

Ceratacanthus schoepfi.

1908, August 19: Many, 1 fish examined.

Clupea harengus.

Collected in 3 of the years from 1905 to 1919, inclusive: On 4 dates in July, 1 to numerous, from each of 6 fish measuring from 5.5 to 8 centimeters in length. On 6 dates in August, on 1 date, several, minute, 40 fish examined, size not noted; on other dates,

1 to many in each of 22 fish measuring from 7 to 10 centimeters in length.

Cyclopterus lumpus.

1915, May 6: 18, 2 to 5 mm. in length in formalin, 1 fish examined. (U.S.N.M., Helm. Coll. 7729.)

Cynoscion regalis.

Collected in 6 of the years from 1903 to 1910, inclusive: Usually present in the cystic ducts of squeteague, where they occur in considerable numbers in clusters with heads buried in the mucous membrane; much smaller examples occasionally met with in the intestine. Some with red pigment spots, some without; some with plain bothria, some with rudiments of acetabula and costae. On about 12 dates in July, in cystic ducts of 47 out of 59 fish examined, and on about 15 dates in August, in 42 out of 44 fish examined. The following measurements were made on living specimens collected July 19, 1905: From the cystic duct a typical specimen varied in length from 2.5 to 6 mm., breadth 1 mm. when contracted. A specimen from the intestine varied from 0.11 to 0.28 mm. in length, and from 0.03 to 0.07 mm. in breadth.

Decapterus macarellus.

1918, August 7: Few, in each of three 95-mm. fish.

1920, August 17: 5 small, 1 fish examined. A distinctly progressive movement was observed in one which was creeping on the bottom of the dish, by alternately extending each of the two pairs of bothria, which acted as suckers to pull the body along.

Decapterus punctatus.

1906, August 17: 18, small, no pigment; head more transparent than body; bothria rather flat and leaf-like, nearly circular when contracted, with transverse wrinkles which suggested rudimentary costae as in the genus *Rhinebothrium*; varying in length from 0.32 to 1.40 mm.

Etrumeus sadina.

Collected in 4 of the years from 1905 to 1918, inclusive: On 1 date in July, few, 25 fish examined; on 2 dates in August, 1 to few from each of 3 fish, length, noted on 1 date, 14 centimeters; on 3 dates in September, 1 to few, 27 fish examined, length, noted on 1 date, 14.5 centimeters. Record of September 2, 1905: Few, length 1.7 mm., diameter of head 0.5 mm.; a memorandum sketch made at the time of collecting shows the bothria grouped into a disk-like head, with no myzorhynchus, 25 fish examined.

Gasterosteus bispinosus.

1919, July 5: 3; lengths 0.37, 0.70, 0.80 mm., from one 20 mm. fish.

Hippoglossus hippoglossus.

1906, June 14: Few, 7 fish examined.

Lagodon rhomboides.

1914, June 4: 31 in 1 fish, 19 in 1 fish; length 2 mm., 2 fish examined.

Leiostomus xanthurus.

1912, October 18: 1, length 1.9; diameter of head 0.33, 6 fish examined.

Leptocephalus conger.

1903, August 24: Small, number not noted, 1 fish examined.

Lophius piscatorius.

Collected in 15 of the years from 1899 to 1920: Usually present in enormous numbers among the villi of the intestine, in most cases from 1 mm., or less to 5 mm. in length; in a few instances the length was as much as 11 mm.; red pigment noted on but one date, but most of the material had been in formalin before it was examined. On 1 date in May, numerous, 2 fish examined; 1 date in June, very numerous, 0.9 to 2.25 mm. in length, 1 fish examined; 5 dates in July, few to very numerous, 9 fish examined. On July 9, 1912, my attention was called by Dr. G. A. MacCallum to small cestodes which appeared to have developed proglottides. This appearance was due to somewhat regular constrictions of the body wall, but there was no indication of the beginning of proglottides. The bothria were rather thick margined with strong acetabula. Structures which appeared to be rudiments of hooks were noted; terminal sucker very small. On 6 dates in August, few on 1 date, very numerous on others, 9 fish examined; 3 dates in September, many, 3 fish examined; 6 dates in October, many to very numerous, 7 fish examined. Record for October 10, 1904: Very numerous, shorter ones about 1 mm. in length, longer, without intermediate forms, 5 mm., or more, in length; bothria with well-defined, Monorygma-like auxiliary sucker. October 13, 1905: Very numerous, maximum length 6.5 mm.; pseudo-segments present; bothria suggest *Echeneiobothrium* or *Acanthobothrium*. On 5 dates in November, many to very numerous, 6 fish examined; 2 dates in December, few on one date, numerous on the other, 4 fish examined.

(U.S.N.M., Helm. Coll. 7730.)

Melanogrammus aeglefinus.

1906, May 7: Few.

Menticirrhus saxatilis.

Collections made in 1903 and 1910: On 1 date in July, 2 from gall-bladder, 2 red pigment patches, collected by Dr. C. W. Hahn; 2 dates in August—(1) very small, number not recorded, 4 fish ex-

aminated; (2) 1, very small, 1 fish examined; 2 dates in September, 1, on each date, large, no pigment, 3 fish examined on 1 date, 14 on the other; 1 date in October, few, lodged in cyst-like structure which was destroyed before its real nature was determined, probably a part of the cystic duct.

Merluccius bilinearis.

Collected in 6 of the years from 1903 to 1913: On 1 date in July, few, very small, red pigment in neck; 5 dates in August—(1) few, red pigment, 1 fish examined; (2) many, small, simple bothria, distinct myzorhynchus, 10 fish examined; (3) many, small, rudimentary costae, red pigment spots, 16 fish examined; (4) few, from gall-bladder, collected by Dr. C. W. Hahn; (5) 1, rather large, with costae, but no pigment, 1 fish examined.

Microgadus tomcod.

1910, July 13: 1; 2 red pigment spots in neck; Dr. C. W. Hahn.

1913, September 23: 1, 6 fish examined.

1915, February 16: 1, 50 fish examined.

Morone americana.

1912, October 28: Few, 5 fish examined.

1913, April 21: 50, 1 to 2 mm. in length, 2 fish examined.

Mugil cephalus.

1913, September 16: 2; length in formalin 1.40, breadth 0.36, 30 fish examined.

Opsanus tau.

1898, October 28: Numerous, small, from intestine.

1910, August 5: Numerous, large, in cystic duct, where they are clustered as in the squeteague and flounder; no pigment, 7 fish examined.

1913, September 29: 1, 13 fish examined.

Osmerus mordax.

1911, October 23: 1; length 0.75, breadth 0.36, length of bothria 0.21, 8 fish examined.

Palinurichthys perciformis.

1910, August 22: Numerous; 2 red pigment spots.

1920, August 6: 1.

Paralichthys dentatus.

Collected in 5 of the years from 1903 to 1920, inclusive: As in the squeteague, so in the summer flounder, these larvae are common in the cystic duct, where they are often in large numbers, clustered together with their heads in the mucous membrane. Much smaller examples occur in the intestine. Red pigment and rudiments of

acetabula and costae noted; one noted on August 16, 1906 that suggested *Phyllobothrium loliginis*.

A case of jaundice was encountered in a flounder on August 6, 1908. Numerous larvae (*S. polymorphus*) formed a subspherical enlargement of the cystic duct. The flounder was about 40 centimeters in length, and was of a bright yellow color, the muscles also were decidedly yellow. The cestodes appeared to completely occlude the duct, which, doubtless accounted for the jaundiced condition of the fish. Larvae active, varying from 2 to 5 mm. in length; myzorhynchus distinct, bothria with faint costae near anterior end; some with red pigment spots in neck.

On 4 dates in July, few on each of three dates, numerous on one date, 7 fish examined; on 10 dates in August, few to numerous, 37 fish examined; on 1 date in October, very numerous, relatively large, adhering in clusters in cystic duct near intestine, numerous in intestine, 3 fish examined.

Paralichthys oblongus.

1905, August 4: Few, small; 2 red pigment spots; bothria with distinct acetabulum, and faint indication of costa near posterior third, 4 fish examined.

1907, June 10: Few, 1 fish examined.

1913, June 6: 1 noted with well defined costae on bothria, 2 fish examined.

Pollachias virens.

1908, August 19: Few, 2 fish examined.

1912, July 1: 1, 18 fish examined.

Pomatomus saltatrix.

1904, August 11: Few, minute, length 0.06 mm., 1 fish examined.

1906, August 27: Few, less than 1 mm. in length, no red pigment, 1 fish examined.

1911, July 17: Few, no red pigment or costae, 10 fish examined.

1919, August 21: 1, in intestine of 125 mm. fish.

Pomolobus aestivalis.

1908, August 11: 6, 2 bright red pigment patches in neck; rudiment of anterior costa, 1 fish examined.

1910, July 20: Many, 6 fish examined.

Pomolobus mediocris.

1906, August 15: 2, small, simple bothria, no pigment, 1 fish examined.

Pomolobus pseudoharengus.

Collected in 5 of the years from 1906 to 1914, inclusive: On 1 date in April, 34 in vial, no pigment in formalin material, but label stated that there were red spots in the living worms; on 2 dates in May,

few on one date from 10 fish, 1 on the other date, from 8 fish; on 3 dates in July, 1 to numerous, red pigment noted, 6 fish examined; on 2 dates in August, few, red pigment present, 15 fish examined; on 1 date in September, few, 6 fish examined.

Poronotus triacanthus.

1905, July 18: 1, length 1.4, breadth 0.7 (compressed), 17 fish examined.

1917, July 24: 14, in a 75 mm. fish. August 11: Few, in a 88 mm. fish. August 14: 1, in a 29 mm. fish. August 21: 1, in a 128 mm. fish. August 30: 1, in a 72 mm. fish.

1918, September 3: 1, in a 48 mm. fish. September 10: 2, in a 50 mm. fish, 1 in each of 3 fish, 48, 57, and 64 mm. in length.

Prionotus carolinus.

1915, April 16: 1, in vial attached to a distome, 1 fish examined.

Pseudopleuronectes americanus.

1914, February 13: 2, length 9 mm., in formalin, 22 fish examined. February 24: 1, length 4 mm., in formalin. It is worthy of note that these larval forms were not found in any of the 398 winter flounders, which were examined for their food. Also, in this connection, it is interesting to recall that Vinal Edward's record shows that 628 adult winter flounders were examined by him on 82 dates.¹⁹

Pterophryne histrio.

1919, September 5: Several, in intestine; largest, length 0.52, breadth 0.31 mm., 1 fish examined.

Remora remora.

1918, July 26: Few, small, in one fish, length 0.27, breadth 0.15 mm., 2 fish examined.

Sarda sarda.

1918, August 27: Few, in one 145 mm. fish.

Scomber scombrus.

Collected in 4 of the years from 1906 to 1914, inclusive: On 2 dates in July, 1 on one date, few on the other, 2 fish examined; on 7 dates in August, 1 on one date, many on one date, few on others, 32 fish, from 7.5 to 17.5 centimeters in length, examined; on 1 date in September, few, from 17-centimeter fish; on 1 date in October, 1, length 1.5 mm., 14 fish examined.

Selar crumenophthalmus.

1913, August 17: Few, small, no pigment, 13 fish examined. September 17: 4, more or less enlarged behind bothria; terminal os, in some cases, everted and vase shaped; length 1.65; breadth of head 0.30, breadth behind bothria 0.45, 1 fish examined.

¹⁹ See Appendix 4 to Report of U. S. Commissioner of Fisheries for 1921, pp. 1-14.

Seriola zonata.

1910, August 16: 1, length 1.12 mm., 2 red pigment patches, head and neck transparent, yellowish, body opaque, 3 fish examined.

1913, September 22: 1, length 1.43 mm., 7 fish examined.

Siphostoma fuscum.

1919, July 15: 1, in one 45 mm. fish.

Spheroides maculatus.

1907, August 1: Number not noted, small, no pigment, 2 fish examined.

Stenotomus chrysops.

Collected in 8 of the years from 1904 to 1920, inclusive: On 7 dates in July, few on 2 of the dates, 12 fish, size not noted, examined: on the remaining 5 dates, from 2 to 27 larvae found in each of 7 fish, measuring from 2.5 to 14 centimeters in length. On 14 dates in August, on 1 date 1 larva, 7 fish examined, on another few, 6 fish examined; on remaining dates from 1 to numerous in each of 88 fish, measuring from 2.7 to 14 centimeters in length. On 1 date in September, many from a 7-centimeter fish.

Larvae all small with two red pigment spots; rudiments of costae noted on one date.

Trichiurus lepturus.

1903, July 6: Very numerous, among villi of pieces of intestine in bottle, estimated to be 3,900 to the square inch, 212 large and 28 small fish examined. August 6: Same conditions as in foregoing, 283 large fish examined. September 16: Enormous numbers from pieces of intestine; much contracted by the formalin, oval-elliptical to globular, 0.6 to 0.8 mm. in length.

1904, August 2: Very numerous, among intestinal villi, 2 fish examined.

1913, June 18: Very numerous, length in formalin about 2 mm., 1 fish examined. These larval cestodes were found in the pyloric caeca, but most abundant in the intestine where, in many cases they were embedded in the mucous membrane so close together as to make the number in a given area equal to that area divided by the area of a cross section of a worm. The number to the square inch, given above, was estimated from several counts made at different places on different pieces of intestine.

Tylosurus marinus.

1904, August 25: Few, 2 pigment patches, no costae, 3 fish examined.

1907, September 9: Few, small, 2 red pigment patches, 5 fish examined.

1912, September 9: 2, small, no pigment, 1 fish examined.

Urophycis chuss.

1903, October 17: 1, from intestine, bothria with costae, 1 fish examined.

1910, August 12: Many, some in gall bladder; red pigment, Dr. C. W. Hahn, 3 fish examined.

1914, October 28: 1, 10 fish examined.

1915, August 20: Numerous, small; Dr. G. A. MacCallum, 10 fish examined.

Urophycis regius.

1908, September 26: Very numerous, 1000; approximately, in vial; length 0.40 to 1.60 mm.; myzorhynchus, in many cases protruded; characteristic shape long oval, or wedge shape, a few clavate; diameter through bothria about 0.30, 1 fish examined. October 21: Few, 1 fish examined.

1912, November 14: 3, 1 fish examined.

Urophycis tenuis.

1911, August 4: Few, small, red pigment, 3 fish examined.

1916, June 15: Few, small; in vial attached to a specimen of *P. loliginis*, 2 fish examined.

1918, September 10: Few, 1 fish examined.

Xiphias gladius.

1904, July 15: Many, and great variety of forms; among them were many small larvae with 2 red pigment spots in the neck, and the rudiment of an auxiliary acetabulum on the bothrium, 1 mm. and less in length; others, much larger, with distinct acetabula, but with pigment spots and as much as 3 mm. in length, are apparently simply larger examples of the cestode which is represented by the smaller forms; some of these larger forms have the neck differentiated from the body, and appear to be young of *Phyllobothrium loliginis*, examples of which were present, but with no intermediate forms. The largest *S. polymorphus* was 3 mm. in length, while the smallest *P. loliginis* was 10 mm. in length, contracted; 4 fish examined. (See 1922b, pp. 10, 11.) July 28: Many, as in foregoing, 1 fish examined.

EXPLANATION OF PLATES.

<i>c.</i> cirrus.	<i>sg.</i> shell gland.
<i>cp.</i> cirrus pouch.	<i>sr.</i> seminal receptacle.
<i>ex.</i> excretory vessel.	<i>sv.</i> seminal vesicle.
<i>gd.</i> germ duct.	<i>t.</i> testes.
<i>lm.</i> longitudinal muscles.	<i>u.</i> uterus.
<i>n.</i> nerve.	<i>up.</i> uterine pore.
<i>nc.</i> nerve cell.	<i>v.</i> vagina.
<i>o.</i> ovary (germarium).	<i>vd.</i> vas deferens.
<i>ot.</i> ootype.	<i>vg.</i> vitelline gland.
<i>ov.</i> oviduct.	<i>yd.</i> vitelline duct.
<i>sd.</i> sperm duct.	

PLATE 1.

Anthobothrium laciniatum Linton.

FIG. 1. Scolex and anterior portion of strobile; balsam; length of portion sketched 3.5 mm. From *Carcharhinus milberti*.

1a. Last proglottis of strobile, the anterior end of which is shown in fig. 1; length 1.12.

1b. Scolex; balsam; breadth 0.6.

1c. Everted cirrus of adult proglottis, from *Raja eglanteria*; life; length approximately 0.4.

Rhinebothrium maccallumi, new species, from *Dasybatis centrura*.

FIG. 2. Free-hand sketch of specimen mounted in balsam; length about 28 mm.

3. Free-hand sketch of another scolex, compressed; diameter of scolex 1.47.

4. Camera lucida sketch of bothrium, showing arrangement of loculi; length 0.45 mm.

Crossobothrium angustum Linton, from *Carcharhinus obscurus*.

FIG. 5. Egg; life; length 0.15.

Monorygma, species, from *Raja stabuliforis*.

FIG. 6. Scolex and anterior part of strobile; alcohol; diameter of scolex 0.56.

Discocephalum pilcatum Linton, from *Scoliodon terrae-novae*.

FIG. 7. Scolex in different states of contraction; free hand from life; diameter of scolex 0.80. This form from the sharp-nosed shark has relatively smaller scolex, and larger pseudoscolex than the type from the tiger shark.

PLATE 2.

Orygmatobothrium forte, new species, from *Cestracion zygaena*.

FIG. 8. Scolex, nearly front view; balsam; breadth 0.72.

9. Section of scolex; diameter 0.58.

10. Portion of section of bothrium, showing two nerve cells in the midst of the muscle fibers, thickness of bothrium 0.06.

Orymatobothrium paulum Linton, from *Galeocerdo arcticus*.

- FIG. 11. Front view of bothrium, contracted, the suckers seen in optical section; balsam; length 0.35.
12. Four proglottides, showing tendency of genital apertures to lie many in succession on the same margin; balsam; breadth 0.5.
13. Adult proglottis; balsam; length 1.68.

Trilocularia gracilis Ollson, from *Squalus acanthias*.

- FIG. 14. Scolex; balsam; breadth 0.5.
15. Front view of bothrium; glycerine; breadth 0.25.
16. Portion of strobile, posterior end to right; balsam; breadth 0.17.
17. Posterior end of same; balsam; breadth 0.14.

Monorygma perfectum (van Beneden), from *Somniosus brevipinna*.

- FIG. 18. Transverse section of proglottis; two sections of the series used; longer diameter of section 4.

PLATE 3.

Monorygma perfectum (continued).

- FIG. 19. Scolex and strobile; balsam; length 85.
20. Scolex of same; balsam; diameter 3.5.
21. Transverse section near anterior end of scolex (fifth section of series), showing rudiment of myzorhynchus, *mz*; maximum diameter 0.88.
22. Tenth section of same series of sections of scolex; longer diameter 1.57.
23. Thirtieth section of series (65 sections in series); longer diameter 2.29.
24. Vagina and cirrus pouch in fourth section from margin, in series of sagittal sections; greater diameter of cirrus pouch 0.17.
25. Same, as seen in tenth section.
26. Same, as seen in twentieth section.
27. Vagina and cirrus pouch, the latter with three sections of the cirrus, as seen in the fortieth sections.
28. Same in fiftieth section.
29. Vagina and vas deferens, sixty-third section. Figures 24-29 drawn to same scale.
30. Diagram of female genitalia reconstructed from sagittal sections.
31. Egg, 0.09 by 0.03 in the two principal diameters.

PLATE 4.

Acanthobothrium paulum Linton, from *Raja eglanteria*.

- FIG. 32. Pair of hooks; length 0.14.

Acanthobothrium coronatum Rudolphi, from *Raja stabuliformis*.

- FIG. 33. Pair of hooks; length 0.11.
34. Bothrium; length 1.
35. Pair of hooks; length 0.15.

Phoreiobothrium lusium Linton, from *Carcharhinus obscurus*.

- FIG. 36. Bothrium; balsam; length 0.30.
37. Front view of scolex; balsam; maximum length of hooks 0.10.
38. Marginal view of bothrium; balsam; length of bothrium 0.35; from *C. limbatus*.
39. Pair of hooks; length 0.10.
40. Spines from neck; maximum length 0.015.

Phoreiobothrium exceptum, new species, from *Cestracion zygaena*.

- FIG. 41. Scolex and anterior part of strobile; balsam; diameter of scolex 0.56.
 42. Bothrium; balsam; length 0.47.
 43. Pair of hooks; maximum length 0.13.
 44. Spines from neck; maximum length 0.036.

PLATE 5.

Phoreiobothrium trilocolatum Linton, from *Carcharhinus obscurus*.

- FIG. 45. Bothrium; balsam; length 0.60.
 46. Pair of hooks; maximum length 0.15. (a) Spines from neck; maximum length 0.012.

Phoreiobothrium pectinatum, new species, from *Cestracion zygaena*.

- FIG. 47. Bothrium; balsam; length 0.18.
 48. Pair of hooks; maximum length 0.06.
 49. Spines from neck; maximum length 0.03.
 50. Proglottis; balsam; length 1.22.

Platybothrium cervinum Linton, from *Carcharhinus obscurus*.

- FIG. 51. Scolex; balsam; breadth 0.52. (a) Spines from neck; maximum length 0.015.

Platybothrium parvum Linton, from *Cestracion zygaena*.

- FIG. 52. Scolex; flattened under cover glass, and fixed over flame; breadth 0.35.
 53. Proglottis; balsam; length 2.10.

Phoreiobothrium lasium Linton, from *Carcharhinus obscurus* (see fig. 36-40).

- FIG. 54. Segmenting ova; length of smallest, 0.06.

PLATE 6.

Ichthiotaenia adherens, new species, from *Cestracion zygaena*.

- FIG. 55. Scolex; balsam; diameter 0.45.
 56. Anterior end of ripe proglottis with wall ruptured exposing the uterus filled with, large, segmenting ova; breadth, in front of genital pore, 1.68.
 57. Part of transverse section of immature proglottis near genital pore; two sections used; diameter of section at median line 0.5.
 58. Spine from cirrus; length about 0.008.
 59. Part of transverse section near posterior end of immature proglottis; diameter at median line 0.5.

PLATE 7.

Otobothrium penetrans Linton, from *Cestracion zygaena*.

