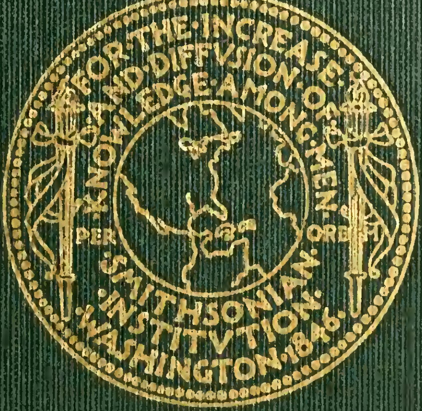
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SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM

PROCEEDINGS

OF THE

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Remington Kellogg,
Director, United States National Museum.

CONTENTS

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[1] Errata: On page 68, figure 6, *h*, for "*Ectmesopus malachoides*" read "*Ectmesopus malachioides*"; on page 97 (key), for "*Ectmesopus malachiodes*" read "*Ectmesopus malachioides*."

[2] Erratum: On page 397, line 1, for "*Phytobia (Xenophytomyza) illinoensis* (Malloch)" read "*Cerodontha* (*Xenophytomyza*) *illinoensis* (Malloch)."

PROCEEDINGS OF THE UNITED STATES NATIONAL MUSEUM

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PYCNASPIS SPLENDENS, NEW GENUS, NEW SPECIES, A NEW OSTRACODERM FROM THE UPPER ORDOVICIAN OF NORTH AMERICA

By Tor Ørvig[1]

Introduction

In this paper a short description is given of a new ostracoderm, *Pycnaspis splendens*, new genus, new species, from the Upper Ordovician of the eastern slope of the Bighorn Mountains in north-central Wyoming. This new form is related to *Astraspis desiderata* from the Harding Sandstone, but it differs from the latter in the shape and microstructure of the tubercles of the exoskeleton. At the type locality it is associated with *Astraspis*? sp. indet. and Eriptychiida gen. and sp. indet. Exoskeletal plates referable to *Pycnaspis*, new genus, but at present indeterminable as to species are represented in the Winnipeg formation of the Williston Basin in Montana and in the Whitewood formation of the Black Hills in South Dakota, but such plates are missing entirely in the Harding Sandstone of Colorado.

Ordovician vertebrates from North America were first recorded by Walcott who, in 1892, described small exoskeletal plates of two forms, *Astraspis desiderata* Walcott and *Eriptychius americanus* Walcott, from the Harding Sandstone outcrops near Canyon City, Colo. These two forms Walcott referred tentatively to the Asterolepidae and Holoptychiidae, respectively, but they are now generally recognized as true representatives of the Heterostraci. Walcott also figured a third fossil from the Harding Sandstone, *Dictyorhabdus priscus* Wal-

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[1] Curator, Department of Paleozoology, Swedish Museum of Natural History, Stockholm.

cott, which he regarded as the "calcified chordal sheath" of a fish allied to the bradyodonts, but which, as later researches have clearly shown (Dean, 1906, pp. 132–135; Bryant, 1936, p. 410; Flower, 1952, pp. 516–517), cannot possibly be of vertebrate origin. The Harding Sandstone vertebrate remains have been dealt with by Jaekel (in an appendix to Walcott's paper of 1892) and subsequently by, among others, Vaillant (1902), Eastman (1907, p. 33; 1917, pp. 236–239, pl. 12, figs. 5, 6), Woodward (1921, p. 179), Stensiö (1927, pp. 314–315, 333), Stetson (1931, p. 153), Bryant (1936), Berg (1940, pp. 107–108, 360–361), Kvam (1946, pp. 19–20, fig. 1), Gross (1950, p. 73; 1954, p. 80, pl. 3, fig. 2, pl. 5, figs. 3, 4, 7), Ørvig (1951, pp. 381–382, 387, 393, 415, 433, fig. 22 B, pl. 3, figs. 3, 4), Gregory (1951, vol. 1, pp. 102–104, vol. 2, figs. 6.2 (A), 6.3, 6.4), Denison (1956), J. D. Robertson (1957), and James (1957, p. 9, pl. 1). A description of *Astraspis desiderata,* based on the only fairly complete carapace of this form known so far,[2] will be given in a forthcoming paper by the present writer (Ørvig, in MS., b). Various notes on the invertebrate fauna and/or the stratigraphy of the Harding Sandstone have been given by Walcott (1892), Darton (1906b), S. R. Kirk (1929), Miller (1930), Stauffer (1930, p. 83), E. Kirk (1930), Branson and Mehl (1933); Behre and Johnson (1933), Ulrich (1938), Johnson (1944, pp. 320–322), Flower (1952), Frederickson and Pollack (1952), Twenhofel et al. (1954), Sweet (1954; 1955), and Denison (1956, pp. 368–369). This formation is now generally believed to be of Middle Ordovician (Trenton) age.