- FIG. 60. Strobile; alcohol; length 122.
 61. Scolex and anterior part of strobile; balsam; length of scolex 4.5.
 62. Proboscis, near base; diameter 0.21.
 63. Proboscis, middle; diameter 0.18.
 64. Hooks from near base of proboscis, drawn to same scale; maximum length 0.11.
 65. Immature proglottides; length of single proglottis 1.26.
 66. Ripe proglottides; balsam; length of longest 8.
 67. Ripe proglottis; balsam; length 5.

FIG. 68. Sagittal section of ripe proglottis; length 1.82.

69. Median region of transverse section of adult proglottis; diameter of section 0.26.

70. Diagrammatic plan of genital ducts in vicinity of shell gland. o. d. oviduct.

Rhynchobothrium, species, from *Narcacion nobilianus*.

FIGS. 71, 72. Views of proboscis; diameter, excluding hooks, 0.03.

73. Hooks; maximum length 0.036 mm.

Rhynchobothrium uncinatum, new species, from *Vulpecula marina*.

FIG. 74. View of mid-region of proboscis; length of hooks 0.05 (see figs. 75-78).

PLATE 8.

Rhynchobothrium uncinatum, new species, from *Vulpecula marina* (see fig. 74).

FIG. 75. Scolex; balsam; breadth through bothria 1.12.

76, 77. Views of opposite sides of the base of a proboscis, small hooks somewhat diagrammatic; diameter in region of small hooks 0.075.

78. Posterior proglottis; length 3.91.

Tetrarhynchus bicolor Bartels, from *Carcharhinus obscurus*.

FIG. 79. Scolex; life; length 10.5.

80. Scolex with proboscides everted; life; length 8.5.

Tetrarhynchus palliatus, new species, from *Cestracion zygaena*.

81. Scolex; balsam; length 1.82.

82. View of proboscis; diameter, including hooks, 0.05.

83, 84. Sagittal sections of a proglottis; length 0.56.

PLATE 9.

Rhynchobothrium exile Linton, from *Galeocерdo arcticus*.

FIG. 85. Scolex; balsam; length 2.52.

86, 87. Views of opposite sides of base of a proboscis.

88. Proboscis, above base; diameter, excluding hooks, 0.03.

89. Hooks of same.

90. Posterior, but still immature proglottis; balsam; length 2.60.

Rhynchobothrium, species, near *R. temispine* from *Dasybatis centura*.

FIG. 91. Scolex and small portion of strobile; balsam; length of scolex 1.06.

92. Base of proboscis.

93, 94. Views of other regions of proboscis; diameter, including hooks, 0.015.

PLATE 10.

Synbothrium malleum, new species, from *Dasybatis centura*.

FIG. 95. Hooks from proboscis; length of smallest 0.015; length of longest 0.03.

96. Hooks from proboscis of another specimen, drawn to same scale as fig. 95.

97. Posterior proglottis; balsam; length 2.34.

98. Transverse section near anterior end of proglottis, passing through the point where the uterus opens to the exterior; longest diameter of section 1.23.

PLATE 11.

Rhynchobothrium insigne, new species, from *Carcharinus milberti*.

Sketches made from specimen mounted in balsam.

- FIG. 99. Scolex and interior part of strobile; length of scolex 20 mm.
 100. Proglottis, about 100 mm. from anterior end; length 3.5.
 101. Proglottis, posterior end of strobile; length 6 mm.
 102. Abnormal proglottides, about 80 mm. from anterior end; breadth 5 mm.
 103. View of proboscis near base; diameter, excluding hooks, 0.21.
 104. Tip of proboscis, same side as that shown in fig. 103; two hooks of the linear row appear on the inverted border; diameter, excluding hooks 0.16.
 105. Linear row of closely placed hooks, at its beginning near the base of the proboscis; camera lucida sketch with Spencer No. 6 ocular and 4 mm. objective.
 106. Linear row of hooks, about 0.9 mm. from base of proboscis, same magnification.
 107. Same, about 1.4 mm. from base of proboscis.

PLATE 12.

Rhynchobothrium, species, from cyst on viscera of *Ceratacanthus schoepfli*.

- FIG. 108. View of proboscis, near base; diameter, excluding hooks, 0.075; balsam.
 109. Anterior end of proboscis, so far as it was everted; diameter, excluding hooks, 0.054.

Rhynchobothrium longispine Linton.

- FIG. 110. View of proboscis near base; diameter, including hooks, 0.054; from *Microgadus tomcod*.
 111. Same, near middle; diameter, including hooks, 0.062.
 112. Same, near tip; diameter, including hooks, 0.036.
 113. View of proboscis near base; diameter, including hooks, 0.048; from *Paralichthys dentatus*.
 114. Same, near tip; diameter, including hooks, 0.030.

Rhynchobothrium, species, from flesh of *Cynoscion regalis*.

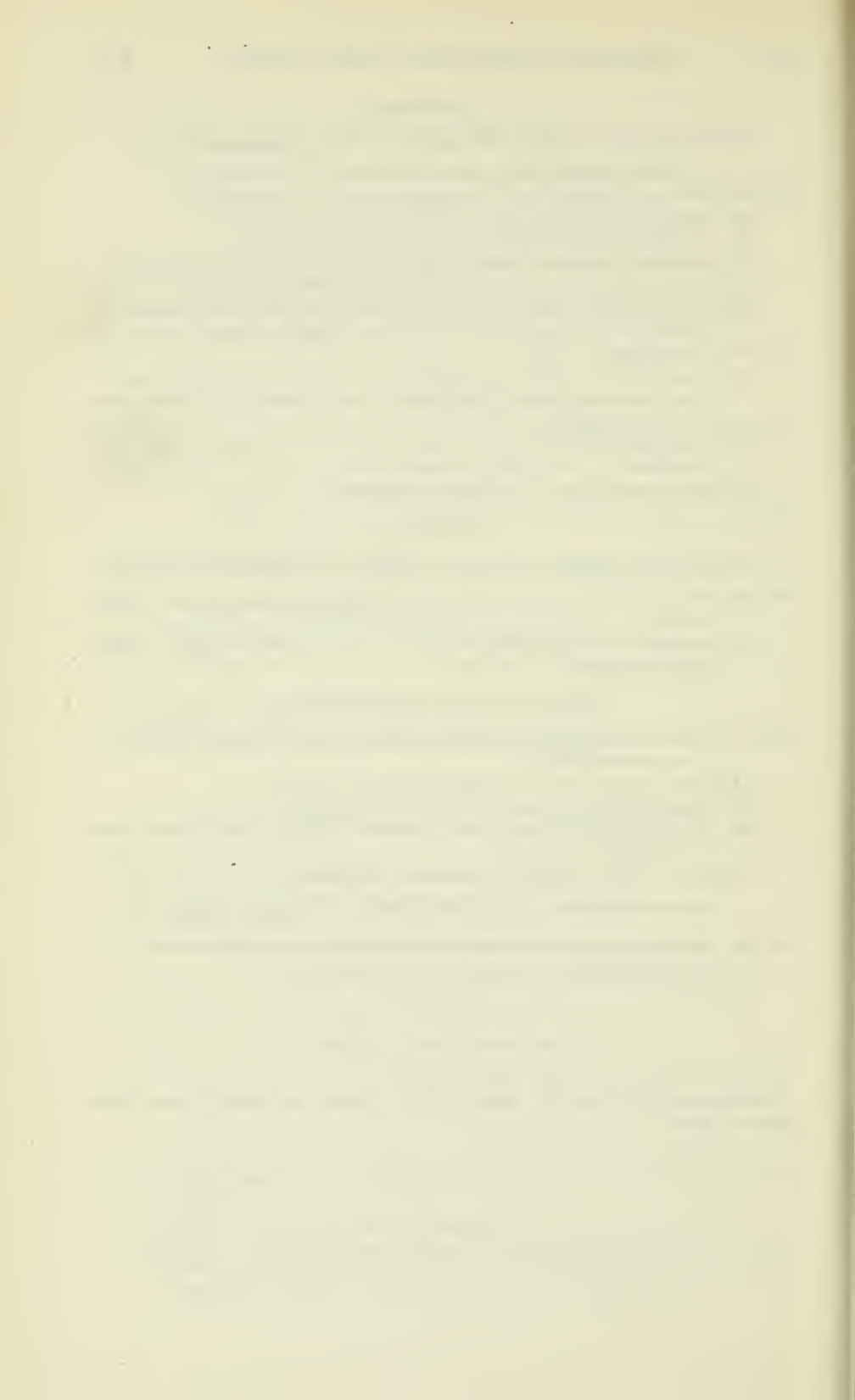
- FIG. 115. Proboscis, so much as was everted; diameter, excluding hooks, 0.18.
 116. View of opposite side from that shown in fig. 115.

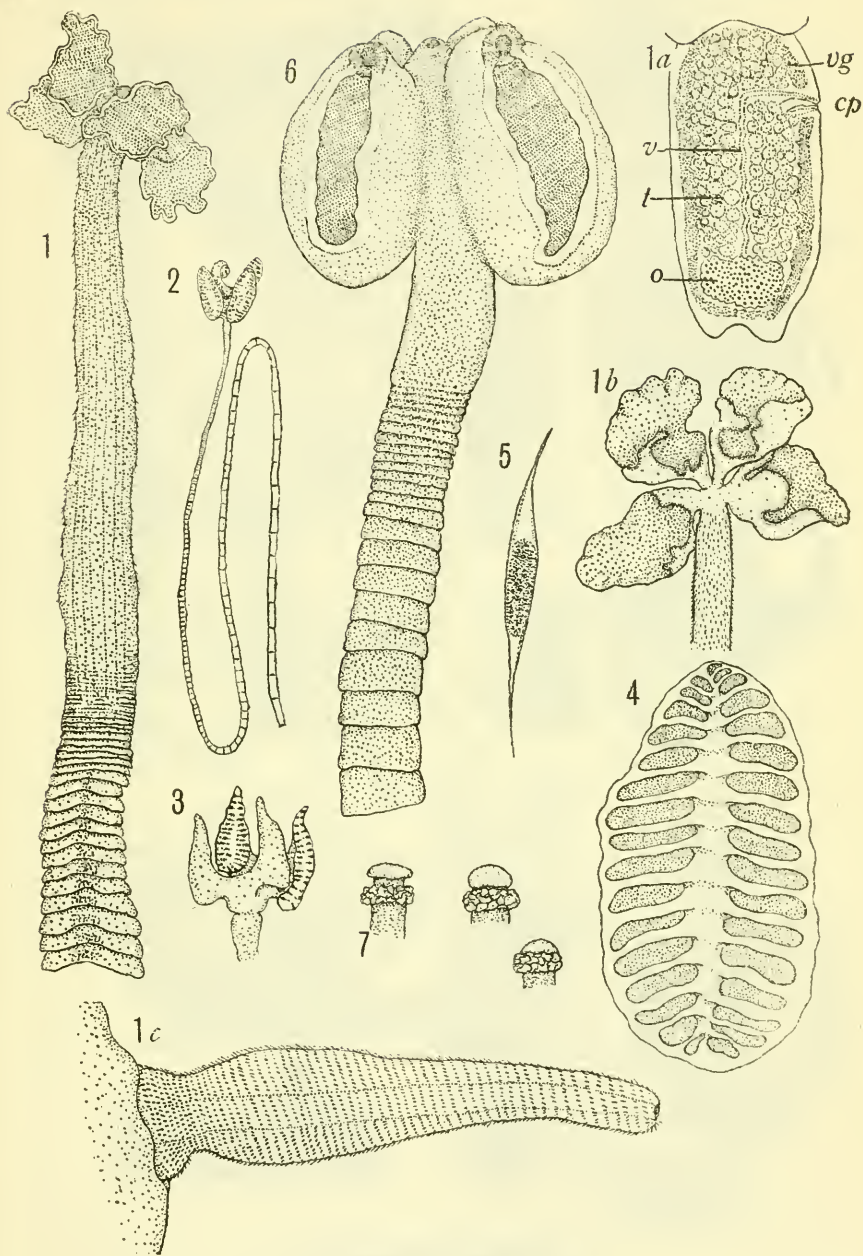
PLATE 13.

Otobothrium crenacolle Linton.

Cysts in flesh of *Poronotus triacanthus*.

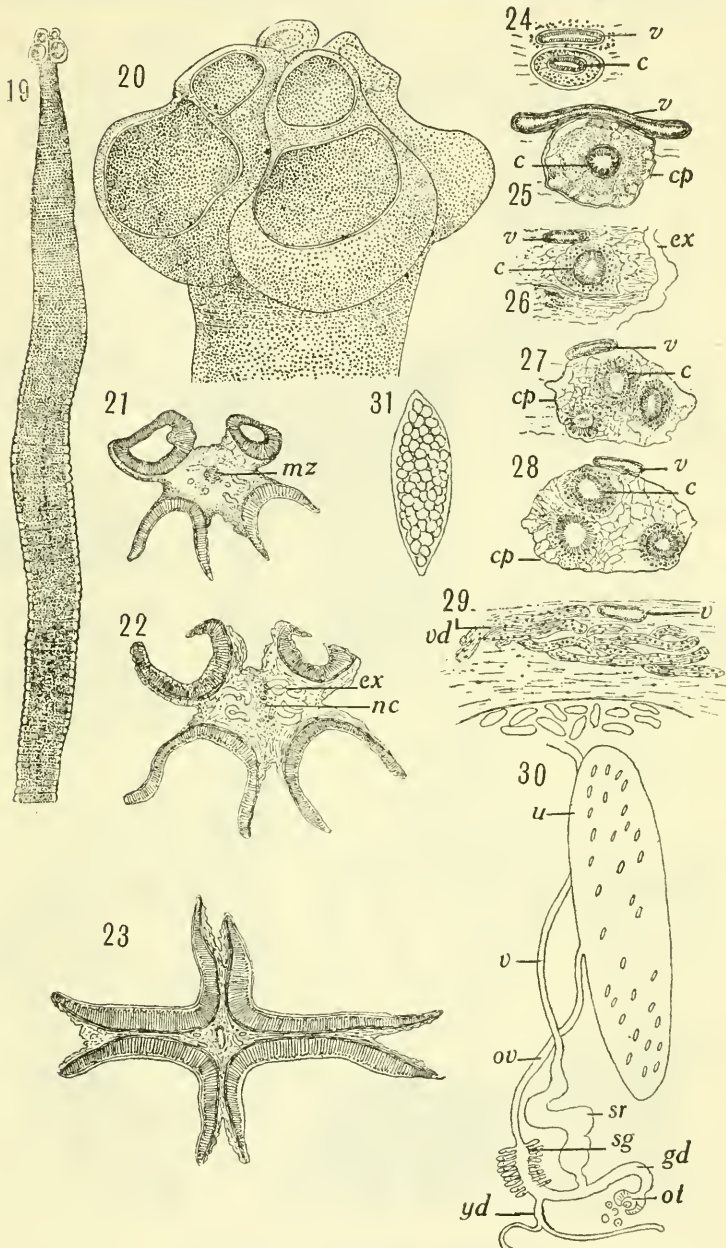
Photographed by Roy W. Minor, in the summer of 1909, Woods Hole, Massachusetts.





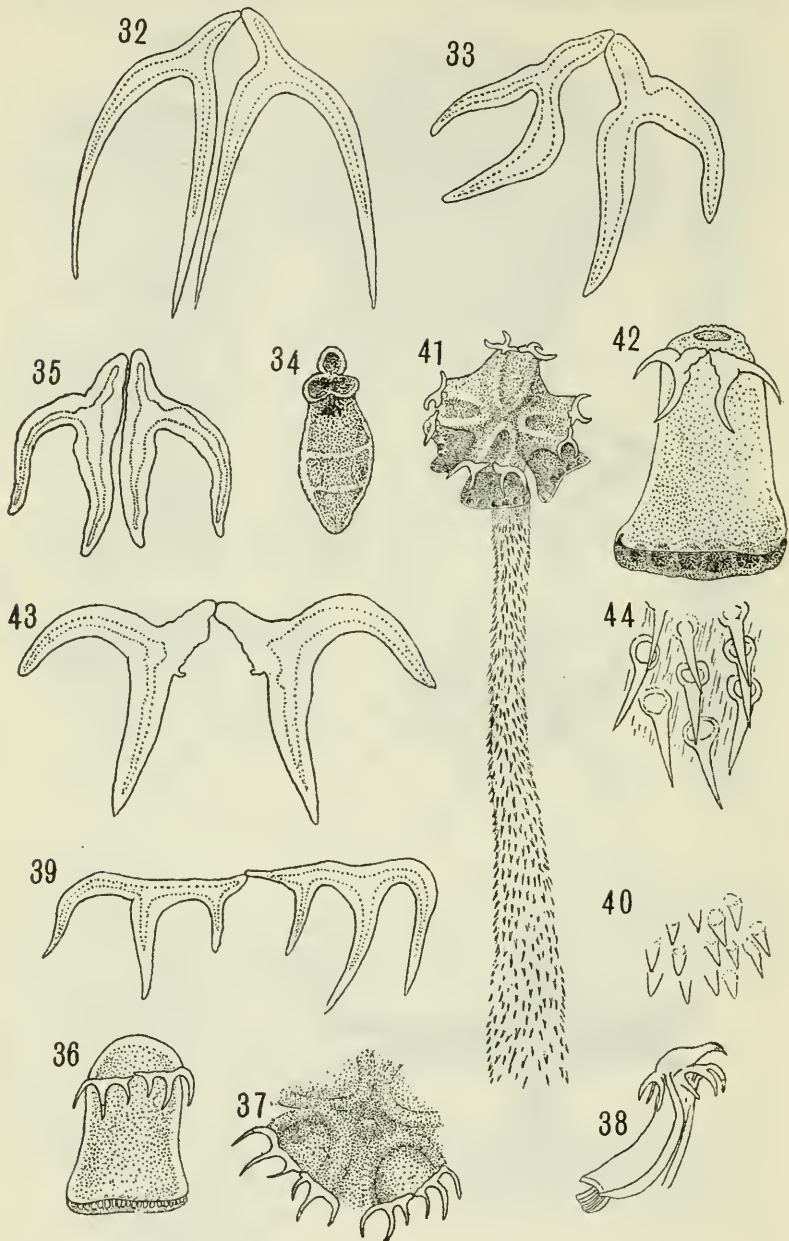
CESTODES OF SHARKS AND SKATES

FOR EXPLANATION OF PLATE SEE PAGE 107.



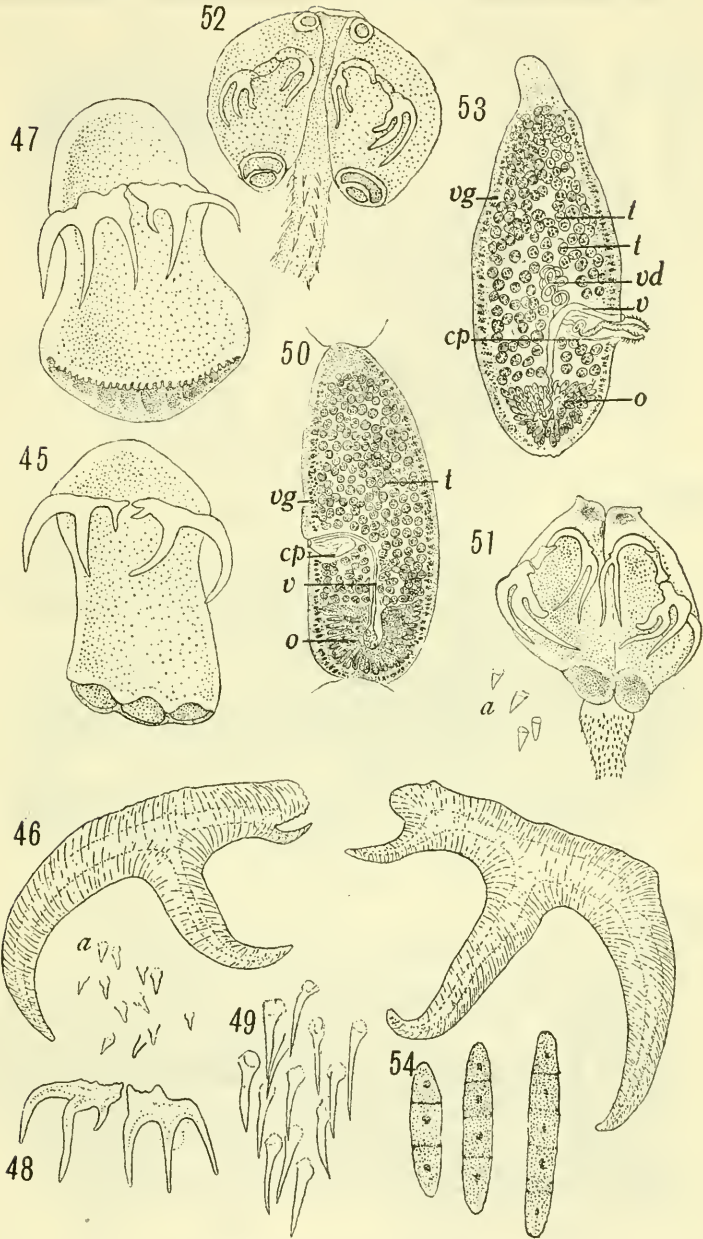
CESTODE FROM SLEEPER SHARK

FOR EXPLANATION OF PLATE SEE PAGE 108



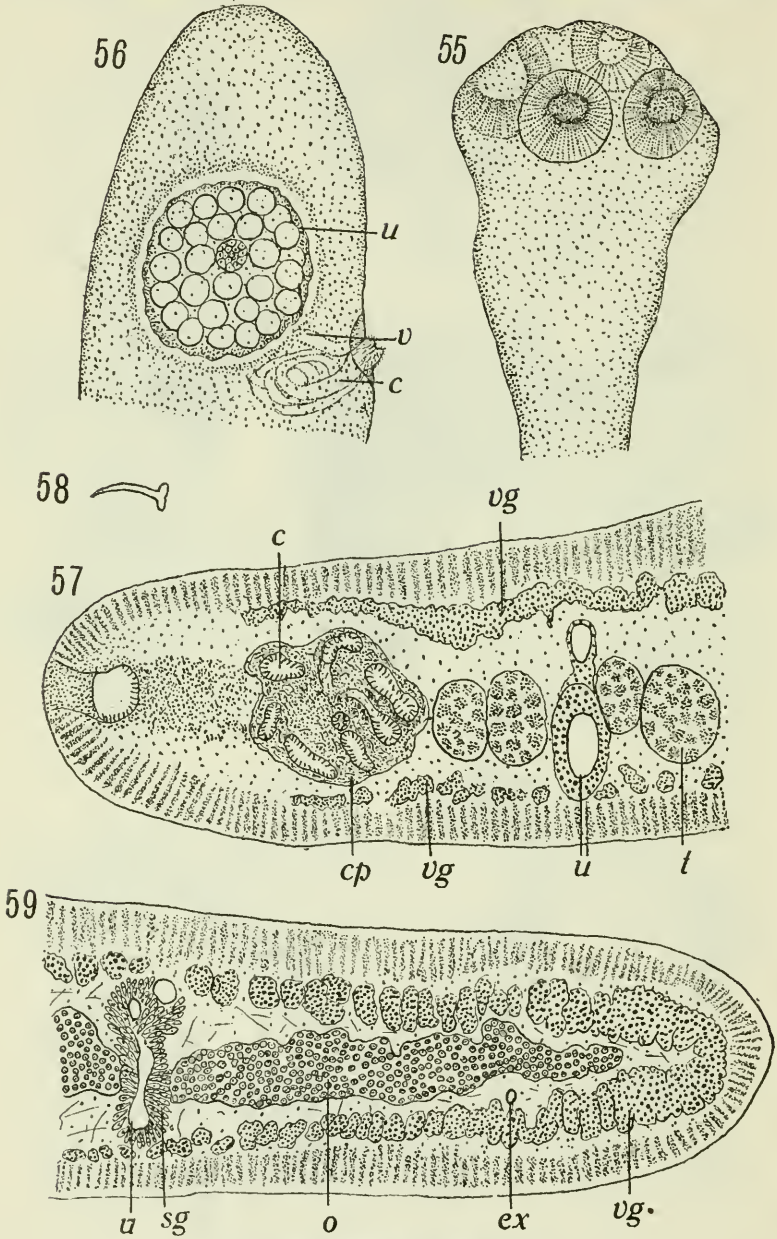
CESTODES OF SHARKS AND SKATES

FOR EXPLANATION OF PLATE SEE PAGES 108 AND 109.