Vertebrates to some extent resembling those of the Harding Sandstone have long been known to occur in certain sandstone beds beneath the Bighorn Dolomite of north-central Wyoming and in the lower sandstone and siltstone members of the Whitewood formation of the Black Hills region in South Dakota, but none of this material has yet been properly described (see Darton, 1906a, p. 29; 1906b, pp. 550–551, fig. 3; 1909; Cockerell, 1913, p. 247; E. Kirk, 1930; Miller, 1930, p. 206; Romer and Grove, 1935, pp. 810–811; Furnish, Barragy, and Miller, 1936, pp. 1335–1338, pl. 2, figs. 14–16; Amsden and Miller, 1942, p. 304; Miller, Cullison, and Youngquist, 1947, p. 31; McCoy, 1952; Denison, 1956, p. 367). Dermal elements of Thelodontida and Osteostraci (*Ateleaspis*?) have been recorded from strata of a presumed lower Middle Ordovician age in the Bighorn Mountains of Wyoming (Tieje, 1924), but everything seems to indicate that those fossils are incorrectly determined. A new occurrence of Ordovician vertebrates has recently been detected farther north, in the sandstone and shale of the Winnipeg formation of the Williston Basin. This latter fauna,

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[2] This specimen (USNM 8121), mentioned already by Walcott (1892, footnote on p. 167) and later described by Eastman (1917, pp. 238–239, pl. 12, figs. 5, 6) and by Bryant (1936, pp. 416–417, pl. 1), is of particular interest in that it shows part of the lateral line canal system on the anterior part of the carapace.

which is contained in drill cores from various places in eastern Montana, has proved to be of considerable interest, and together with other undescribed vertebrate material from the Ordovician of Wyoming and South Dakota it will be dealt with by the writer on a future occasion.

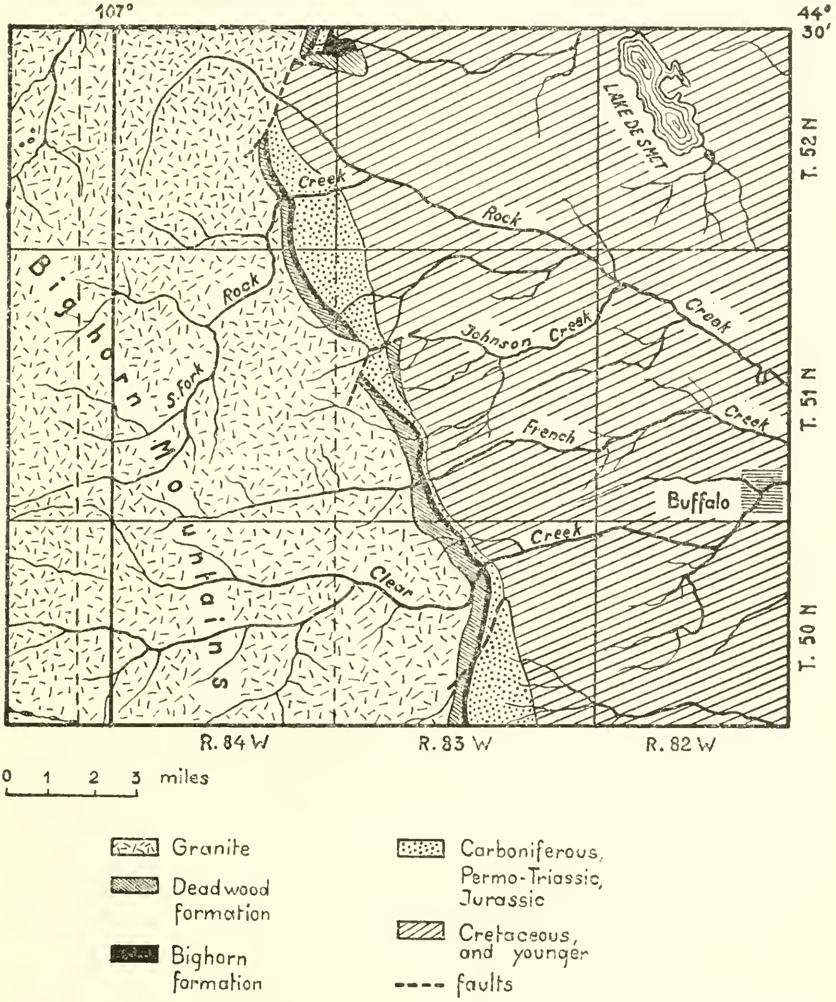

FIGURE 1.—Map showing the outcrops of Ordovician rocks on the eastern slope of the Bighorn Mountains in the area west of Lake De Smet and Buffalo, Johnson County, Wyo. Redrawn and to some extent simplified from the geological maps of the Bighorn Mountain Region published by Darton (1906a, pl. 47; 1906b, pl. 73).

The new astraspid, *Pycnaspis splendens*, new genus, new species, described in this paper comes from the Upper Ordovician deposits of the Bighorn Mountains of Wyoming. The histology of the exoskeleton in this form will be dealt with more in detail in another connection (Ørvig, in MS., a).

Fossils presumed to be remains of early vertebrates have been recorded on two occasions from North American deposits that are older than the Harding Sandstone of Colorado and the other vertebrate-bearing beds of Wyoming and South Dakota referred to above, viz.: (a) small, tuberculated plates from the Middle Cambrian St. Albans Shale of Vermont, described by Bryant (1927) and Howell (1937, pp. 1200–1202, p. 2, figs. 7, 8) under the name of *Eoichthys howelli* Bryant, and (b) *Archeognathus primus* Cullison, a peculiar V-shaped element with tooth-like cusps along one margin, which comes from the Lower Ordovician Dutchtown formation of Missouri (Cullison, 1938, p. 227, pl. 29, fig. 16a,b; Miller, Cullison, and Youngquist, 1947, pl. 1). It is by no means certain, however, if any of these fossils really are of vertebrate origin (Ørvig, 1951, footnote 1, on p. 381). The *Eoichthys* plates, at any rate, which I had the opportunity to study in 1953 during my visit to the department of geology of Princeton University, Princeton, N. J., cannot possibly have belonged to any true chordate. According to Rhodes and Wingard (1957, p. 453), *Archeognathus primus* is, in several ways, reminiscent of the Neurodontiformes (the "fibrous conodonts" of previous writers). Whatever its affinities are, this fossil cannot possibly be a detached cornu of an early representative of the Osteostraci (as tentatively suggested by G. M. Robertson, 1954, p. 733).

Outside North America, pre-Silurian vertebrates are only known with certainty from the lower Ordovician Glauconitic Sand of Esthonia. From these beds Rohon (1889) has described small tooth-like fossiles belonging to two genera, *Palaeodus* and *Archodus*, which, by Russian paleoichthyologists, are nowadays referred to the Thelodontida (Obrutchev, 1948, p. 285; Bystrow, 1955, p. 473; Berg, 1955, p. 33; according to Denison, 1956, p. 367, they are indeterminable as to group). As will be shown in another connection (Ørvig, in MS., a), however, it is fully evident that *Palaeodus* represents broken-off tubercles from the exoskeleton of a form belonging to the Astraspida. That the Astraspida are met with not only in various places in the Cordilleran Region of the United States (Colorado, Wyoming, South Dakota, and Montana) but also in Northern Europe is a circumstance of some interest as it indicates that this ancient group of the Heterostraci may have had a worldwide distribution in Ordovician times.

Methods and materials: All of the specimens figured in this paper except two (figs. 1–3 of pl. 2 and figs. 1–4 of pl. 3) are contained in beds of Upper Ordovician age from the Rock Creek section on the eastern slope of the Bighorn Mountains. As far as can be judged from the limited material at my disposal, these beds are similar to the other vertebrate-bearing rocks from the Ordovician of North America in that they contain a thanatocoenotic assemblage of detached exoskeletal plates and scales, more or less fragmentary; however, no single specimen shows any of these elements in their natural association. The average size of the plates and scales is somewhat larger than that in the Harding Sandstone of Colorado and the sandstone and shale of the Winnipeg formation of the Williston Basin in Montana, and very small elements are missing altogether, a circumstance which probably indicates that the material has been sorted mechanically (by currents, etc.) prior to fossilization. The plates and scales have been abraded by rolling to some extent, but cannot, nevertheless, have been transported very far from their place of origin.

The state of preservation of the material is unusually favorable both for macroscopial and microscopical investigation. The plates and scales are easily freed of adhering sand-grains, e. g., by means of a sharp needle-scalpel, and the thin coat of reddish iron oxides which frequently obscures the fine details of their ornamentation can be removed, either with sodium hexametaphosphate or by boiling, for a very short time only, in a 10 percent solution of potassium hydroxide. The histological structure of the hard tissues is excellently displayed in those specimens which are light yellowish in color, but it has become obscured to some extent in those which are impregnated with iron oxides. For the preparation of exactly orientated thin sections, it is advantageous to embed the specimens in thin rods of acrylatic plastic by means of a bakelite press, according to the method recently described by the writer (Ørvig, 1957, p. 370).