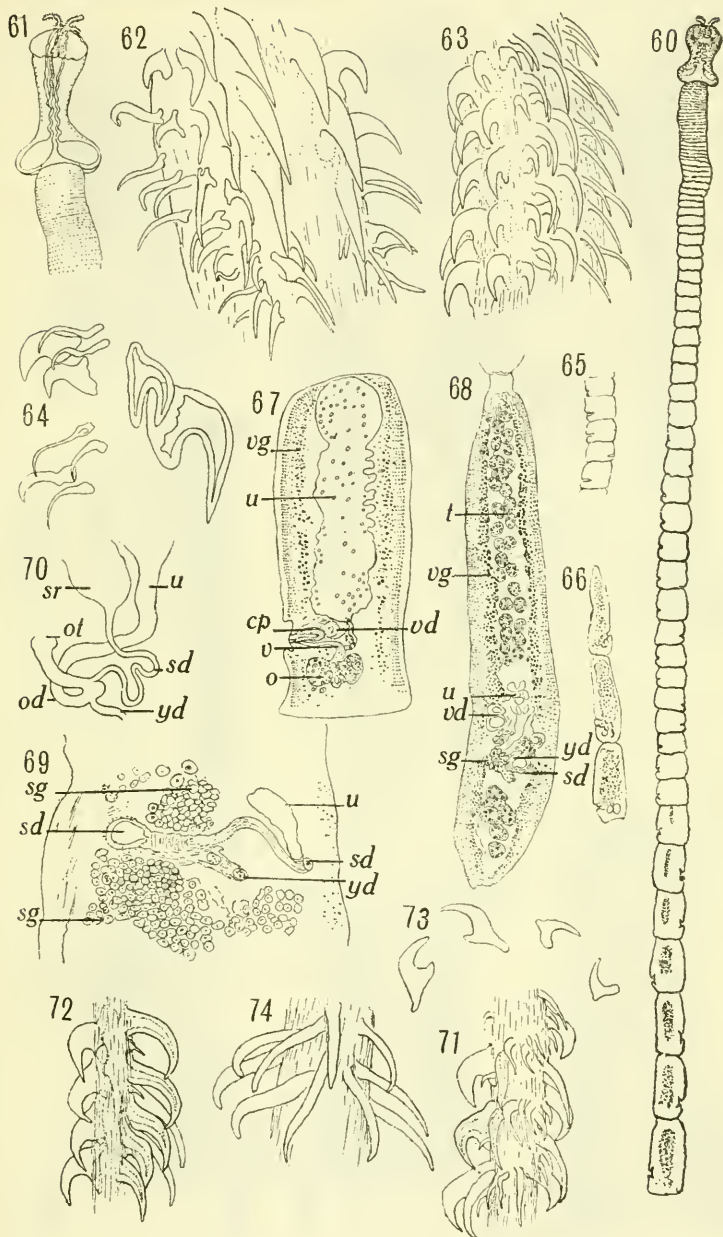
CESTODES OF SHARKS

FOR EXPLANATION OF PLATE SEE PAGE 109.



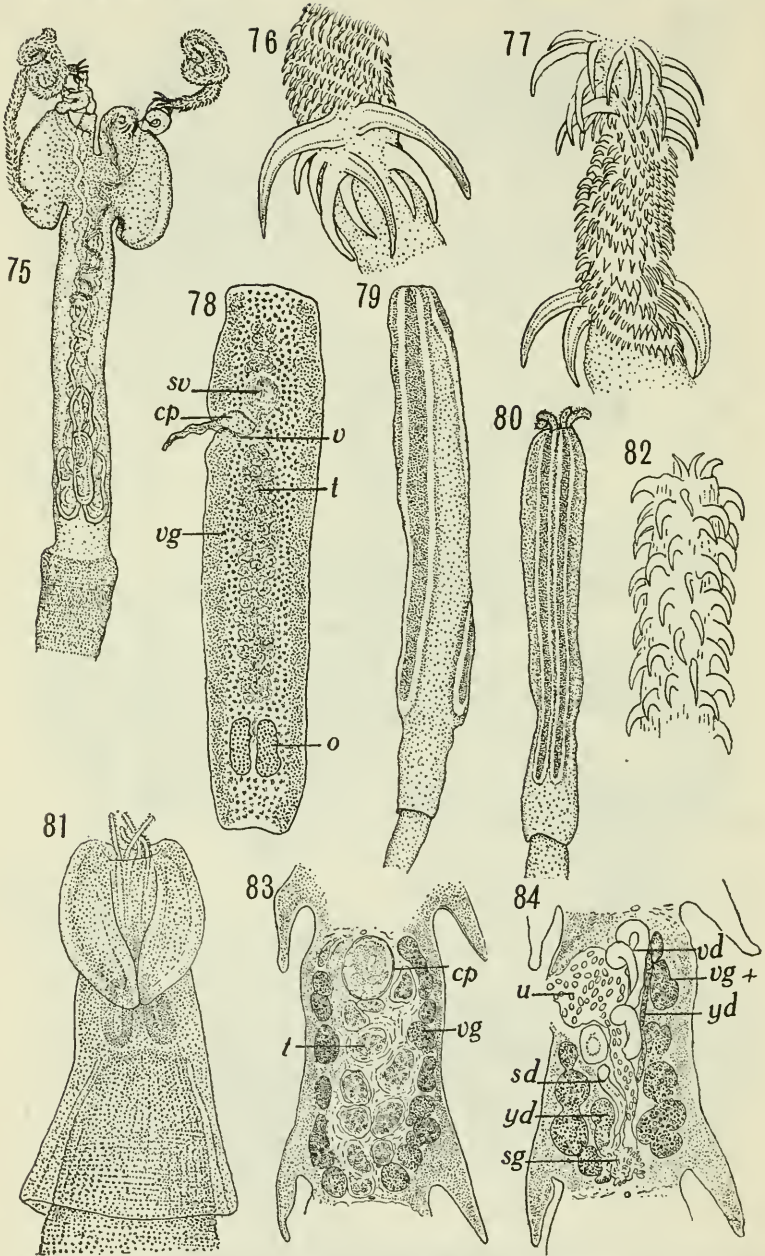
CESTODE FROM HAMMER-HEADED SHARK

FOR EXPLANATION OF PLATE SEE PAGE 109.



CESTODES OF HAMMER-HEADED SHARK, THRASHER SHARK, AND TORPEDO

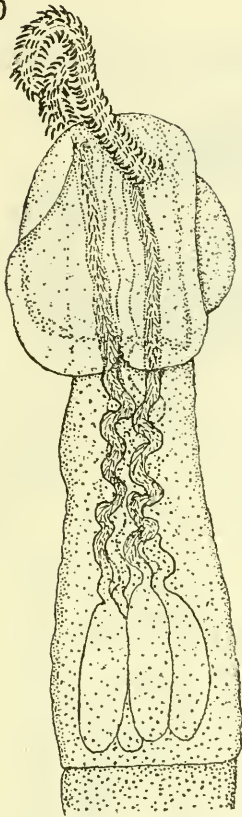
FOR EXPLANATION OF PLATE SEE PAGES 109 AND 110.



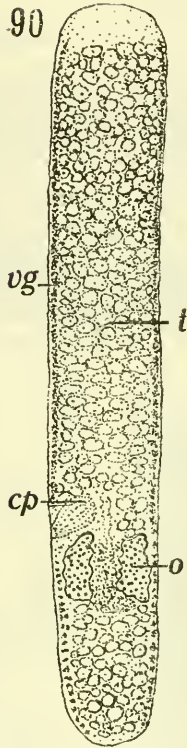
CESTODES OF SHARKS

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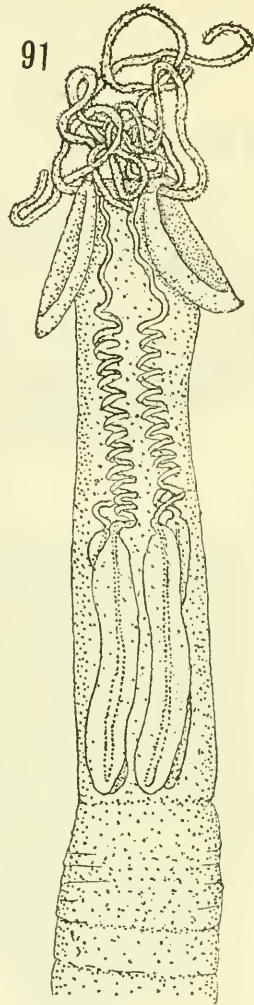
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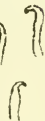
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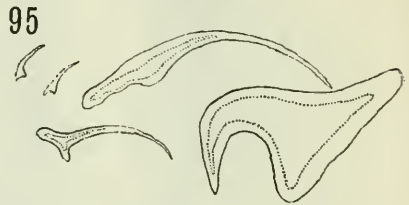
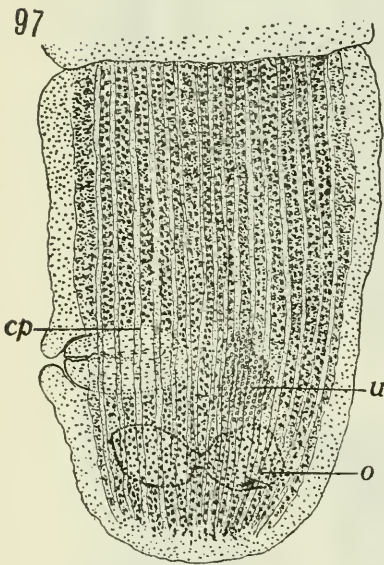
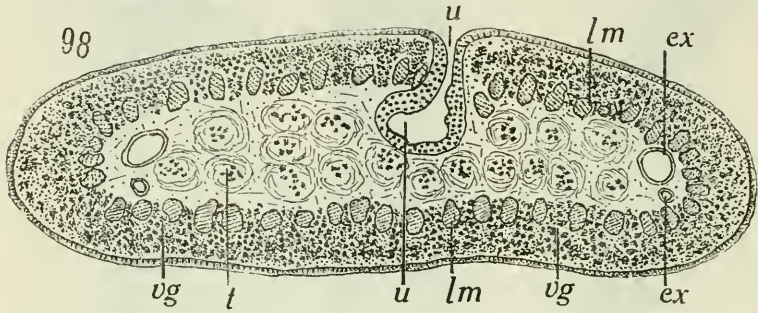


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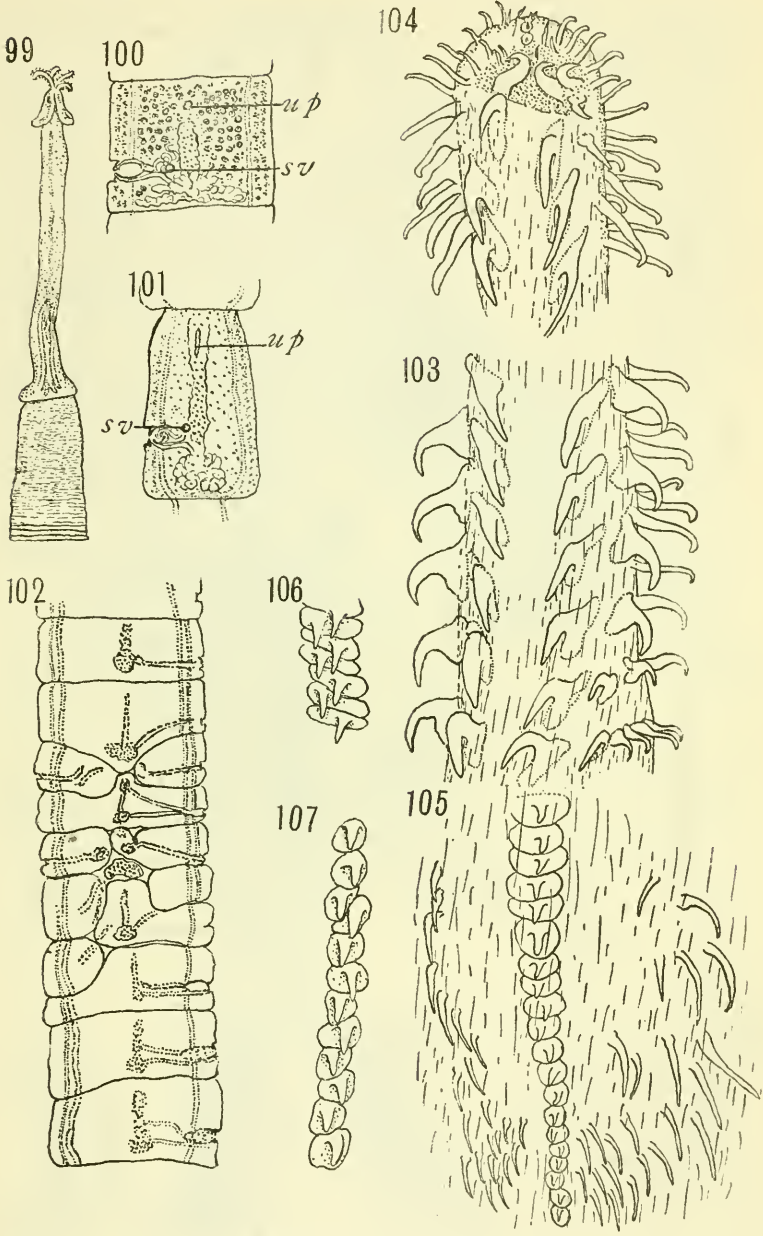
CESTODES OF TIGER SHARK AND STING RAY

FOR EXPLANATION OF PLATE SEE PAGE 110.



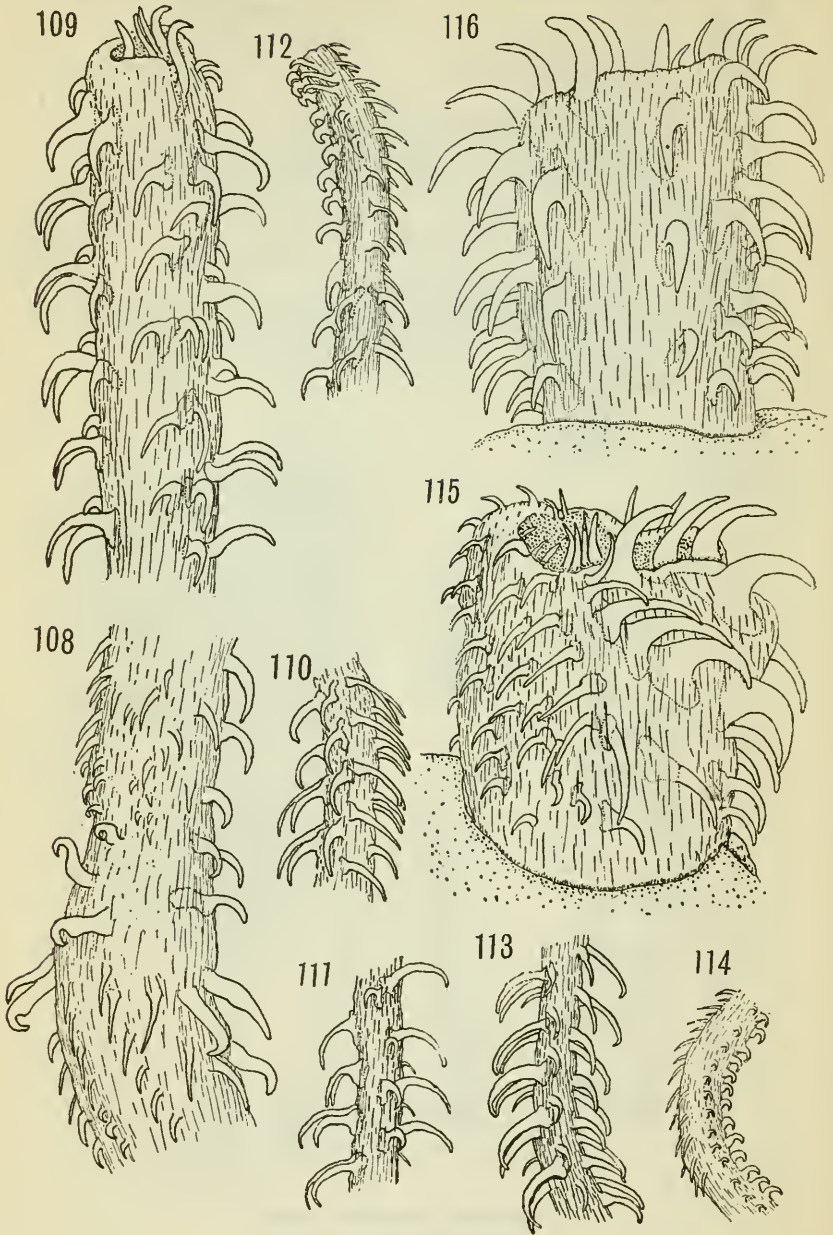
CESTODE FROM STING RAY

FOR EXPLANATION OF PLATE SEE PAGE 110.



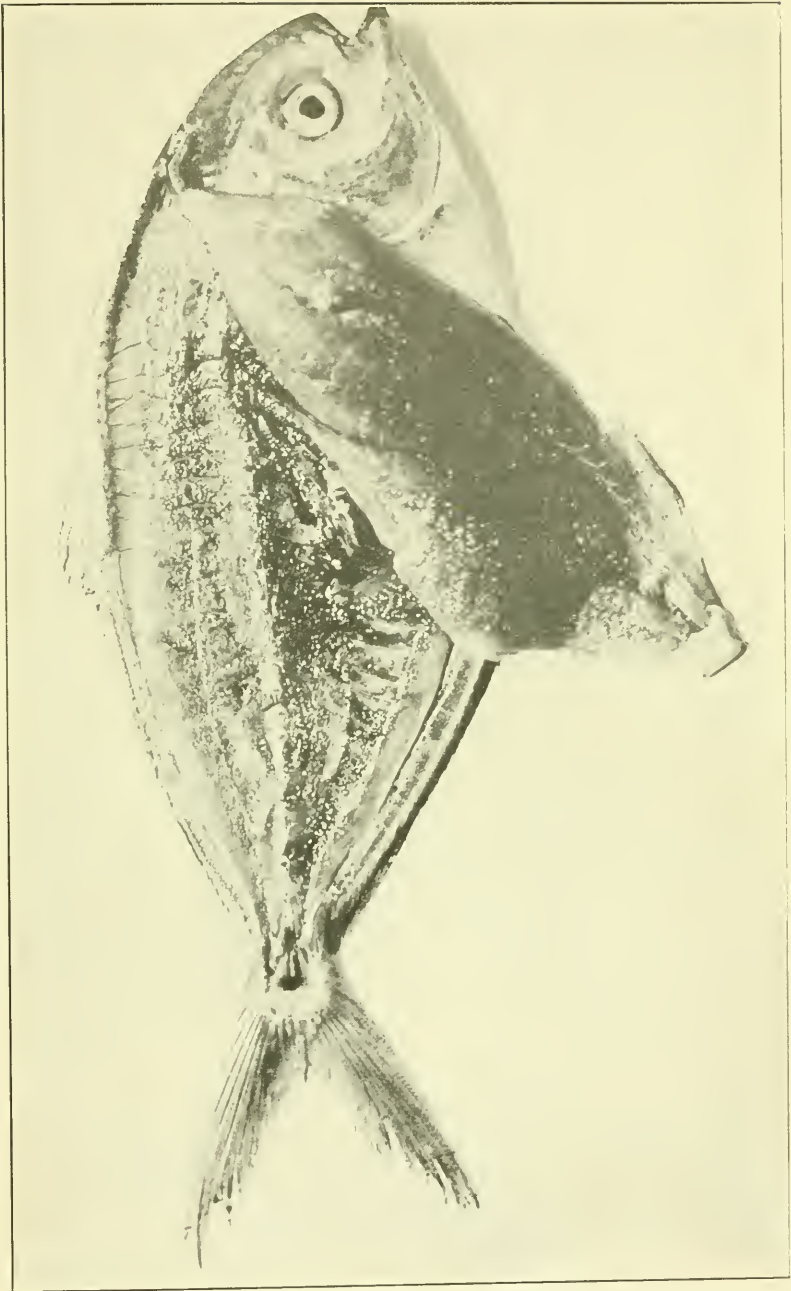
CESTODE FROM BLUE SHARK

FOR EXPLANATION OF PLATE SEE PAGE 111.



CESTODES OF SHARKS AND SKATES

FOR EXPLANATION OF PLATE SEE PAGE 111.



LARVAL STAGE OF SHARK CESTODE ENCYSTED IN FLESH OF A TELIOST

FOR EXPLANATION OF PLATE SEE PAGE 111.

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NOTES ON BIRDS COLLECTED BY DR. W. L. ABBOTT ON
THE KARIMATA ISLANDS, OFF WEST BORNEO.

By HARRY C. OBERHOLSER,

Of the Biological Survey, United States Department of Agriculture.

Karimata Island lies in Karimata Strait, some 60 miles west of the coast of West Borneo, and about 140 kilometers (85 miles) northeast of the island of Billiton. It is 18 kilometers (11 miles) long, east and west, 11 kilometers (7 miles) wide, and its peak rises to an altitude of between 600 and 900 meters (2,000 and 3,000 feet).

Pulo Serutu, or Serutu Island, is but across a narrow channel and southwest of Karimata Island. It is of smaller area—about 10 kilometers (6 miles) long, east and west, and 3 kilometers (2 miles) wide—and its highest point is about 425 meters (1,400 feet) above sea level. These two islands, together with some neighboring islets, are sometimes called the Karimata Islands.

Dr. W. L. Abbott, in the course of his East Indian journeys, twice visited Karimata Island—August 16 to September 4, 1904, and October 4 to 7, 1908—on one of these occasions touching also on Pulo Serutu. Although most of his time was devoted to the collection of other objects, he succeeded in obtaining 11 specimens representing 10 species of birds, some of which prove to be of considerable interest. Since there seems to be little or nothing known of the avian life of Karimata Island, and since there is slight probability of Doctor Abbott's returning there, it seems to be worth while to place on record such information as is now available.

Judging from the few species of birds in hand, which, of course, are indicative only so far as they go, Karimata Island shows more faunal affinity to the Anamba and Natuna Islands of the South China Sea, than to the neighboring coast of Borneo. Two species are represented by subspecies identical with those of the Anamba Islands; and one other by a subspecies apparently the same as that of the Natuna Islands; while the *Cyornis banyumas* found here is apparently a well-marked endemic race. The other birds obtained by Doctor Abbott belong to more or less wide-ranging forms. All are catalogued below.

CUNCUMA LEUCOGASTRIS (Gmelin).

[*Falco*] *leucogaster* GMELIN, Syst. Nat., vol. 1, pt. 1, 1788 (before July 25), p. 257 (no locality; type locality given by Mathews as New South Wales, Australia).

One fine adult female, No. 181626, U.S.N.M., from Karimata Island, taken, October 6, 1908. Length in flesh, 700 mm. This example is rather darker above than others from Simalur Island, western Sumatra, but it may not be so old.

STERNA SUMATRANA SUMATRANA Raffles.

Sterna sumatrana RAFFLES, Trans. Linn. Soc. Lond., vol. 13, pt. 2, 1922 (November or later), p. 329 (Sumatra).

One adult female, No. 181602, U.S.N.M., is in the collection. It was taken on Karimata Island, October 7, 1908. Length in flesh, 343 mm.

PLUVIALIS DOMINICA FULVA (Gmelin).

[*Charadrius*] *fulvus* GMELIN, Syst. Nat., vol. 1, pt. 2, 1789 (before April 20), p. 687 (Tahiti Island, Society Islands).

One juvenal specimen, marked doubtfully female, is in the collection. It was obtained on Karimata Island October 7, 1908. Length in flesh, 243 mm.

HIEROCOCCYX FUGAX FUGAX (Horsfield).

Cuculus fugax HORSFIELD, Trans. Linn. Soc. Lond., vol. 13, pt. 1, May, 1821, p. 178 (Java).

One specimen, No. 180515, U.S.N.M., from Karimata Island, August 21, 1904. Total length in flesh, 297 mm. "Feet yellow." It is a juvenal male, and is molting both quills and contour feathers.

ALCEDO ISPIDA BENGALENSIS Gmelin.

[*Alcedo*] *bengalensis* GMELIN, Syst. Nat., vol. 1, pt. 1, 1788 (before July 25), p. 450 (Bengal, India).

One juvenal female, No. 180520, U.S.N.M., from Telok Edar, Karimata Island, September 2, 1904. Length in flesh, 165 mm.

SAUROPATIS CHLORIS CYANESCENS Oberholser.

Sauropatis chloris cyanescens OBERHOLSER, Proc. U. S. Nat. Mus., vol. 52, February 8, 1917, p. 189 ("Pulo Taya, off the southeastern coast of Sumatra").

One specimen, an adult female, No. 180519, U.S.N.M., from Telok Edar, Karimata Island, taken September 4, 1904. Length in flesh, 265 mm. This bird is in fresh plumage and is just completing the molt. The feathers of the breast have narrow gray scale-like edgings.

MUSCITREA GRISOLA SECEDENS (Stresemann).

Pachycephala grisola secedens STRESEMANN, Novit. Zool., vol. 20, No. 2, June 17, 1913, p. 355 ("Sirhassen" [Island, Natuna Islands]).

A single adult female, No. 180581, U.S.N.M., from Pulo Serutu, taken, August 16, 1904. Length in flesh, 157 mm. It is apparently identical with birds from the Natuna Islands. It is in the midst of the molt of both quills and contour feathers.

CYORNIS BANYUMAS KARIMATENSIS, new subspecies.

Subspecific characters.—Similar to *Cyornis banyumas rufigastris* (Raffles) from Sumatra, but much larger; throat, breast, and crissum decidedly darker.

Description.—Type, adult male, No. 181667, U. S. N. M.; Karimata Island, off southwestern Borneo, October 4, 1908; Dr. W. L. Abbott. A narrow line across the extreme anterior part of forehead at base of maxilla, together with lores and chin, black; rest of forehead and supra-oral stripe jay blue, passing into gendarme blue on supra-auricular region; tail brownish black, but the two middle rectrices and outer webs of all the rest of the same color as the posterior upper parts; wings fuscous black, but the outer webs of tertiaries, the narrow margins of secondaries and of the basal two-thirds of primaries, together with the exposed areas of greater and median coverts, like the posterior upper surface; lesser wing-coverts jay blue; sides of head, of throat, and of neck like the cervix; jugulum and sides of breast between cinnamon rufous and xanthine orange; throat the same but rather lighter; middle of breast, together with sides and flanks, deep ochraceous buff; middle of abdomen very pale ochraceous buff; crissum ochraceous tawny; axillars and inner under wing-coverts colored like the flanks and sides; outer under wing-coverts light ochraceous buff, mixed with fuscous; edge of wing jay blue.

Measurements.—Adult male (type); total length in flesh,¹ 166 mm; wing, 78; tail, 67; exposed culmen, 12; height of bill at base, 4.5; tarsus, 18; middle toe without claw, 13.

While we have but a single example, this is an adult male in perfect plumage, which differs so much from all the known forms of the genus that we have no hesitancy in describing it as new. Although we have not seen the female, this new bird is evidently a subspecies of *Cyornis banyumas*. It differs from all the described forms of *Cyornis* from Borneo in its great size and very deeply colored crissum, which is nearly as dark as the jugulum. It is apparently confined to the Karimata Islands.

¹ Measured by the collector.

ANTHREPTES MALACENSIS ANAMBAE Oberholser.

Anthreptes malacensis anambae OBERHOLSER, Bull. U. S. Nat. Mus., No. 98, June 30, 1917, p. 61 ("Pulo Mobur, Anamba Islands").

A single specimen is in the collection. It is a juvenal male, No. 180611, U.S.N.M., from Pulo Serutu, August 16, 1904. Length in flesh, 136 mm. It is in process of acquiring the adult plumage. So far as it is possible to judge from a single immature example, this is referable to the recently described race from the Anamba Islands.

AETHOPYGA SIPARAJA OCHROPYRRA Oberholser.

Aethopyga siparaja ochropyrra OBERHOLSER, Bull. U. S. Nat. Mus., No. 98, June 30, 1917, p. 65 ("Pulo Rittan, Anamba Islands").

Two specimens were obtained by Doctor Abbott:

Adult male, No. 180609, U.S.N.M.; Telok Edar, Karimata Island, September 2, 1904. Length in flesh, 120 mm.

Adult male, No. 180610, U.S.N.M.; Pulo Serutu, August 16, 1904. Length in flesh, 116 mm.

These are both in fine, fresh plumage, and seem to be the same as birds from the Anamba Islands, thus extending the range of this subspecies a long distance to the south.

THE BLISTER BEETLE TRICRANIA SANGUINIPENNIS—
BIOLOGY, DESCRIPTIONS OF DIFFERENT STAGES, AND
SYSTEMATIC RELATIONSHIP.

By J. B. PARKER,

Of the Catholic University of America, Brookland, District of Columbia,
and

ADAM G. BÖVING,

Of the Bureau of Entomology, United States Department of Agriculture.

INTRODUCTION.

The family Meloidae is distributed all over the world and has been the subject of the studies of several prominent entomologists. Nevertheless, it is a group but insufficiently looked into from the different angles of natural history and especially has the biology of the family and the description of its different larval stages been less worked out than is generally realized.

The metamorphosis was unknown until 1851 and since then only a few important contributions have appeared on this subject, namely, the classical papers of Newport, Fabre, Mayet, Riley, Beauregard, Künckel d'Herculais, and the modern, numerous, very important publications by A. Cros, who has given complete or partial accounts of the biology of many of the hitherto little known or entirely unknown genera and species.

However, as mentioned, much knowledge is still lacking of the life history and structural details of several important forms, this being especially true of our American species. Concerning these little has been written since Riley's famous publications on *Epicauta* and *Hornia*. Thus, the life history of a genus so common as *Macrobasis* has not yet been fully investigated, though F. B. Milliken has recently contributed some valuable information. Of 31 North American genera we have complete biological records of only 1, namely *Epicauta*; and partial records of 2, *Hornia* and *Macrobasis*; the life history of the remaining 29 being unknown or known only through European publications on European species.

This fact is the more amazing when it is considered that at present we know from North America many more genera and species than

from any other equally large region of the world, and that the imagines of many of the American genera, for instance *Gynaecomeloe*, *Cysteodemus*, *Megetra*, *Phodaga*, *Eupompha*, and *Calospasta* show the most extraordinary and interesting features.

The present writers consider it their good fortune to be able to reveal the entire life history of the species *Tricrania sanguinipennis* and to describe its different stages, thus adding another complete record of a North American Meloid to the one given by Riley.

In presenting the results of the work the subject has been divided into two coordinate parts, the first dealing with the biology of the insect and the second with the anatomy and systematic description of the different stages, especially the larval stages. J. B. Parker is responsible for the first part, Adam G. Böving for the second.

It has been considered appropriate to include in the second part a brief account, with a key, of a classification, based on larval and pupal characters, of the entire subfamily *Nemognathinae*, and, at the end of the paper, to give an annotated bibliography of literature which refers to this account.

The illustrations are all original and consist of photographs, taken by J. B. Parker, and pen drawings by Adam G. Böving.

The large and unique collection of material of *Tricrania*, from which the descriptions and figures have been made, has been collected by J. B. Parker and has been donated by him to the collections of Coleopterous larvae in the United States National Museum.

The authors wish to extend their best thanks to Dr. E. A. Schwarz and Mr. H. S. Barber, who kindly have aided them by valuable information and suggestions.

PART I.

BIOLOGY.

The beetle, *Tricrania sanguinipennis* Say, which belongs to the family Meloidae, is in its larval stage a parasite of the solitary bee, *Colletes rufithorax* Swenk. The adult beetle is about ten millimeters in length, black with blood-red wing covers and, being destitute of true wings, is unable to fly. It passes the winter in the adult stage deep down in the ground in the brood cell of its host.

The nesting site of the host, where these observations were made, is located on the grounds of the Catholic University of America, Brookland, D. C., on a sloping bank facing south. The soil in which the burrows of the bee are placed is a mixture of sand and clay and the depth at which the host places her brood cells varies from eighteen inches to two and one-half feet. The time of the emergence of the adult beetle from the earth in the spring depends upon climatic conditions in which temperature seems to be the chief factor. In

1917 emergence in large numbers occurred on April 12; in 1920, this did not occur till April 21; and in 1921 large numbers were present on April 3 and 4. In each year a few individuals emerged earlier than the dates given above and a few stragglers came out later, but our observations indicate that the time of maximum emergence covers a period of only one or two days.

Mating occurs coincident with emergence and oviposition begins immediately unless delayed by an unfavorable change in the weather. The female crawls beneath some object lying loose upon the ground and fastens her eggs in a mass to the under side of this object. In the present investigation eggs were found chiefly on the under side of bits of dried cow's dung (see fig. 42). They were also found under loose stones and in one case on the under side of a clam shell, *Venus mercenaria* Linnaeus, lying in the field. The eggs (fig. 22) are glistening white and are coated with a sticky substance that causes them to adhere together in a mass. They vary somewhat in size; of those measured in 1920 the average was 0.8 mm. in length by 0.32 mm. in breadth and in 1921, 0.83 mm. in length by 0.315 mm. in breadth. The female being wingless does not wander far from the point of emergence from the ground and having selected a place to deposit her eggs remains, if she is not disturbed, in that place till oviposition is complete, shortly after which death follows, due to exhaustion, since little, if any food is taken in the adult stage.

The number of eggs laid by each female is large and the period of oviposition, as observed in the laboratory, covers about two weeks. Early in the morning of April 21, 1920, two unfertilized females were taken in the field and permitted to mate in the laboratory. They were then put in separate cages suitable for oviposition. Eggs were present in both cages on the morning of April 22, but no count was made till April 27. On this date female No. 1 had deposited 788 eggs and No. 2 had deposited 1,020. From this date forward daily counts were made with the following results:

No. 1 had deposited—	Eggs.	No. 2 had deposited—	Eggs.
April 28-----	53	April 28-----	0
April 29-----	35	April 29-----	192
April 30-----	26	April 30-----	50
May 1-----	9	May 1-4-----	0
May 2-----	0	May 5-----	27
May 3-----	17	May 7, the beetle died.	
May 4-----	0		
May 5-----	5		
May 9, the beetle died.			

Thus in the case of No. 1 the beetle deposited a total of 933 eggs in a period of 13 days, perishing 4 days after oviposition was complete. In the case of No. 2, the female deposited 1,295 eggs in the

same period of time, perishing two days after oviposition was complete.

On the morning of April 3, 1921, two unfertilized females were taken in the field and after being permitted to mate were placed in cages in the laboratory where daily count of the eggs deposited by each beetle was made and the eggs removed at about 5 o'clock in the afternoon. The results were as follows:

No. 1 had deposited—	Eggs.	No. 2 had deposited—	Eggs.
April 4.....	1,017	April 4.....	374
April 5.....	392	April 5.....	487
April 6.....	165	April 6.....	249
April 7.....	118	April 7.....	213
April 8.....	87	April 8.....	107
April 9.....	60	April 9.....	79
April 10.....	27	April 10.....	41
April 11.....	28	April 11.....	77
April 12.....	26	April 12.....	81
April 13.....	1	April 13.....	27
April 17, the beetle died.		April 14.....	14
		April 15.....	25
		April 16.....	5
		April 17.....	4
		April 18.....	1
		April 19.....	2
		April 21, the beetle died.	

In the case of No. 1. the beetle deposited a total of 1,925 eggs within a period of 10 days, perishing 4 days after oviposition was complete. In the case of No. 2, a total of 1,786 eggs was deposited within a period of 16 days, the beetle perishing 2 days after oviposition was complete. It will be well, however, to note that these results were obtained under laboratory conditions where the environment was very favorable and practically unchanged; consequently, they do not show accurately what transpires in the fields where hot days and cold nights, violent rains and drying winds play a very important part in determining the length of the period of oviposition and the power of the female to deposit the maximum number of eggs.

The period of incubation of the egg is variable, depending upon temperature as the main determining factor. Under laboratory conditions where the temperature varied but slightly above or below 70° F., the time required for the eggs to hatch was from twelve to fourteen days. In the field, where temperature conditions are exceedingly variable at the time the eggs are present, the period of incubation is considerably longer than that required in the laboratory. Out of repeated attempts to carry eggs in the field through the period of incubation only one proved successful. The eggs used were deposited in the laboratory on March 30 and 31, 1921, and

were placed in the field on April 1. They began hatching on April 25. These eggs were placed in the field on the under side of a piece of dried cow dung, on which they had been deposited, and then were kept during the period of incubation under conditions as nearly normal as possible. While these eggs were in the field frosts were frequent at night in the early part of April and on one night the ground was slightly frozen.

In 1917 the beetles appeared in the field in large numbers on April 12, indicating that this was the time of maximum emergence, and eggs that year were found hatching in the field on May 12. When these eggs were deposited is not known, but when other facts together with the meager data actually obtained are taken into consideration the probability is great that their period of incubation covered approximately one month. However this may be, enough was learned in these investigations to show that, since the beetles normally emerge and lay their eggs a certain length of time before the host emerges and begins nesting, those factors that retard the hatching of the eggs also retard the emergence of the bees, so that when the first larval instars do appear the bees are providing in their nests the food required by the beetle for its survival as a species.

Just how long this first instar can survive in the field after hatching is not known. When kept confined together in numbers in the breeding jars in the laboratory none survive for a period greater than 11 days. When kept together in a small space the larvae are constantly attacking one another, and, although no case was observed in which one larva killed another outright, there can be no doubt that these constant fights and contentions serve to exhaust the larvae sooner than would be the case if they were allowed to scatter about unmolested, a condition that prevails in the field. Furthermore in the laboratory the larvae were without water or food of any kind. In experimenting with them it was found that the first instars will take water when they come in contact with it and will also eagerly sip honey when they first find it. Their power of resistance to the vicissitudes of their environment is very great. It is next to impossible to drown them in water. The means for overcoming this danger, probably the greatest they have to face in the field is found in the development of the last pair of spiracles as will be explained in the discussion of the morphology of the larvae. (See p. 17.)

Just how the first instar gets down into the nest of the host has not been positively learned. The eggs are laid in the immediate vicinity of the nesting burrows of the host and when the larvae emerge from the eggs they immediately scatter about over the ground in every direction. Under these conditions it is possible that the larva

simply finds the mouth of a burrow and crawls down into the nesting cell of its host. Observations, however, indicate that this is not the way entrance is effected. Repeated attempts to induce larvae reared in the laboratory to enter the burrows known to be occupied by the host invariably failed. If placed at the mouth of a burrow the larvae refused to enter it; if placed down on the walls of the burrow inside it, they invariably scrambled out and wandered away. It is our conviction that the first instar succeeds in attaching itself to the host, and when she enters the burrow rides down to the nesting cell upon her. The mandibles of the parasite (fig. 13) are notched on the inner margin, which fits them admirably for seizing and holding on to the hair of the host, and if a bee is placed in a breeding jar among active larvae every one that comes in contact with her will seize hold of a hair or spine with the mandibles and hold on so tenaciously that both bee and parasites can be killed in a cyanide bottle without the parasites releasing their hold (fig. 24). Likewise, if a camel's-hair brush is brought into contact with them they will seize the hairs with their mandibles and hold on tightly so long as the brush is moved vigorously about or rubbed against some object in an effort to dislodge them. So soon, however, as the movement of the brush is stopped the larvae will release their hold and scramble off the brush. If the brush is free of contact with another object the larva will release its hold with the mandibles and crawl about over the brush; but if it is dislodged while moving about it can attach a thread to the brush and thus let itself down by spinning a thread as do the larvae of many Lepidoptera. In this operation the larva goes down head first. What advantage the larva derives from this power to spin a thread has not been learned.

On May 20, 1920, males of *Colletes rufithorax* were abundant about the nesting site eagerly searching for the females, which on that date were emerging freely. A number of both males and females was captured and killed in a cyanide bottle and, after being taken to the laboratory and placed on pins, were examined for first instars. Sixty per cent both of males and of females were found infested, the different individuals carrying from one to four *Tricrania* larvae. On the males, all the larvae, with the exception of one, were found clinging to hairs on the posterior, ventral part of the head. On the females, however, although a few were found adhering to hairs on the ventral parts of the thorax, the great majority of the larvae were clinging to hairs on the posterior, dorsal part of the head or on the vertex.

Beauregard, quoting from the researches of Fabre, writes that the female of *Sitaris humeralis* places her eggs in the entrance of the burrow of the host (*Antophora pilipes*) and that the first larval instars, which on hatching from the eggs find themselves at the open-

ing of the burrow, attach themselves to the males of the host, which emerge first and are carried about by the males till the females appear and then during copulation, transfer themselves to the females and in this manner finally reach the brood chamber of the host. It seems highly probable that *Tricrania sanguinipennis* makes use of similar methods in gaining access to the brood cells of *Colletes rufithorax*. The eggs of the beetle are laid in a cluster as stated above in the vicinity of the burrows of the host and the larvae when hatched scatter about actively in all directions and this dispersal takes place normally at the time when the males of the host are most active in searching out the females. In their efforts to find the females, the males range hither and thither over the nesting site, spending much of their time crawling about over the ground and dodging in and out of burrows. The parasites are thus given far greater opportunities to attach themselves to the male than to the female, for the latter is seldom on the ground save when entering or leaving a burrow. When to these facts we add the data given above, that, on infested males and females of *Colletes* taken in the field at a time when matings were in progress, the majority of the parasites on the males were found on the ventral side of the body whereas on the females they were found on the dorsal side, it would all seem to indicate that the male of the host is an active agent in enabling the parasite to attach itself to the female.

But there is evidence to show that the parasite is not wholly dependent upon the male to find its way to the female of its host. In opening the burrows for cells of the host containing parasites, it was invariably found that where nests were opened in an area on which a clutch of the eggs of the parasite had hatched or on which a large number of the parasites hatched in the laboratory had been turned loose, the percentage of infested brood cells of the host was always greater than was the case in places more remote from such centers of dispersal of the parasite. If the parasite depended entirely upon the male to gain lodgment on the female this difference in degree of infestation in different parts of the nesting area would be hard to explain, since the males roam freely and uniformly over the extent of the nesting area in search of the females. Furthermore, cells infested with parasites were found that were constructed long after all males had disappeared from the field, cells that were constructed by bees whose previously constructed cells did not contain the parasite. In addition, some females of *Andrena perplexa* Smith (of which species the males perish before the young of *Tricrania* hatch), taken at the time the parasite was active in the field, were found with first instars attached to them. These parasites must have attached themselves directly to the bee and, in spite of the fact that *Andrena*

crawls about over the ground to a greater extent than does *Colletes*, if the parasites can reach the female of *Andrena* by their own efforts there is no very good reason for believing that some of them can not reach the female of *Colletes* in the same way.

- It may be well to report at this time some other observations made in connection with the study of the life history of this beetle. Another solitary bee, *Andrena perplexa* Smith, also nests in great numbers on this same sunny slope and the nests of the two species are intermingled promiscuously over the nesting site. *Andrena* emerges earlier in the season than *Colletes* and the nesting operations of the former are in full swing when the latter first appears on the scene, but for a considerable length of time the nesting activities of the two species go on side by side. If our conclusion is correct, that the parasites get down into the nests of *Colletes* by obtaining a hold upon the host and riding down to the brood cell in this position, then there can be no doubt that a great many go down into the nests of *Andrena*; for this bee alights usually at a short distance from her burrow and crawls over the ground to the entrance, whereas *Colletes* alights directly in the mouth of her burrow, which is always left open, and disappears within immediately.

This beetle can not parasitize *Andrena*, however, and the explanation lies in the nesting habits of this species. *Andrena perplexa* Smith constructs as a brood chamber, at the end of a vertical tunnel, a cavity whose walls are smoothed and made waterproof by means of a waxy substance. At the bottom of this chamber the bee places a mass of pollen upon which she deposits an egg (fig. 39). The egg is placed on end and never in contact with the wall of the brood chamber. Then upon this pollen-mass, upon which the egg rests, she places a quantity of thin, watery honey that completely surrounds and almost submerges the egg. Hence, the cell when completed is so arranged that the parasite can not reach the egg without first falling into this watery honey. A large number of nests of *Andrena* were brought into the laboratory in the course of our investigations and placed in breeding receptacles into which first instars of the beetle were introduced. In every case, without a single exception, the parasites got into the honey and perished. We repeatedly placed the larva directly upon the egg, but in every instance the larval beetle sooner or later got into the honey and perished. A larva may become mired in the honey furnished by *Colletes* and later struggle out and survive, but once it becomes mired in the honey supplied by *Andrena* it never gets out and perishes in a short time.

In the case of *Colletes rufithorax* Smith, the bee, in constructing a brood chamber, excavates, at the end of a tunnel, a cavity, and within it, closely applied to its walls, she constructs a cell of thin, tough,

homogeneous, transparent substance that in chemical composition seems closely related to chitin (fig. 36). In the bottom of this cell the bee places a quantity of food composed of honey and pollen mixed into a sticky semi-fluid mass. Then within the cell she deposits an egg attaching it by one end to the side of the cell wall above the food mass (fig. 36.) The parasite within the cell can, therefore, readily reach the egg without coming in contact with the food at all.

When the Meloid larva gains entrance into the cell of *Colletes* it attacks and devours the egg of the bee. This is the normal procedure but it is not absolutely necessary that the parasite, in order to survive, make its first meal upon the egg of the host. For we reared one parasite in the laboratory from egg to adult wholly upon the food (pollen and honey) provided by the bee for her offspring. By devouring the egg of the host the parasite in addition to obtaining a nutritious food performs an act of self-preservation; for if the egg of the host were permitted to hatch and the young survive, the quantity of food available would be insufficient for the two larvae and both would perish. If the beetle is to survive, the egg of the host must be destroyed. The food thus derived from the egg of the host is sufficient for the development of the first instar. During this period of development the larvae expands greatly so that the chitinized rings of the abdomen are widely separated and its length increases to nearly double that of the instar on its emergence from the egg (fig. 37). After the first moult the body of the larval beetle assumes a boat-shaped form with the spiracles placed dorsally, for the larva, which normally while in its first stage remains on the side of the cell, now rests directly upon the food mass and its shape is such that it floats safely upon the semi-fluid food in much the same manner as a duck floats on water (fig. 38). This same position with relation to the food mass is maintained by the following third instar (fig. 40), but by the time the fourth instar is reached so much of the food has been consumed and the larva has grown to such size that it may now safely assume any position in the cell that may be necessary to enable it to obtain all the food remaining (fig. 41).

On the morning of June 9, 1920, a number of brood cells of *Colletes* was obtained from the nesting ground each of which contained a parasite in the first stage. In six of these the parasites were still feeding on the egg of the host and these molted for the first time as follows: 2 on June 14; 1, June 15; 2, June 17; and 1, June 20. In regard to six others the egg of the host had already been completely devoured and molting took place as follows: 1, June 9 (at 4 o'clock in the afternoon); 1, June 11; 1, June 12; 1, June 14; and 2, June 17. From the data given above it is evident that the time re-

quired to complete the first stage in development varies. Of two parasites taken from the ground in the act of devouring the egg of the host, one required 11 days to reach the second instar while another required but 5.

It frequently happens that two or more first instars gain entrance into the same cell, but in every case observed, either in the field or in the laboratory, only one survived. In removing the brood cells of *Colletes* from the ground on June 9, 1920, one cell was crushed out of shape, but no rupture occurred in its walls. When examined in the laboratory a first stage Meloid larva was discovered submerged in the disturbed food mass. The side of the cell was opened, the parasite fished out, given a bath in water to remove the honey from it, and was restored to the cell, which was placed in a breeding vial. The egg of the host could not be discovered in the cell and the larva showed by its appearance that it had taken food before the cell had been removed from the ground. On the morning of June 14 it was found that this larva had molted and was lying dead on the food mass and that a second larva in the first stage was present in the cell. The dead larva and its cast skin were removed from the cell at once and the second parasite left in the cell. On June 19 this second parasite molted. On the morning of June 20 a third parasite in first stage appeared in the cell. This third one had killed the newly molted second instar and was feeding on its body. The cast skin and the dead body of the second instar were removed from the cell and the third parasite left in possession. This third parasite, a first instar, molted on July 2.

Now, all three of these parasites were in the cell when it was taken from the ground, for *Colletes* seals her brood cell up after she deposits her egg so that nothing can get in without rupturing the cell wall. All three must have been submerged in the food mass when the cell was crushed out of shape in its removal from the ground, but all three survived in spite of the fact that only one was discovered and had the honey removed from it. How the egg of the host was destroyed, whether by the three jointly or by the first alone (which is most probable) is not known. But that the first larva to molt was killed by the second and the second by the third is quite evident. Here then is a case where a first instar introduced into a cell of *Colletes* prior to June 9 and later messed up in the food survived and completed this first larval stage July 2, a period of more than 23 days.

In the development of the larval beetle there are in all six instars and consequently six cast skins before the pupal stage is reached. Aside from that relating to the first larval stage the data obtained dealing with the length of time required to complete the other larval

stages have not been found satisfactory, owing to failure in many cases to discover the exact time of the second molt and to the necessity of killing many of the larvae in different stages to provide material for morphological study. Out of eight larvae that were permitted to complete their larval development six had transformed to the pupal stage by August 23, 1920. All six were taken from the ground in cells of the host in the first stage on June 9, 1920. They completed the fourth larval stage—that is, the period of feeding—on dates ranging from July 4 to July 19. In other words the approximate time of feeding in these cases varied from 26 to 41 days under laboratory conditions. On August 31, 1920, two cells of *Colletes* were taken from the ground each containing the parasite; in each case the beetle was in the pupal stage. Both of these beetles as well as all those permitted to reach the pupal stage in the laboratory had transformed to the adult stage by September 17, 1920.

In the development of the larva the skins of the first three instars are cast off free of the insect, but the fourth cast skin is not ruptured at all, the larva simply shrinking away from its skin and remaining within it. Likewise the fifth skin is not ruptured but is cast off within the fourth in the same manner as the fourth is cast off. The skin of the sixth instar, however, which immediately precedes the pupal stage, is ruptured and pushed down to the posterior end of the pupa where it may be found adhering to the ventral side of the pupa within the fifth larval skin. Thus the fourth and fifth larval skins serve as a protecting case for the pupa within which the beetle finally transforms to the adult stage and from which it emerges the following spring to begin anew the life cycle of the species.

To Edward S. Reinhard we are indebted for the following interesting observations on the life-history of this beetle. On April 24, 1921, he obtained from a burrow of *Colletes inequalis* Say near Poughkeepsie, New York, a brood cell containing the larva of this beetle that had completed its fourth stage and perhaps its fifth also. At least the larva was lying free within the fourth cast skin. The beetle was removed from the brood cell of the bee but was not otherwise disturbed. On July 29, 1921, Mr. Reinhard found that this larva had broken through the wall of its protective covering composed of its cast fourth and fifth skins and was lying naked in the breeding receptacle. On August 12 it transformed to the pupal stage and on September 5 to the adult condition.

From this data obtained by Mr. Reinhard it is evident that this individual for some unknown cause failed to complete its transformations in the summer of 1920 and, consequently, passed the winter of 1920-21 in the larval condition and completed its transformations as noted above. In our investigations no case of this kind was observed.

In every case in our study of the life-history of this insect, where we followed out the transformations of the individual from egg to adult, these transformations occurred within a period of time extending from April to September, and in every case also the beetle did not rupture its protecting case composed of its cast fourth and fifth skins till it emerged as an adult insect. Whether so slight a change in the normal course of events as that caused by the removal of this individual from the cell of the bee before it had reached the pupal stage was responsible for the unusual behavior of this larva, or whether this departure from what seems to be the normal course of events in the process of development represents a return to a more primitive stage in the insect's life-history, we are unable to say.

PART 2.

MORPHOLOGY AND TAXONOMY.

A. EGG.

On page 3 an account has been given of the way in which the egg masses are distributed and cared for by *Tricrania*, the number of eggs masses deposited has been given, as well as the size, shape and color of the individual egg.

In the *Nemognathinae* the act of caring for the safety of the egg masses is more neglected than in the other blister beetles whose females dig a 3-5 mm. deep thimble or bell-shaped cavity in the soil and deposit one or two egg masses at the bottom of it. Thus *Sitaris muralis*, *Apalus bimaculatus*, and *Stenoria analis* lay their eggs as an uncovered pile in some little groove in the galleries of the host bee, and *Sitaris rufipes*, *Sitaris solieri*, *Nemognatha chrysomelina*, and *Zonitis bilineatus*¹ deposit their sometimes rather numerous egg masses on the leaves or stems of different large herbs. To place the egg masses under small stones or dry cow dung, as *Tricrania* does, is the simplest way recorded in this group of caring for them.

The total number of eggs laid by a single female varies much in the Meloids, ranging from about 50 in some of the species of *Zonabris* to about 2,000 or more in genus *Meloe*. The *Nemognathinae* deposit as many as *Meloe*.

The proportional size of the single egg depends on the number of eggs laid, being comparatively large, from 2-3 mm. in forms

¹Two egg masses of *Zonitis bilineatus* were collected by A. N. Caudell, Bureau of Entomology, on underside of one leaf of *Verbesina occidentalis* growing near Fletcher's boat-house, south side of Georgetown Canal, Washington, D. C., Aug. 14, 1917. Other egg masses identical to these, from which larvae hatched Sept. 1, 1917, were collected at the same place and on the same plant species about 1½ inches from a spent female of *Zonitis bilineatus*, by H. S. Barber, Bureau of Entomology, Aug. 24, 1917. All egg masses are preserved in the U. S. National Museum.

which deposit a small amount of eggs and comparatively very small, only $\frac{1}{2}$ –1 mm., in forms which lay many eggs. The absolute size, of course, depends also on the size of the species.

The shape of the egg is cylindrical with both ends rounded, but it varies in the different forms from short and wide with embryo bent double, as in many species of *Zonabris*, to rather elongate with embryo straight with bent head as in all *Nemognathinae*.

Contrary to what is found in *Tricrania*, it has been recorded that in many blister beetles the same female deposits her eggs at different periods and in different places. Two, or three, or four separate ovipositions with the interval of one or two weeks frequently occur, and in the forms which oviposit on plants, the female places her eggs in several packages, each containing about 100 eggs or more. Further, it has been recorded that in several Meloids the female copulates more than once to effect two or more consecutive deposits, and the males do not die after the first copulation.

B. DESCRIPTION OF THE SIX INSTARS OF LARVA.

FIRST LARVAL INSTAR.²

Figs. 1–6, 9, 13, 23–25.

Length, 1–1.5 mm. Width, about 0.4 mm.

Color, head shining, ochraceous, with a black round spot surrounding the eyes; tergal shields and legs shining, sepia brown, with base of legs and hind margin of shields darker; intersegmental membranes grayish.

Setae, in general few and small; antenna, maxilla, legs and ninth abdominal segment carrying a single, or a few long or fairly long setae (macrochaetae), possibly with tactile function.

Body form, rather short, fusiform with metathorax the broadest segment; thoracic segments of subequal length; head and thorax together half the size of entire body. Medio-dorsal longitudinal suture almost fully developed on prothorax; fully developed on meso- and metathorax. Legs long; tarsus slender, conico-falciform with two rather strong setae at base. Abdomen subconical, with one short machochaeta terminally on each side of ninth segment.

Head, (figs. 3, 13) large, almost one-fifth the length of the body, length from anterior margin of head capsule to dorsal margin of occipital foramen approximately equal to extreme width. Porrect

²The terms "stage" and "instar" have been applied as used by David Sharp and as formulated by J. W. Folsom in his Manual, 1913, p. 128: "During the growth of every insect, the skin is shed periodically and with each moult, or ecdysis, the appearance of the insect changes more or less. The intervals between the moults are termed *stages* or '*stadia*.' To designate the insect at any particular stage, the term '*instar*' has been proposed and is growing in favor; thus the insect at hatching is '*the first instar*,' after the first moult the '*second instar*,' and so on."

and extended; subtriangular, gradually narrowing behind ocellar area toward the large, posteriorly placed foramen occipitale; collum distinct; dorsal surface convex, sloping apically and laterally. Smooth with minute, few and scattered setae.

Frons, (fig. 3) anteriorly without clypeal suture, laterally not sharply limited by distinct frontal sutures, posteriorly acute, not reaching occipital foramen; angulus frontalis not developed.

Clypeus and labrum, immovably united and fused with anterior margin of frons into a nasale.

Nasale, (figs. 3, 13) convex, shaped like an eye shade, anterior margin broadly arcuate, laterally deflexed, forming the roof above a short cylindrical, horizontal space which in size corresponds to a bee's hair; lower half of the space framed in by the mandibles when closed (fig. 4).

Epicranial halves, large, meeting dorsally along a short, not sharply defined epicranial suture, laterally and posteriorly bulging, with ocellar area almost on top. Antennal foramen (figs. 5, 13) anteriorly continuous with the foramen for the mandible; oval; length about one third of the lateral length of epicranium; ventral margin of epicranium between mandibular condyle and posterior end of maxilla oblique, about as long and extending as far back as the antennal foramen; behind the end of maxilla, longitudinal, almost straight and anteriorly with a triangular, slightly depressed enlargement.

Gula, (fig. 13) narrow, longitudinal, subrectangular, about four times as long as wide, smooth, without setae.

Ocelli, (figs. 3, 5) two on each side, anteriorly placed in the bulging lateral region of epicranium, rather distinct, with well developed lenses and surrounded by a round, blackish, pigmented spot.

Antenna, (fig. 13) slender, one fourth the length of head, distally almost reaching the anterior end of the head, three jointed, with basic articulating membrane extremely large, permitting a very free motion of the entire antenna; articulating-membrane reaching from external part of base of mandible more than half way to the ocellar spot; basal joint short, cylindrical, with width about twice the diameter of the mandibular condyle, and length about half the width; second joint cylindrical, three fourths the width of basal joint, three times as long as wide, distally and externally with a very low, round, convex supplementary appendix and a few minute setae; apical joint half as thick and almost as long as the second joint, distally with a few short setae and one macrochaeta, which is about twice as long as all antennal joints together.

Mandible, falcate, basically enlarged, gradually attenuate, strongly incurved, about half as long as the lateral outline of head from

the mandibular condyle to the occipital foramen. Axis (an imaginary line) between the dorsal and the ventral mandibular articulation almost longitudinal and horizontal, hence the plane of movement perpendicular; no molar structure; inner edge from middle to apex with a series of six tooth-like transverse ridges; the position, the shape and the dentation of the mandibles enable the larva readily to seize and keep a firm hold of one of the hairs of the host by pressing it against the hollow underside of nasale (figs. 4, 24).

Maxilla, with cardo reduced (or fused with stipes). Stipes developed as an immovable, slightly convex plate, with suboval outline, framed in by the bracon, by the anterior portion of the ventral margin of epicranium, by the triangular enlargement of the epicranial margin, and by the posterior, lateral part of mentum.³ Stipes with one small seta and one macrochaeta of same shape and extraordinary length as the terminal antennal seta. Maxillary mala single, small, semiglobose, fleshy, set with several medium long or short setae. Palpus, three jointed, almost twice as long as stipes, slender, straight, apically obliquely truncate; with few and minute setae; basal joint small, cylindrical, about as wide as mala, somewhat shorter than wide; second joint cylindrical, somewhat narrower than the basal joint, and three times longer; apical joint as long as basal and second joints together, clavate, terminally truncate, somewhat narrower than the second joint.

Submentum and mentum, fused into a single approximately pentagonal region which is broad in front, attenuate behind, and within the posterior corner marked on each side by a narrow, bow-like chitinization; anterior margin concave, as wide as labium; each anterolateral margin concave, half as long as the anterior margin; each postero-lateral margin twice as long as the anterior margin; entire region slightly chitinized, flat medianly, longitudinally depressed, probably offering a convenient resting place for the hair of the beehost when it carries the larvae to its nest. One pair of medium long setae at middle of mentum.

Labium, a semicircular region, about one third as long as one of the maxillary stipites; posteriorly limited by a bow-shaped chitinization which carries one pair of punctures (or possibly minute setae). Palpigers chitinized; each occupying one fourth of the entire ventral labial region. Palp two-jointed, small, as long and half as wide as palpiger; basal joint cylindrical, hardly one third as long as entire

³ A slightly chitinized narrow arm extends from the triangular enlargement of epicranial margin, passes along the posterior lateral part of mentum to the anterior free part of mentum and fuses here with the rod-like chitinous thickening, or bracon, of the buccal membrane between the ventral mandibular articulation and the hypopharynx. Thus the base of the maxilla is completely surrounded by a chitinous ring, which consists of the same anatomical elements as in the *Staphylinini* and the *Melandryidae*.

palp; apical joint subelavate, about two thirds of palp. Ligula short and thick, with two small setae.

Paragnathae (=“Maxillulae”=“Paraglossae”), not developed. Hypopharynx, membranous.

Epipharynx, with a single granulated transverse plate, the ends of which are swollen, more heavily chitinized and rounded. The plate probably assists in keeping the hair to which the larva clings in proper and steady position during the period of transportation. Epi- and Hypopharyngeal rods, long and thin.

Bracon, present, forming a bridge in front of the maxillary stipes.

Tentorium, slender, with ventral tentorial pits immediately outside the gular sutures.

Prothorax. (fig. 3, 5) Prothoracic tergal shield subtrapezoidal, about two thirds the length of head; anterior width about the same as posterior width of head; posteriorly $\frac{1}{4}$ wider than head and more than twice as wide as the length of the segment; postero-lateral angles sharp; medio-dorsal suture fully developed posteriorly, occupying about four fifths of the length of the segment, but not reaching anterior margin of segment. Setae of shield few, minute. Prosteronum not distinct, probably included in not divided sternal region. Hypopleural chitinizations distinct but small. Setae of segment scattered, minute.

Meso- and metathorax, similar in shape; metathorax slightly the larger, and also the largest of all the body segments. Tergal shield subtrapezoidal, twice as wide as long with latero-posterior angles sharp; medio-dorsal sutures fully developed; setae of shields few and minute. Hypopleural chitinizations present in both segments, but small. Sternal regions not divided. Setae of segments scattered, minute. Intersternal bands present, but not distinct.

Legs, slightly and gradually increasing in length from first to third, about one and one-half times as long as the width of the corresponding segment. Coxae widely separated, free, inclining, obconical, about twice as long as wide at base, about one-fourth the length of entire leg; without groove for the reception of femur; one long seta and a few of medium size. Trochanter distinct, shaped like a signet ring; with one seta as long as coxa and with a transverse series of small circular spots. Femur slightly longer than coxa, half as thick, elongate, slightly clavate, distal end oblique; with a few small setae and one seta as long as femur and coxa together. Tibia as long as femur, about half as thick, subcylindrical, distally somewhat attenuate, almost straight; setae rather small, scattered. Tarsus (fig. 6.) half as long as tibia, claw-shaped, slender, falcate, apically attenuate; near base of tarsus with two slender, slightly curved setae, about four-fifths as long as tarsus, distally as far from

tarsal tip as proximally from tarsal base. Tarsus moved by a flexor and a retractor, (m_1 and m_2 , fig. 6) but no muscles attached to the two setae at the base.⁴

First to seventh abdominal segments, with tergal shields subtrapezoidal; first abdominal segment about four times wider than long; segments gradually decreasing posteriorly in length and width; seventh abdominal segment about half as long and not much more than one-fourth as wide as the first one; latero-posterior angles of tergal shield in all segments almost rectangular, carrying a short terminal seta.

Eighth abdominal segment, subquadrate. From posterior margin of the tergal shield one pair of falciform, distally attenuate, flat processes extends backward about as far as the segment is long; they are diverging, their convexities opposed, at base as far apart as half their length and distally twice as far or more; each is adjacent to the inner and upper side of an equally long but somewhat wider and conical hook, which projects slightly below the falciform process. Apically and facing the process each hook carries the annular peritreme of the eighth abdominal spiracle, and inwardly contains the elongate, ovoid spiracular atrium (fig. 2). Undoubtedly the object of these structures is to facilitate the breathing under extraordinary and difficult conditions. The function of the adjacent processes may possibly be that of holding a supply of air between themselves and the ends of the hooks to prevent water from penetrating into the tracheal system at the period when the larva is free living in the field (see p. 5). Later on, when the larva has invaded the cell of *Colletes*, the air supply may prevent honey from obstructing and clogging the spiracular opening, if accidentally the larva should become temporarily submerged.⁵

Ninth abdominal segment, cylindrical, two-thirds as wide, twice as long as the eighth abdominal segment; terminally on each side, with one rather short macrochaeta of same length as the segment.

⁴ These setae in the Meloid larvae have been interpreted and termed as "claws" by most authors; but erroneously, because true claws, as developed for instance in Carabid larvae, are provided with individual muscles.

⁵ The interpretation of the object of the hooks and processes, given by Fabre, Mayet, and Beauregard, who consider them as locomotory and grasping organs, has already been abandoned by Cros in several of his masterly papers, for instance on page 59, in his study on *Nemognatha chrysomelina* (Bull. Soc. Hist. Nat. Afrique du Nord, vol. 10, 1919). Cros calls the organs "appareil respiratoire erectile dorsale" and probably looks upon their physiology and use as here described. He has, however, avoided proposing any definite theory on this subject, unless such is found in his study on *Hornia nymphoides* (Bull. Soc. Hist. Nat. Afrique du Nord, vol. 5, 1913), which is not available to the present writers. To this study Cros refers in his "Larves primaires des Meloidae," (Ann. Soc. Ent. France, 1919, p. 262) as follows: "In my paper on *Hornia nymphoides* Escal., I have discussed at great length the structure and the functions of these organs to which J. H. Fabre has assigned, but by no means proven, the rôle of fixation and locomotion; in reality they are but modified spiracles."

When Cros mentions the organs as "erectile," the present writers must admit that they never have been able to see them make actual motions.

Tenth abdominal segment, terminal, cylindrical, almost as long as ninth, one-third narrower; anterior half slightly chitinized, and posterior half membranous with round anal opening.

Spiracles, annular; one thoracic and eight abdominal pairs. The thoracic spiracle, in the mesothoracic preepileurum, about as large as tibia in cross section. The first seven abdominal spiracles placed in the middle of the ventral surface of the lateral expansions of the tergal shields. The eighth abdominal spiracle on top of the spiracle bearing hook. The first abdominal spiracle as large as the thoracic one; the rest much smaller and rather minute (fig. 1).

Spinning glands on ninth or tenth abdominal segments not found, but microtomical sections have not been made; the first instar, however, has been observed by the present writers (see p. 6) to spin a thread, lowering itself with head turned downward, but it was not definitely determined from what part of the body the thread originated; possibly it is an exudation from the malpighian tubules and comes out through the anus.

Differentiating characters.—The genus *Tricrania* belongs to the subfamily *Nemognathinae*, as borne out by the biological and morphological characters of both imago and the six larval instars. The first instar of this subfamily is always carried by a bee-host to its nest. It has spiracle-bearing elevations on the dorsal side of the eighth abdominal segment, a head with labrum, clypeus and frons fused together, two ocelli on each side and dentate mandibles which move in a plane transverse and vertical to the body; tarsus, as a rule, is conicofalcate and ninth abdominal segment has either two fine and short caudal setae, or none.

In this subfamily the first instar of genus *Hornia* is distinguished by mandibles with seven or eight teeth; *Hornia minutipennis*, also by low, rather soft spiracle-bearing elevations on eighth abdominal segment. First instar of *Stenoria* has spathulate tarsus and both tarsal setae almost as long as tarsus itself; it approaches *Tricrania* closely by possessing six teeth on the mandible, all the rest of the genera of the *Nemognathinae* having but two or three teeth. *Sitaris* and *Apalus* have fine and short tarsal setae. *Nemognatha*, *Zonitis*, *Leptopalpus*, and *Sitarobrachys* which are well limited from all the other genera by having the sixth instar adherent to the exuvium of the fifth instar are not easily characterized as a group by their first instars. In *Nemognatha* first instar is without caudal setae, the medio-dorsal suture is present on all thoracic segments and continued on the head into the epicranial and frontal sutures, and the tarsal setae are two and almost as long and strong as tarsus. In *Zonitis bilineatus* the spiracle bearing hooks are short and distant, and this character applies according to Cros' description, also to the genus *Leptocephalus*, but in all the old world species of *Zonitis*, in-

vestigated by Cros, the hooks are found normal in size and position. In *Leptopalpus*, *Nemognatha*, and *Sitarobrachys* the tarsal setae, one or two in number, are always weak.

SECOND LARVAL INSTAR.

Figs. 7, 8, 14, 26, 27.

Length immediately after first moult, 2.25 mm.; before second moult, 2.75 mm. Width after first moult, 0.5 mm.; before second moult, 1.2 mm.

Color, whitish. All segments soft.

Setae, none, but body densely set with minute, pointed asperities.

Body form, in the beginning of the stage rather slender and spindle shaped with comparatively long legs stretched out like oars, later on distended, more ovate, dorsally flat and ventrally very convex (figs. 26, 27). Thoracic segments of about equal length; prothorax much narrower than mesothorax and the latter slightly narrower than metathorax. Ten distinct abdominal segments; first to third abdominal segments the largest. Spiracles located on the flat dorsal surface at a short distance in from its lateral margin, freely exposed to the atmosphere and permitting easy and safe breathing. Below the wide overlip fleshy and supple mouth parts work as exquisite tools of the gluttonous larva.

Head, porrect and extended; length from free margin of labrum to occipital foramen almost one-eighth of entire body length. Width of head about the same as the length. Form of head, with labrum included, quadrate-rotundate; anteriorly rounded, sides straight and parallel, posterior corners rounded. Short collum. Occipital foramen wide, broadly oval and posterior. Dorsal and ventral surfaces of head capsule slightly convex and smooth.

Frons (fig. 7), rather distinct, posteriorly rounded, not reaching the occipital foramen. Frons and clypeus fused.

Labrum, large, immovable but separated from clypeus by a fine line; shaped like an eyeshade, covering the other mouth parts completely.

Epicranial halves, dorsally meeting along a well-developed epicranial suture.

Antennal foramen, anteriorly continuous with mandibular foramen; almost circular, diameter about one-fourth the length of the epicranium from mandibular condyle.

Hypostomal margin between mandibular condyle and posterior end of maxilla (fig. 14), transverse, semicircularly emarginate.

Margin between end of maxilla and occipital foramen, fused with intermediate gular region.

Gular region, longitudinal, subrectangular, about three times as long as wide.

Optic spot, horizontal, dorso-lateral, blackish pigmented and reniform; length about equal to diameter of antennal foramen; ocelli not distinguishable by the presence of lenticular convexities.

Antenna, thick and conical, about one-eighth the length of head, distal end not reaching middle of mandible, three jointed with basal membrane well developed; basal joint cylindrical, about half as long as wide, diameter about three times as long as diameter of mandibular condyle; second joint cylindrical, about half as wide as basal joint, somewhat shorter than wide; supplementary appendix very small; a few sensorial papillae; apical joint papilliform, pointed, as long as second joint and one-fifth as wide; no macrochaeta.

Mandible, rather soft, almost equilateral, triangular, length and width about equal. The exterior side-margin half as long as head from mandibular condyle to occipital foramen: axis between dorsal and ventral articulations approximately perpendicular to the length of the body, hence mandibles operate horizontally; terminal third part of mandible slightly set off from the rest, with inner margin obliquely truncate, somewhat concave, and minutely serrate; rest of mandible flat, broad, without molar portion or any other particular structures.

Maxilla, free, protracted, fleshy, subcylindrical, twice as long as wide, palpus not counted. Stipes indistinctly divided into a distal and a proximal part of equal size.⁶ Cardo absent, or more probably fused with the proximal part of stipes. Mala single, low and indistinct, fleshy and without spines or long setae. Palpus three jointed, short, one-fourth the length of the entire stipes, thick and conical; the joints are in shape and proportion similar to the antennal joints.

Mentum (possibly including submentum) and Stipites labii, fused into a free, thick, fleshy, subcylindrical organ which acts like a spoon; it is twice as long as wide, and as long and one-fourth as wide as one of the stipites maxillae.

Labial palp, two jointed, same size as the two combined terminal joints of the maxillary palp.

Ligula, indistinct.

Paragnathae (=Maxillulae=Paraglossae), not developed.

Hypopharynx as well as the anterior portion of the floor of the buccal cavity, fleshy, soft and covered with fine pubescence.

⁶ An interpretation of these maxillary components as being stipes and cardo might be possible. Such an interpretation, however, does not present itself as quite so valid as the one given above because it does not concur with the maxillary development in the first instars of Meloid larvae of the more unchanged types, like *Zonabris*. Neither would it agree with the interpretation given below of the maxillary parts in the third and fourth stages. Briefly expressed, the maxilla of the second instar of a Meloid larva seems more comparable to the maxilla of a Carabid larva as *Amara*, than to the maxilla of a Staphylinid larva like *Philonthus* or *Ocyopus*.

Bracon and Tentorium, not observed.

Prothorax, without shield, subtrapezoidal, somewhat shorter than head, anteriorly not wider than head, posteriorly about twice as wide, postero-lateral angles obtuse; presternum not distinct; no hypopleural chitinizations; sternal regions simple.

Meso- and metathorax, same general shape and development as prothorax, but wider; metathorax the widest thoracic segment.

Legs, inserted widely apart, of ambulatory type, but weak and not fitted for walking, all of about the same medium size; in the young second instar, about half as long as posterior margin of metathorax, in the full fed and wider larva, proportionally shorter. Coxa free, with length about one-fourth the entire length of the leg, and twice as wide as long. Trochanter well developed, ring-shaped. Femur subcylindrical, about as long as coxa, about one-third as wide as long. Tibia same length as femur, slightly narrower, conico-cylindrical. Tarsus claw-shaped, triangular, somewhat curved, about twice as long as the width at base.

First to third abdominal segments, subequal in length, each segment as long as one of the thoracic segments; transverse, subrectangular, four times as wide as long; second abdominal segment slightly wider than the two others and also wider than metathorax. Fourth to eighth abdominal segments, of about same individual length as previous segments; in the young second instar the segments decrease gradually but considerably in width, measuring from about as wide as third abdominal segment to one-fourth as wide; but in the full-grown instar the segments decrease less in size, the eighth segment being about half as wide as the third. Ninth and tenth abdominal segments, rather small, about equal in length, and each about half as long as the eighth abdominal segment; in the young second instar the ninth and tenth segments are about as wide as long, but in the mature instar the ninth and tenth segments are respectively three times and twice as wide as long.

Anus, terminal. Anal slit rather well developed, vertical and ventrally bifurcate.

Spiracles, annular, one mesothoracic and eight abdominal ones present. All of about same size, rather small, about as wide as second antennal joint.

Differentiating characters.—Second instar in all *Nemognathinae* stays in the same bee-cell into which it was carried as first instar and feeds on the honey; it liberates itself completely from the exuvium of first instar. The head capsule, mouthparts, and body are thinly chitinized and rather soft in all genera of the subfamily and prothorax is always without prothoracic shield, but the shape of the body varies somewhat, from ovate-fusiform and straight to sub-

cylindrical and slightly curved. However, it does not seem possible to find any definite character by which the second instars of the different genera of *Nemognathinae* can be separated.

THIRD LARVAL INSTAR.

Figs. 28, 29.

Length of larva immediately after second moult, about 3 mm.; before third moult, about 5.5 mm. to 6 mm. Width after second moult, about 1 mm.; before third moult, about 2 mm.

Color, whitish.

Setae, very few and short on head parts and legs; body set with dense, minute asperities.

Body, very similar to that of second instar, soft, thick, straight, subovate, a little more fusiform than in the mature second instar, but like this instar dorsally flat, ventrally convex and built for floating on the surface of the honey-paste which gradually becomes harder and more solid.

Head, seminutant; at first large in comparison with rest of body, that is, as wide and twice as long as prothorax; later on in fully fed larvae only of moderate size, the body having grown immensely, the head but slightly, and in this last period of the third stage the width of head in comparison with the width of prothorax is as one is to one and one-half, and the lengths of the two structures are about equal.

Head capsule, slightly chitinized; nasale not fully as large as in the second instar; ventral side of head capsule transverse and shaped like a dumb-bell; gula short with posteriorly converging sides.

Ocellus, represented only by a small round point of dark pigment.

Antenna, more cylindrical than in second instar.

Mandible, broad, triangular, with chitinous, finely denticulate tip and with chitinized ventral condyle; tip of mandible reaching somewhat beyond the nasal margin.

Maxilla, retracted, well developed, very slightly chitinized, the different maxillary parts a little more slender, more distinct and more individually movable than in the second instar.

Labium, free.

Thorax, occupying about one-fourth or less, of body.

Legs, three pairs, of same shape as in second instar but comparatively smaller in proportion to rest of body, not well fitted for locomotion.

Abdominal segments, 10; the four anterior ones widest.

Spiracles, dorsal, annular, very large, all of same size, the eighth abdominal pair apparently not developed.

The anatomical details of the head and the rest of the body are similar to those of the following fourth larval instar, only smaller. To avoid identical descriptions of these details in the two instars they will be recorded only for the fourth larval instar in which they are more easily seen and investigated.

Differentiating characters.—The third instar in the *Nemognathinae* has been recognized by very few authors as representing a definite stage. Cros, however, has recorded it in most of the genera of the subfamily and Beaugard⁷ has given a rather full description of it in *Sitaris muralis* Foerster. In all the genera it seems to be identical; not a single distinguishing difference has been found, be it in habits, size, or shape.

FOURTH LARVAL INSTAR.

Figs. 10, 15, 16, 30, 31.

Length of larva, immediately after third moult, about 7 mm.; before fourth moult, about 12 mm. Width, after third moult, about 3 mm.; before fourth moult, about 5 mm.

Color, pale cream; chitinizations light brownish.

Setae, fine and short on head-parts and legs; body densely set with fine asperities (fig. 10).

Body, soft, fusiform-ovate, with both dorsal and ventral surfaces convex. Epipleural areas large, but not forming a swollen lateral ridge. Prothorax, dorsally slightly longer than either of the two other thoracic segments and carrying a pair of light brownish chitinous patches corresponding to a tergal shield.

Head, seminutant, extended, with head capsule and appendices thinly chitinized, but slightly thicker than in third instar.

Head capsule, dorsally about 1 mm. long; length and width almost equal; developed as in third instar; dorsal and ventral surfaces slightly convex and smooth.

Frons, indistinct; laterally fused with epicranium, anteriorly with clypeus.

Labrum, rather short and broad; immovable, posteriorly distinct, but almost fused with clypeus. Antennae, maxillary palps and distal part of mandibles projecting in front of its anterior margin. Setae short, mostly set along the free anterior margin.

Epicranial halves, fused dorsally, no median epicranial suture; antennal and mandibular foramina combined, about one-third the length of cranium from the mandibular condyle.

Hypostomal margin between mandibular condyle and posterior end of cardo, oblique and very concave, half as long as side of cra-

⁷ Insectes vésicants, p. 341.

nium. Margin between cardo and occipital foramen convex, separated by a well defined suture from intermediate gular area.

Gular area, almost fan-shaped, broad in front, attenuate behind; anterior margin convex; lateral margins concave; anterior and lateral margins of about same length, and equal to that of the hypostomal margin.

Optic spot, dorso-lateral, reduced to a blackish pigmented point, placed behind the antennal foramen in a distance that is almost equal to the length of the basal antennal joint.

Antenna, conico-cylindrical, distal end reaching about to the anterior third of the mandible; basal membrane large; basal joint largest and about as wide as long; second joint half as long and somewhat narrower; apical joint very small and carrying a minute seta; supplementary appendix minute; sensorial papillae few and minute; medium-long setae at the base of basal and second joints.

Mandible, triangular, with length and width about equal, exterior lateral margin about as long as the hypostomal margin; axis between the dorsal and ventral mandibular articulations almost perpendicular to the dorsum of the body. Terminal third heavily chitinized, triangular, with inner surface somewhat concave; edge serrate. Median part of mandible thinly chitinized, light colored, wide and with inner margin very convex. Basis and particularly the ventral condyle heavily chitinized and dark.

Maxilla, free, protruding, slightly chitinized, rather slender, three times as long as wide (palpus not counted), divided into two almost equal parts; the posterior part probably formed by a fusion of a proximal section of stipes and the cardo; the anterior part is a distal section of stipes. Mala single, fleshy and rounded, with short setae. Palpus three-jointed, somewhat shorter than the distal section of stipes; rather slender, conico-cylindrical; the joints almost equally long, apical joint about one-third, and second joint about half as wide as the basal joint; short setae on all joints; tactile palpillae on tip of apical joint.

Submentum, transverse, anteriorly convex with median incision, posteriorly concave.

Mentum, transverse, trapezoidal, about twice as wide as long, broadest anteriorly.

Stipites labii, fused; the joint formation transverse, anteriorly and medianly somewhat incised, as wide as posterior margin of mentum; no distinct palpiger. Labial palp two-jointed.

Ligula, absent.

Paragnathae, not developed.

Bracon, indistinct but present.

Tentorium, not observed.

Prothorax, subtrapezoidal, before moult with posterior margin medially almost effaced. On each side of middle line of tergum with one light brownish, subtriangular plate, about half as large as ventral side of epicranium. Prothorax somewhat longer than and about twice as wide as head. Hypopleural chitinization small and linear.

Meso- and metathorax, subtrapezoidal; in first period of stage somewhat shorter, in last period somewhat longer, than head. Posterior width of mesothorax in proportion to its length, as three to one, of metathorax as four to one. Epipleural area large, not distinctly separated from tergum. Hypopleural chitinizations small and linear, same size as in prothorax. Sternal region simple.

Legs, inserted widely apart; ambulatory type, but small and unfitted for locomotion. All of same size, about as long as side of head-capsule from base of antenna backwards. Coxa large, conical, with oblique base, about one-third of the length of the entire leg and somewhat longer than the mandible. Trochanter well developed. Femur subcylindrical, a little shorter than coxa, about half as wide as long. Tibia conico-cylindrical, almost as long as femur, but somewhat narrower. Tarsus short and claw-shaped.

Abdominal segments, with dorsal and ventral sides convex; laterally with large, but not protruding or ridge-forming epipleural areas; ventro-lateral suture not sharp in the last period of the stage. First to seventh abdominal segments alike; third and fourth segments somewhat wider than others; abdomen tapering anteriorly, and still more posteriorly toward the terminal complex of the eighth to tenth abdominal segments, which together form a cone of equal length and width. Tenth segment not much shorter than the ninth.

Anal opening, perpendicular, ventrally bifurcate.

Spiracles, placed dorsally, annular; one mesothoracic and seven abdominal, extraordinarily large, gradually decreasing somewhat in size posteriorly; seventh abdominal spiracle about half as wide as the anterior spiracles; eighth abdominal spiracle very minute.

Differentiating characters.—The fourth instar is known in more Meloid genera than the third, partly because the third stage has been overlooked or not recognized as a distinct stage, different from the fourth, partly because the cast skin of the fourth instar either is attached to the end of the fifth instar as in *Zonabrin*, *Epicautini*, and *Lytini*, or partially envelops it, as in the *Meloini*, or completely surrounds it as in all the *Nemognathinae*, and this fifth instar is more easily and frequently found than the previous instars.

The genera of the subfamily *Nemognathinae* of which the fourth instar is known are: *Hornia*, *Allendesalazaria*, *Stenoria*, *Sitaris*, *Apalus*, *Sitarobrachys*, *Leptopalpus*, *Zonitis*, and *Nemognatha*. In most of these genera the instar does not need to change from one

cell to another as the content of honey in one cell is large enough to supply the parasite with food for its whole feeding period; it therefore remains as in *Tricrania* in the same cell in which it has been parasitizing during the preceding stages; but in *Zonitis* and, according to Cros, probably also in *Nemognatha* the fourth instar leaves its first cell and enters another, devouring the whole content, bee-larva as well as honey, before it changes into fifth instar. The fourth instars of the two last genera are characterized by small but distinct spiracles on the eighth abdominal segment, all the other genera possessing either minute eighth abdominal spiracles, as *Sitaris*, or apparently none, as *Apalus*. In *Nemognatha* the instar is described by Cros as very curved ("fortement courvée en arc"), in the other genera it is fusiform-ovate as in *Tricrania*.

The chitinizations, present on the prothoracic tergum in *Tricrania*, are not developed in all genera, for instance not in *Apalus* and *Sitaris*; in *Hornia*, on the contrary, a complete, rather large, but thin prothoracic shield is present.

FIFTH LARVAL INSTAR.

Figs. 11, 17, 18, 32, 34.

Larva inclosed in and entirely surrounded by the unbroken and not shed exuvium of fourth instar.

Length of larva, about 10.25 mm.; width, about 4.25 mm.; consequently smaller than the previous full-grown instar.

Color, yellowish.

Setae, none; body covered with fine asperities.

Body, with thin, pellucid but rather rigid skin; almost regularly ovoid, dorsally and ventrally convex, ventrally slightly flatter; mouth parts and legs very reduced and tuberculiform; segments plainly indicated; main areas distinguishable, terga transversely divided into two folds, epipleural areas not forming any continuous lateral ridge above the distinct ventro-lateral suture; ninth and tenth segments rather short, flatly rounded; anus oval, facing downwards.

Head, nutant, somewhat retracted, vaguely formed. Head-capsule transversely oval; length medio-dorsally about 1 mm., slightly shorter than in fourth stage; laterally only half as long as in fourth stage; width the same in both stages, about 1 mm.; ventral side behind the ventral mouth parts very short, developed as a transverse, narrow, laterally somewhat enlarged band. Dorsal and ventral surfaces of head slightly convex.

Antenna, mandible, maxilla and labium, short, thick, tuberculiform, without segmentation, recognizable only by their relative positions.

Ocellus, merely represented by a single, transverse dash of dark pigment, somewhat larger than in fourth stage.

Legs, represented by three pairs of low, broad, poorly segmented tubercles.

Spiracles, dorso-lateral; the mesothoracic and first seven abdominal ones somewhat salient and cupuliform, all alike and of medium size; the metathoracic and eighth abdominal spiracles present but minute.

Differentiating characters.—The fifth instar is found in the same comparatively large number of genera of the subfamily *Nemognathinae* as is the fourth. In all of these the instar is completely enveloped by the unbroken exuvium of fourth instar, but the shape of the body and the texture of the surface is somewhat variable.

In *Hornia minutipennis* Riley, the instar is curved, subovate, with distinct segmentation, shining, thin skinned, rather soft and gradually becoming shrunken and almost triangular prismatic; however, it recovers its original swollen shape before the transformation into the next stage. Mouth parts and legs less reduced than in *Tricrania*, *Stenoria (analis* Schaum), and most others.

In *Stenoria*, *Apalus*, and *Sitaris* the instar is straight, ovoid, with shining skin; in *Stenoria* rigid and never deformed, in *Apalus* and *Sitaris* soft and periodically triangular prismatic as in *Hornia*.

In *Zonitis* and *Nemognatha* the larva is curved, almost regularly cylindrical with bluntly rounded ends, rigid and, seen from the side, velutinous due to the development of short hairs on the finely shagreened skin; body opaque. Skin of sixth instar in these two genera adherent to the inside of the skin of the fifth. In *Sitarobrachys*, which possibly belongs near *Zonitis*, the surface is shining as in *Stenoria*.

All *Nemognathinae* have one pair of mesothoracic and seven pairs of abdominal spiracles, all well developed, of medium size or larger; the eighth pair of abdominal spiracles vestigial; the comparative size both of the normal and vestigial spiracles somewhat varying according to the different genera; thus the normal spiracles are smaller in *Tricrania* than in *Hornia (minutipennis)* but in both much smaller than in *Stenoria (analis)*; on the contrary the vestigial eighth abdominal pair is smaller in *Stenoria* than in the two other genera.

SIXTH LARVAL INSTAR.

Figs. 12, 19, 20, 32, 35.

Sixth instar inclosed in, but not adherent to, the unbroken and not shed exuvia of the fifth and fourth instars.

Length of larva, about 10.25 mm. Width, about 4.25 mm.

Color, pale cream.

Setae, few and short; body densely set with fine asperities.

Body, ovate, ventrally slightly less convex than dorsally; eighth, ninth, and tenth abdominal segments short, together forming an

obtusely rounded, downward-bent end of body, and not, as in fourth instar, an attenuate, straight and conical one; anus round, facing obliquely forward, not posteriorly as in the fourth instar; segments distinctly limited, with most of the segmental areas distinguishable, not effaced as in fourth instar, but more similar to the conditions of the fifth instar; tergal areas transversely divided into two folds; epipleural areas rather large with epipleural lobes round and distinct, not forming a continuous lateral ridge above the ventro-lateral suture; this latter is sharply set off; ventral areas all represented. Legs, three pairs of equal size, as long as in fourth instar, but much thicker, soft, not fitted for locomotion; femur and tibia distinct; tarsus less so; coxa indistinct and trochanter lacking.

Head, rather large and flat, nutant and directed backward, somewhat retracted; head-capsule and appendices obese but distinct, very similar to the same structures in fourth instar; all soft, except tip and condyle of mandible, which are darkly chitinized.

Head-capsule, dorsally with slightly convex surface and rounded outline; length, about 1 mm.; width, 1.25 mm.; ventral side, behind maxillae and submentum, very short, medianly about 0.12 mm. long, half as long as in fourth instar and much shorter than in second instar; lateral side of head about 0.75 mm. long.

Frons, small, anteriorly wide, posteriorly attenuate, lateral margins convex, rather distinctly set off from epicranium by frontal sutures; also a definite indication of a fronto-clypeal suture; separated from foramen occipitale by a distance about half as long as the frontal area itself.

Clypeus, large, anteriorly about half as wide as posteriorly, lateral margins convex.

Labrum, transverse, subtrapezoidal, with almost straight anterior margin; the mandibles, maxillae and labium, but not the antennae, projecting in front of labrum.

Epicranial halves, large, laterally and posteriorly rounded, medianly meeting along well developed epicranial suture; hypostomal margin very concave, half as long as side of cranium; margin between cardo and foramen occipitale short.

Gular area, short, half as long as in fourth instar, somewhat similar in shape; laterally limited by two gular sutures.

Ocellus or pigmented optical spot, absent.

Antenna, conical, distally extending over posterior third of the mandible, three jointed, basal joint much larger than in fourth instar, somewhat longer than the two other joints together, about as wide as long; apical joint small; supplementary appendix same size as apical joint. A few setae on all joints.

Mandible, triangular, with about equal length and width. Imaginary axis between dorsal and ventral articulations located as in

fourth instar. The tip and the condyle slightly harder than the rest, but not well chitinized as in fourth instar; the tip also much shorter and its inner surface less developed than in that instar.

Maxilla, free, protruding, turgid and plump, about as wide as long (palpus not counted). Stipes divided into a distal and proximal part; the distal part with rounded fleshy setose mala, and short, thick, conical three-jointed palpus. Basal, second, and apical palpal joints somewhat smaller than the corresponding antennal joints, but of same shape and relative proportions; short setae on all joints.

Submentum, mentum, and stipites labii, with two-jointed labial palps, very similar to the same structures in fourth instar.

Ligula, absent.

Thoracic and abdominal segments, similar in size and development to the corresponding features of fifth instar.

Legs, short, thick, conical, protruding, and immovable; with same general appearance but larger than antennae. Coxa indistinct, flat and wide. Trochanter not developed. Femur rather distinct, conico-cylindrical, short, three times as wide as long. Tibia, like femur, rather distinct, subcylindrical, as long as femur, but considerably narrower. Tarsus indistinct, very short, apically rounded without claw-like end.

Spiracles, lateral, circular, of medium size; development and size as in fifth instar; one mesothoracic and seven abdominal pairs present; seventh abdominal pair somewhat smaller than rest; eighth abdominal pair wanting.

Differentiating characters.

The sixth instar is known from the same genera of the *Nemognathinae* as are the fourth and fifth instars. In all of these genera the sixth instar rests inactive inside the unbroken exuvia of the two preceding instars. In *Zonitis* and *Nemognatha* the integument adheres to the inner wall of the skin of the fifth instar and is not shed by the pupa, but surrounds it completely together with the two previous exuvia: in the other genera it is free, is shed by the pupa, pushed backwards, and found attached to the end of the pupal abdomen.

C. PUPA.

The process of the pupation inside a capsule formed by the exuvia of the fourth and fifth larval instars, has been described in Part 1. During the moult, the exuvium of the sixth instar opens along the back, is slowly moved behind by contractions of the young pupa, and pushed together into a little flat mass or pellicle, which is loosely attached to the end of the pupa. This pupa is pale yellowish, completely glabrous, and has a swollen abdomen. It does not differ in any respect from the pupae of

Sitaris and *Stenoria*, figured and described by Valéry Mayet and Beauregard, nor from the pupa of *Hornia* which, according to Riley is like that of *Sitaris*. Therefore a detailed description is considered unnecessary.

A different pupal type with slender abdomen and hair or spines on the dorsal side of the head and the posterior margins of prothorax and abdominal segments is characteristic for *Meloid* with errant fourth larval instar and with the pupa developing in the ground, for instance the genera *Zonabris*, *Cerocoma*, *Epicauta*, *Macrobasis*, *Lytta*, and several species of genus *Meloe*.



FIG. 1. — *TRICRANIA SANGUINIPENNIS* SAY. PUPA WITH EXUVIUM OF SIXTH INSTAR ATTACHED TO POSTERIOR PART OF BODY.

D. IMAGO.

The genus *Tricrania* LeConte has been divided into two genera by Wellman,⁸ namely, the old genus *Tricrania* LeConte s. str. with *Tricrania sanguinipennis* Say as the type species and *Tricraniodes* Wellman with *T. stansburii* Haldeman as type species. The genus *Tricrania* s. str. is characterized as follows:

Body rather hairy. Head triangular. Labrum small, short, and triangular, anteriorly rather obtuse. Mandible long, strong, projecting, armed with a low, almost obsolete tooth below the middle of the inner edge. Maxilla with stipes proper, subgalea, the lacinia-carrying intermaxillare and lacinia itself amalgamated into a single piece; maxillary palp with apical joint distally obtuse, a little longer than the following joint. Labium small. Antenna serrate; antennal joints obconical, slightly compressed. Head and thorax slightly narrower than the base of the elytra. Hind wings absent. Tarsi rather robust; those of the anterior and middle legs about as long as their tibiae; tarsus of hind leg not more than two-thirds of the length of tibia. Tarsal claws double, with a pectinate and thicker upper portion, and an equally long, simple, and bristle-shaped lower one; upper portion distally with a single, proximally with a double row of short teeth.

According to Wellman *Tricraniodes* differs from *Tricrania* by possessing hind wings and by having a single row of long, regular teeth both distally and proximally on the upper portion of each double claw.

⁸ Wellman, C.—On the classification of the Lyttidae, Ent. News, vol. 21, 1910, p. 219.

The first description of the present species *Tricrania sanguinipennis* is by Say, who treats it under the name of *Horia sanguinipennis*. It is as follows:⁹

Body black; elytra sanguineous, immaculate. Inhabits Pennsylvania. Body short, robust, deep black, scabrous, with dense punctures; head lobate at the basal angles, with a slightly elevated longitudinal, glabrous line on the front; antennae impunctured; third joint as large or larger than the first; terminal joint acuminate from its middle; mandibles glabrous and with the palpi impunctured; thorax transverse-quadrate, very obtusely rounded behind; scutel conspicuous, rounded behind, punctures more minute than those of the thorax; elytra very flexible, sanguineous, immaculate; feet punctured (nails denticulated on the middle, tip, and base simple).¹⁰ Length more than two-fifths of an inch.

SYNOPSIS OF THE TRIBES AND GENERA OF SUBFAMILY NEMOGNATHINAE.¹¹

The following synopsis, given in the form of a key, summarizes the contents of the above-given descriptions of the egg, larval, and pupal stages of *Tricrania* and the comments on the corresponding stages of other genera of *Nemognathinae*. The key is based, partly on the present authors' personal examinations of the North American and some of the European species, partly on the texts and figures of other authors, but especially on Cros' very important publications about European and African forms.

The sequence in which the tribes and genera are arranged in the key expresses our conception of their natural grouping.

CHARACTERIZATION OF SUBFAMILY NEMOGNATHINAE.

The subfamily *Nemognathinae* is differentiated from the other members of the family *Meloidae* by the following characterization:

FIRST INSTAR: Head subtriangular or subcordate, labrum fused with head capsule into a nasale which is hollowed longitudinally on ventral surface. Epicranial margins behind ends of cardines, parallel or posteriorly converging. Gular area distinct.

Ocelli two on each side, sometimes close together.

Mandibles not projecting in front of labrum; axis between fossa and condyle of mandible, horizontal and mandible consequently moving in a vertical plane; with from 2 to 8 distinct teeth.

Labial palp two-jointed.

Thorax about of the same size as abdomen.

Tarsus, except in *Stenoria* in which spatulate, slender and conico-falcate, with one or two either small and fine, or long and strong setae laterally at base.

⁹ Journ. Acad. Nat. Sci., Philadelphia, vol. 3, 1823, p. 279.

¹⁰ Say's description of the claws is not correct; compare the generic description above.

¹¹ The term "*Nemognathinae*" takes here the place of the more commonly used "*Zoni-tinae*," which has long been applied to a subfamily of Mollusca; see T. D. A. Cockerell, Ent. News, vol. 21, 1910.

Ninth abdominal segment with or without two, fine, short caudal setae.

First abdominal spiracle about as large as the mesothoracic spiracle and much larger than rest.

Eighth abdominal tergum with spiracle-bearing chitinous hook, or a low, soft elevation.

SECOND, THIRD, AND FOURTH INSTARS: Body ovate or cylindrical, often slightly or, in *Nemognatha*, strongly curved.

Head-capsule and mouthparts thinly chitinized.

Prothorax, never with strongly chitinized shield.

FIRST, SECOND, AND THIRD EXUVIA shed. FOURTH AND FIFTH EXUVIA not shed; fifth instar covered with one exuvium and sixth instar with two closed exuvia.

SIXTH EXUVIUM completely shed, except in tribe *Nemognathini* in which it is adherent to inside of exuvium of fifth instar.

FIRST TO SIXTH INSTARS parasitizing on bees, feeding on the egg and honey of a single bee cell or, in the *Nemognathini*, feeding on the contents, egg, larva, and honey of two cells.

FIRST INSTAR carried by bee host; attached to bee hair by mandibles alone.

FOURTH INSTAR always sedentary.

KEY TO TRIBES AND GENERA.

1. FIRST instar with mandible carrying 6 to 8 teeth. SIXTH instar not adherent to fifth exuvium. SIXTH exuvium shed..... 2
 FIRST instar with mandible carrying 2 to 3 teeth. SIXTH instar either not adherent or adherent to exuvium of fifth instar..... 5
2. FIRST instar with mandibles carrying 7 to 8 teeth; anterior nasal margin obtuse, almost truncate; head comparatively short and broad; tarsus conico-falcate, long and slender with two, not equally long, slender tarsal setae, none of which are as long as tarsus; spiracle-bearing elevation either short or well developed. FIFTH instar with thin skin; gradually becoming triangular-prismatic..... 3
 FIRST instar with mandible carrying 5 or 6 teeth; anterior nasal margin sub-conical, not truncate; head comparatively elongate; medio-dorsal suture on thoracic segments varying; tarsus variable in form, always with well developed tarsal setae; spiracle-bearing elevation well developed, and as long as ninth abdominal segment. FIFTH instar more or less rigid; never deformed..... 4
3. FIRST instar with mandible with 8 teeth; spiracle-bearing elevation low, rather soft, much shorter than length of ninth abdominal segment; one well developed, almost ventral tarsal seta; medio-dorsal suture on all thoracic segments complete; one pair of fine and very short caudal setae SITARINI-HORNIIDES.
 Genus *Hornia*.
 FIRST instar with mandible with 7 teeth; spiracle-bearing elevation well developed and hook-shaped..... SITARINI-HORNIIDES.
 Genus *Allendesalazaria*.
4. FIRST instar with spatulate tarsus; both tarsal setae almost as long as tarsus SITARINI-STENORIIDES.
 Genus *Stenoria*.
 FIRST instar with conico-falcate tarsus; tarsal setae somewhat shorter than tarsus..... SITARINI-TRICRANIIDES.
 Genus *Tricrania*.

5. FIRST instar with two fine and short tarsal setae; spiracle-bearing hook well developed; caudal setae present. FIFTH instar ovate, smooth and soft skinned, gradually becoming deformed and almost triangular-prismatic. SIXTH instar free; exuvium of sixth shed-----SITARINI-APALIDES.

Genera *Sitaris* and
Apalus.

FIRST instar either with fine and short tarsal setae and spiracle-bearing hook shorter than half the length of eighth abdominal segment, or with strong and long tarsal setae and spiracle-bearing hook well developed, about as long as eighth segment. FIFTH instar, except in *Sitarobrachys*, finely shagreened and set with fine minute hairs, opaque and rigid. SIXTH instar adherent to exuvium of fifth; exuvium of sixth not shed----- 6

6. FIRST instar without or with fine and short caudal setae. Epicranial and frontal sutures not distinct and the median dorsal suture on prothorax either not present, in *Leptopalpus*, or, present only posteriorly, in *Zonitis*; always present on meso- and metathorax. Tarsal setae weak, one or two in *Zonitis*, two in *Leptopalpus*; seta on trochanter either long, in *Zonitis*, or normally developed, in *Leptopalpus*. Spiracle-bearing hook short and distant in *Leptopalpus* and in the North American species *Zonitis bilineatus*; normal in other species of *Zonitis*-----NEMOGNATHINI-ZONITIDES.

Genera *Zonitis*, *Leptopalpus*, and possibly *Sitarobrachys*.

FIRST instar without caudal setae. Epicranial and frontal sutures distinct, median suture fully developed on all thoracic terga. Tarsal setae almost as long and strong as tarsus, two present; trochanter with a long seta. Spiracle-bearing hook well developed.

NEMOGNATHINI-NEMOGHATHIDES.

Genus *Nemognatha*.

RECORDED SPECIES OF THE SUBFAMILY NEMOGNATHINAE, REPRESENTED BY ALL, SOME OR ONE INSTARS.¹²

Subfamily NEMOGHATHINAE.

Tribe SITARINI.

Hornia minutipennis Riley (3, 4, 54, 55).

Allendesalazaria nymphoides Escalera (13, 21).

Stenoria analis Schaum (3, 18, 42, 43, 44, 45, 58).

Stenoria apicalis Latreille (2, 3, 19, 43, 58).

Tricrania sanguinipennis Say (30).

(*Sitaris colletis* Mayet=*Stenoria analis* Schaum.)

(*Sitaris humeralis* Fabricius=*Sitaris muralis* Foerster.)

Sitaris muralis Foerster (1, 3, 4, 8, 9, 19, 24, 25, 26, 28, 43, 47, 58, 63).

Sitaris rufipes Gory (14, 19).

Sitaris solieri Pecchioli (15, 19, 51).

Apalus bimaculatus Linnaeus, var. *lecontei* Pic (3, 8, 13, 16, 33, 58, 61).

Tribe NEMOGNATHINI.

(*Zonitis analis* Abeille de Perrin=*Zonitis praecusta*, var. Fabricius.)

(*Zonitis fenestrata* Pallas=*Zonitis praecusta*, var. Fabricius.)

Zonitis immaculata Oliver (3, 4, 19, 34, 58).

(*Zonitis mutica* Scriba=*Zonitis immaculata* Olivier.)

¹² Numbers in parenthesis refer to the guide-numbers in the bibliography (p. 34) indicating the papers in which the species is mentioned.

- Zonitis praeusta* Fabricius (3, 19, 25, 27, 58).
Leptopalpus rostratus Fabricius (13, 18, 64, 66).
Sitarobrachys brevipennis Reitter (19).
Sitarobrachys buigasi Escalera (10, 19, 20).
Nemognatha chrysomelina Fabricius (11, 12, 17, 19).

COMMENTS TO THE SYSTEMATIC ARRANGEMENT OF THE SYNOPSIS.

The main taxonomic results recorded in the above given synopsis may briefly be presented as follows:

The subfamily *Nemognathinae* consists of two tribes:

- a. SITARINI and b. NEMOGNATHINI.
 a. SITARINI with four subtribes:
 1. Horniides, 2. Stenoriides, 3. Triceraniides, 4. Apalides.
 b. NEMOGNATHINI with two subtribes:
 1. Zonitides, 2. Nemognathides.

The genus *Stenoria* is placed in a subtribe *Stenoriides* next to *Horniides* and apart from subtribe *Apalides* which comprises *Sitaris* and *Apalus*, two closely related genera, entirely distinct from *Stenoria*. Genus *Tricerania* has been placed by Wellman and Borchmann in tribe *Horiini* together with *Horia* and *Cissites* and by Leng in his tribe *Zonitini* immediately after *Zonitis* and *Nemognatha* and right before *Horia*. In this paper, however, *Tricerania* is considered very close to *Stenoria* and *Hornia* and listed accordingly.

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On pp. 262-303, *Sitaris muralis*; pp. 323-349, metamorphosis of *Sitaris* and *Zonitis mutica*; p. 277, description of hooks of first instar of *Sitaris*; p. 287: "The *Anthophores* do not appear to be bothered at all by their presence."—Compare: *Assmuss, Ed.*, 1865. Die Parasiten des Honigbiene. Berlin, pp. 18-19, and *Cros, A.* 1914. "Meloe autumnalis." Bull. Soc. nat. Afrique Nord, vol. 6, pp. 105-106; both of these authors state that first instars of *Meloe* species are nourished from the carrying bees.

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P. 123: Definition of terms "instar" and "stage."

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Figures (vol. 1, fig. 34, nos. 4-9) the first instar of *Sitaris muralis* and recognizes it. on p. 298, as such.

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EXPLANATION OF PLATES

(All figures refer to *Tricranium sanguinipennis* Say.)

PLATE 1.

Larval instars.

- FIG. 1. *First instar.*—Ventral view, showing hypopleural chitinizations with articulation for coxa; the thoracic and seven abdominal spiracles.
2. *First instar.*—Hook with eighth abdominal spiracle on top and atrium inside. Scale adjacent to hook.
3. *First instar.*—Dorsal view.
4. *First instar.*—Anterior part of head, showing excavation of nasale and completely closed mandibles. Compare fig. 24.
5. *First instar.*—Lateral view.
6. *First instar.*—Claw-shaped tarsus with two basal setae; m_1 , and m_2 muscles of claw-shaped tarsus.
7. *Second instar.*—Dorsal view. Eight pair of abdominal spiracles.
8. *Second instar.*—Lateral view.
9. *First instar.*—End of abdomen, showing tracheal system and spiracles.
10. *Fourth instar.*—Lateral view. Seven large abdominal spiracles. Posterior view of anal segment shown separately.
11. *Fifth instar.*—Lateral view. Seven abdominal spiracles of medium size.
12. *Sixth instar.*—Lateral view. Seven abdominal spiracles of medium size.

PLATE 2.

Head Structures.

- FIG. 13. *First instar*.—Ventral view.
 14. *Second instar*.—Ventral view.
 15. *Fourth instar*.—Ventral view; *mi*, mentum; *sm*, submentum; *gu*, gula.
 16. *Fourth instar*.—Dorsal view.
 17. *Fifth instar*.—Ventral view. First pair of vestigial legs shown; *a*, antenna; *la*, nasale—the fused labrum, clypeus and anterior margin of frons; *leg.*, leg; *li*, labium; *md*, mandible; *mx*, maxilla.
 18. *Fifth instar*.—Dorsal view.
 19. *Sixth instar*.—Ventral view.
 20. *Sixth instar*.—Dorsal view; *cly.*, clypeus; *hy*, hypopharynx; *la*, labrum.

PLATE 3.

Eggs and Larval Instars.

- FIG. 21. Cell of the bee *Colletes rufithorax* Swenk with fourth larval instar of *Tricrania* inside. Notice the unbroken covering of the cell and the great amount of excrement-pellets of the Meloid larva. The honey supply is exhausted.
 22. Eggs of *Tricrania*. Cement spots on the egg-shells.
 23. *Colletes rufithorax*, female, with first instars of *Tricrania* just having attached themselves to its hair. Drawn from a specimen in captivity; in nature the larvae are found mainly clinging to hairs on the posterior, dorsal part of the head or on the vertex.
 24. *First instar* of *Tricrania* grasping a bee's hair with its mandibles, the legs having nothing to do with this performance. Compare fig. 4.

Different instars of Tricrania.

All figures and the interposed millimeter-scales drawn with the same magnification to demonstrate the growth of the larva and to indicate the real size of the instars. *md.*=mandible.

- FIG. 25. *First instar*.
 26. *Second instar*, first period.
 27. *Second instar*, second period.—Notice that head and legs have the same size as in fig. 26.
 28. *Third instar*, first period.—Lateral and ventral views; *c. s. 2*, cast skin of second instar. Compare the size of head and spiracles with the size of the same structures in figs. 27 and 29.
 29. *Third instar*, second period.
 30. *Fourth instar*, first period; *c. s. 3*, cast skin of third instar. Notice the dorsal sclerite of prothorax, not developed in third instar.

PLATE 4.

Various instars.

- FIG. 31. *Fourth instar*, second period.
 32. *Sixth instar* (6), enveloped by the exuvia of fifth (5) and fourth (4) instars. In nature both exuvia are unbroken and placed against each other and against the sixth instar; in the figure they are cut open, pulled out and partly separated.

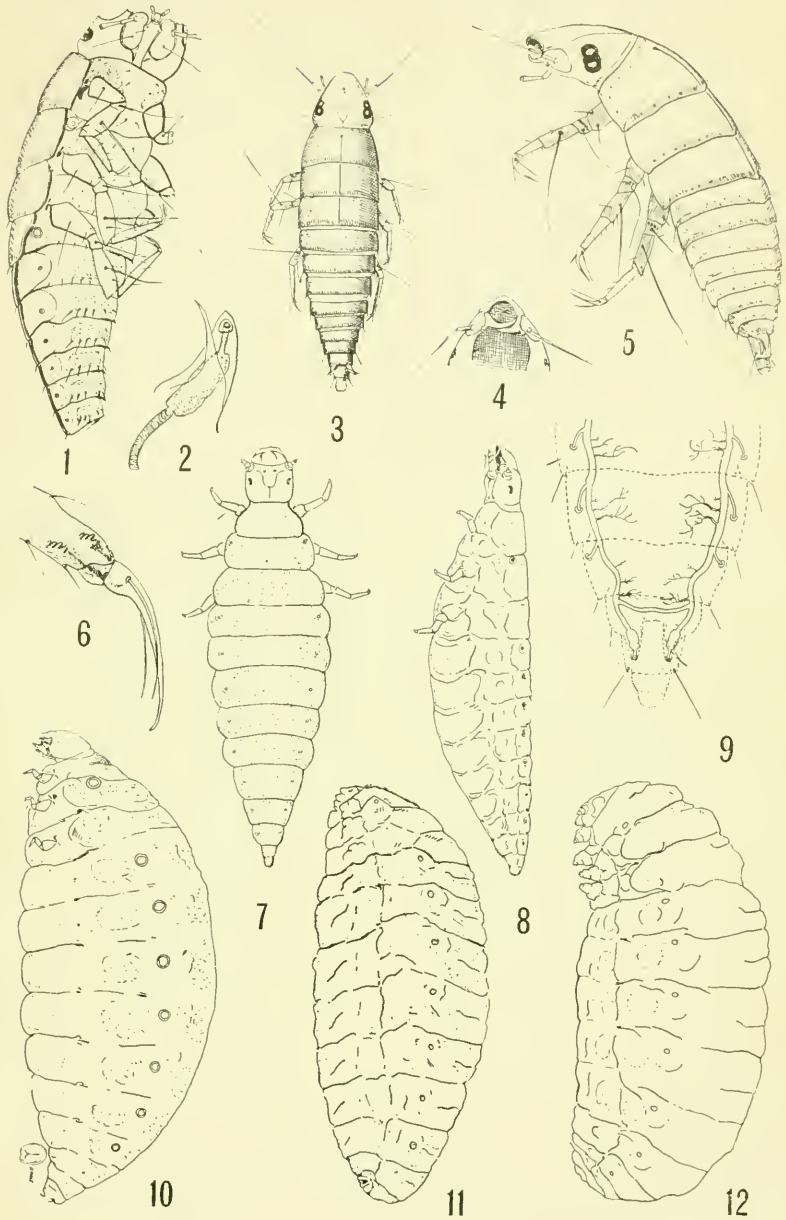
- FIG. 33. Imago inside capsule formed by the exuvia of fourth and fifth larval instars. *1*, imago; *4* and *5*, exuvia of fourth and fifth instars; *6*, the shed and crumbled exuvia of sixth instar and of the pupa pushed to the bottom of the capsule; *c*, unfertilized very small eggs abnormally deposited inside unbroken capsule.
34. *Fifth instar*.—Lateral view of head.
35. *Sixth instar*.—Lateral view of head.

PLATE 5

Eggs of bees and instars of Tricrania.

- FIG. 36. Brood cell of *Colletes rufithorax* Swenk in its natural position in the soil, slightly enlarged. The egg of the bee in its normal position above the food mass is shown through the transparent wall of the brood cell.
37. *First Instar* of *Tricrania* resting on the edge of the food mass in the brood cell of the bee, immediately preceding the first moult. $\times 16$.
38. *Second Instar* of *Tricrania*, resting on the food mass in brood cell of bee. $\times 3$.
39. Brood cell of *Andrena perplexa* Smith showing egg of bee in its normal position on the mass of pollen in the bottom of the cell. In this case no honey had yet been placed in the cell about the egg. Slightly enlarged.
40. *Third Instar* of *Tricrania* resting on food mass in cell of bee. $\times 3$.
41. *Fourth Instar* of *Tricrania* feeding in brood cell of bee from which the wall has been cut away.
42. Female of *Tricrania* ovipositing on the under side of a mass of dried cow's dung. Enlarged about two diameters.

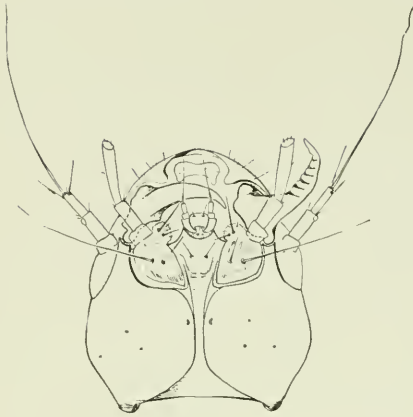




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LARVAL INSTARS OF *TRICRANIA SANGUINIPENNIS*

FOR EXPLANATION OF PLATE SEE PAGE 38



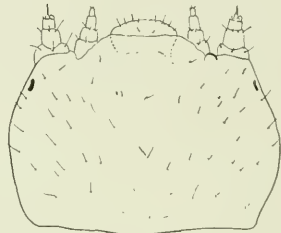
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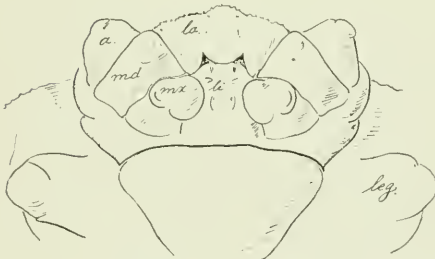
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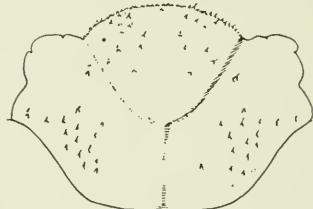
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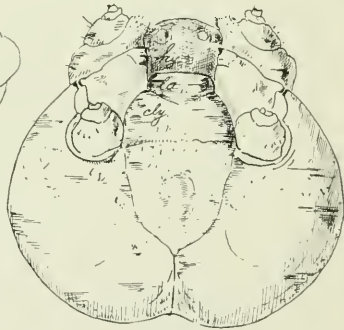
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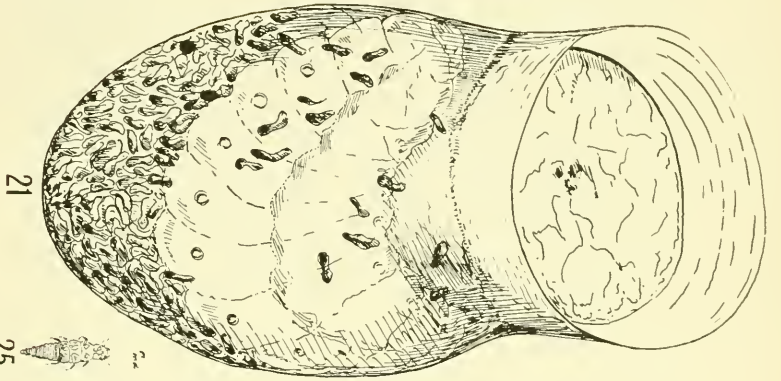
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HEAD STRUCTURE OF TRICRANIA SANGUINIPENNIS

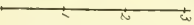
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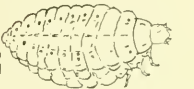
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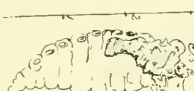
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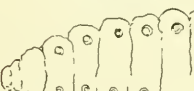
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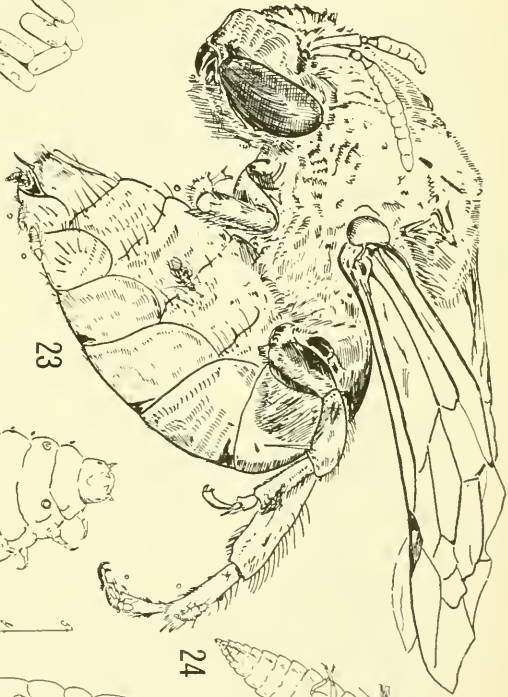
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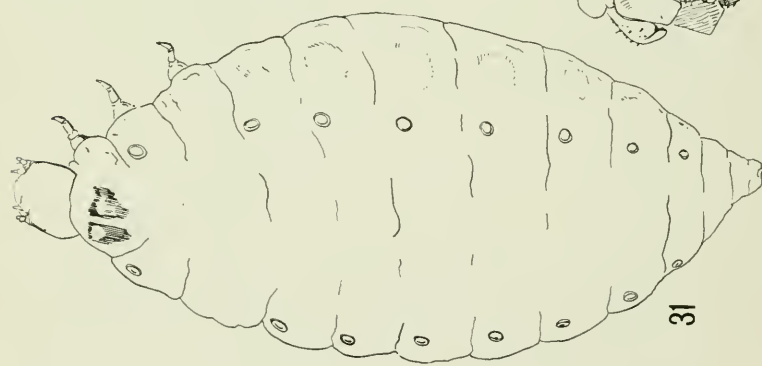
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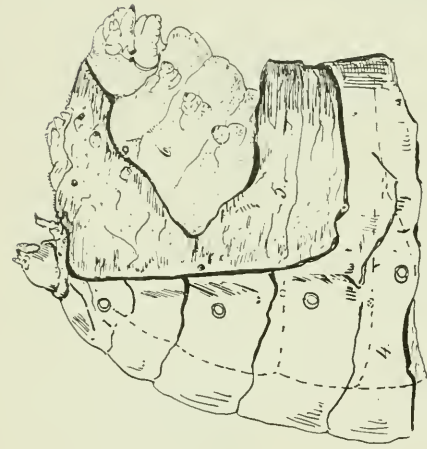


EGGS AND LARVAL INSTARS OF TRICROCRANIA SANGUINIPENNIS

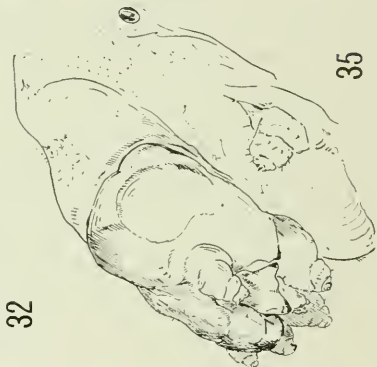
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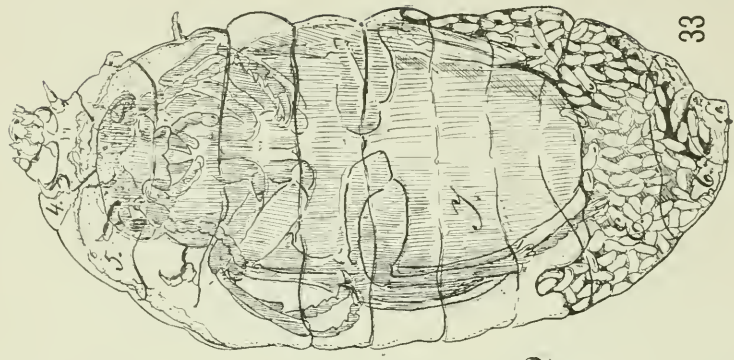
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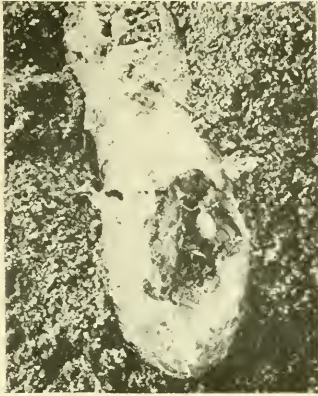


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W. G. B.

VARIOUS INSTARS OF *TRICRANIA SANGUINIPENNIS*

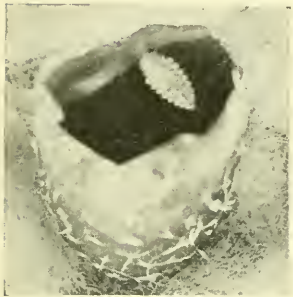
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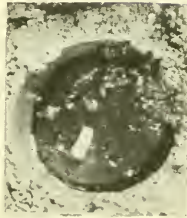
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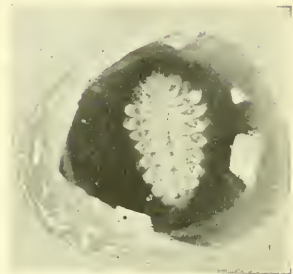
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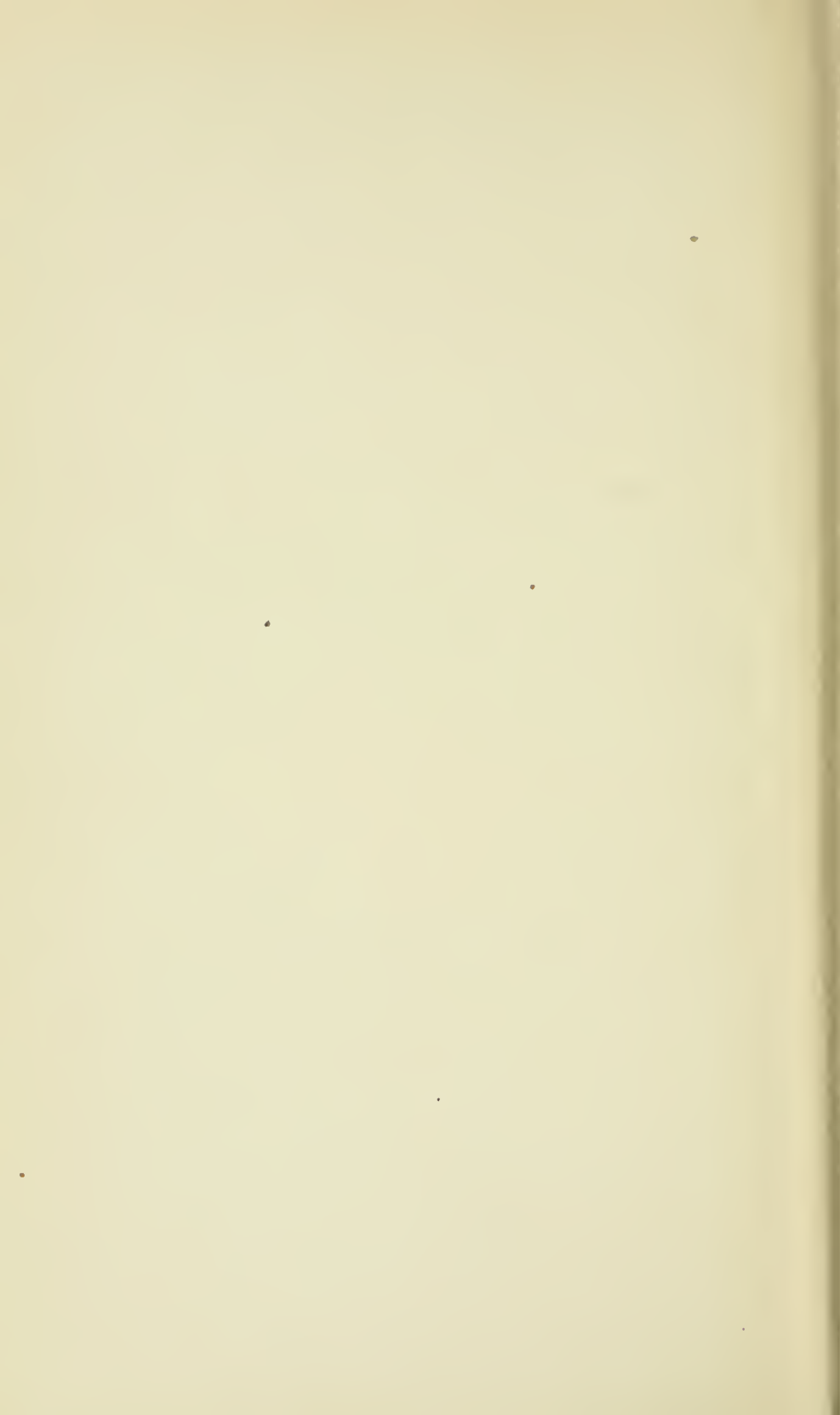
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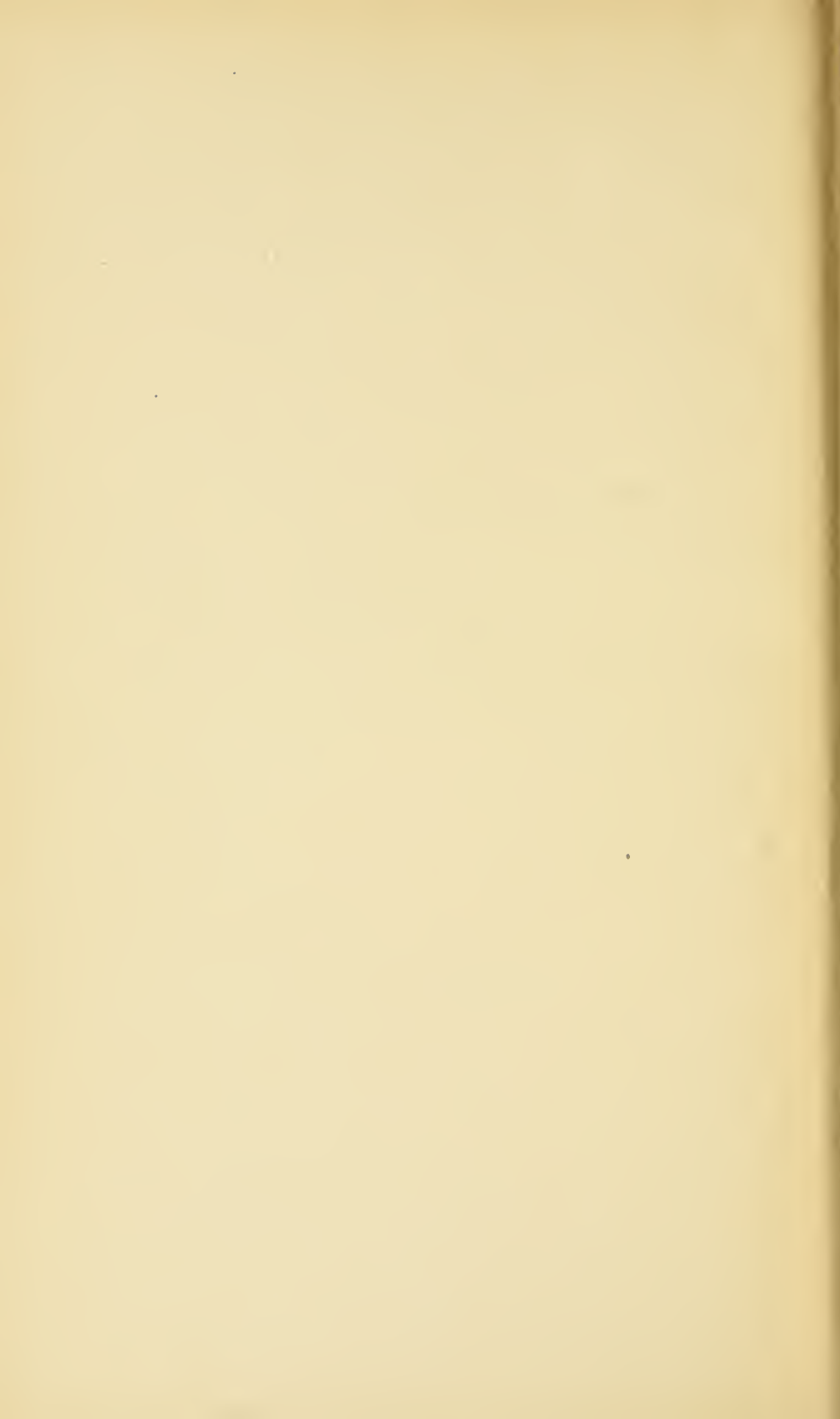
EGGS OF BEES AND INSTARS OF TRICRANIA

FOR EXPLANATION OF PLATE SEE PAGE 40









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