The exoskeletal plates figured on plate 2, figures 1–3, and plate 3, figures 1–4, are from the gray, fissile shale of the Winnipeg formation of the Williston Basin (see, e. g., Ehlers, 1943, p. 1620; McCabe, 1954, p. 1998, fig. 10) contained in the drill core material from eastern Montana at my disposal. In this shale, which also exhibits phosphatic nodules, various invertebrate fossils such as lingulid shells, etc., and conodonts, the vertebrate remains are dark brownish or black. Their histological structure is frequently well preserved but is, in places, obscured by post-mortem changes caused by penetrative Algae or Fungi (see, e. g., Peyer, 1945; Bystrow, 1956).

It is worth mentioning here, finally, that the plates and scales of the Harding Sandstone—whose ornamentation is, in many cases, difficult to bring out satisfactorily by the ordinary methods of mechanical preparation—can be studied to great advantage on latex micro-moulds made from the impressions in the rock after the removal of the hard tissues with hydrochloric acid. A perfect reproduction of even very minute details of the ornamentation of those elements can be obtained by the method (described by Baird, 1955, p. 202; see also Gill, Caster, and Boswell, 1956, p. 198) of treating the etched surface of the sandstone with liquid detergent (e. g., Johnson

Wetting Agent 326) immediately before the first thin latex coat is applied.

All figured specimens belong to the U. S. National Museum. The technical work in connection with this paper has been carried out by members of the staff of the Swedish Museum of Natural History in Stockholm.

Acknowledgments: For their generosity in placing Ordovician vertebrate material from a series of localities in North America at my disposal, I wish to express my indebtedness to Drs. P. E. Cloud, Jr. and R. J. Ross, Jr., of the U. S. Geological Survey in Washington, D. C., and Denver, Colo., respectively, and to Drs. A. K. Miller and W. M. Furnish of the University of Iowa. My thanks also are due to Dr. D. H. Dunkle of the U. S. National Museum for his kind assistance in procuring the material and to Dr. Jean M. Berdan of the U. S. Geological Survey, Washington, D. C., for her information concerning the stratigraphy at the type locality of *Pycnaspis splendens*, new genus, new species.

Subclass PTERASPIDOMORPHI

Superorder HETEROSTRACI

Order ASTRASPIDA [3]

Pycnaspis, new genus

Diagnosis: A genus of the Astraspida of large size. Plates of the exoskeleton thick. Ornamentation in early stages of growth consisting of a shagreen of small tubercles exhibiting deep, radiating grooves on their crowns; in succeeding stages of growth consisting of stout, mushroom-like tubercles, smooth on top and ranging in outline from round to elongated or somewhat kidney-shaped. All tubercles consisting of an external layer of dentinous tissue and a basal portion of bone (aspidin) surrounding a "pulp" cavity. In tubercles belonging to early stages of growth the dentinous tissue is penetrated throughout its height by very fine canals originally housing cell-processes, and the aspidin is devoid of vascular canals issuing from the upper part of the "pulp" cavity. In tubercles of succeeding stages of growth the dentinous tissue in its basal part contains short, stemlike dentinal tubes which, in a superficial direction, rapidly subdivide into very fine ramifications, and the basal, bony portion is pierced by narrow, straight vascular canals radiating upwards and outwards from the roof of the "pulp" cavity and extending to about the boundary between the aspidin and the dentinous tissue.

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[3] New rank, from Astraspidae Eastman, 1917. Synonym: Astraspiformes Berg, 1940.

Type species: *Pycnaspis splendens*, new species.

Geological occurrence: Upper Ordovician: Upper part of the Bighorn formation, eastern slope of the Bighorn Mountains, Wyoming. Middle Ordovician: Whitewood formation, "Icebox" shale, Black Hills Region of South Dakota; Winnipeg formation of Williston Basin, Montana.

Remarks: The order Astraspida, comprising the genera *Palaeodus* Rohon, *Astraspis* Walcott, and *Pycnaspis*, new genus, has been defined in another connection (Ørvig, in MS., b). The diagnosis of *Pycnaspis* given here lists mainly such characters by which this genus is distinguishable from *Astraspis*.

The generic name is derived from the Greek πυκνός, thick, closely set, referring to the shape and distribution of the tubercles of the exoskeleton; and ἀσπις, shield.

Pycnaspis splendens, new species

Diagnosis: Same as for genus (single species).

Holotype: USNM 21333; detached exoskeletal plate, showing typical ornamentation (pl. 1, figs. 1, 2).

Locality and geological horizon: The holotype and the other material of *Pycnaspis splendens*, new genus, new species, dealt with here were collected in 1951 by Dr. Jean M. Berdan, of the U. S. Geological Survey, at the South Fork of Rock Creek, center, N½NE¼ SW¼SW¼, sec. 25, T. 52 N., R. 84 W., Johnson County, Wyo. (locality number USGS 1362–CO; see fig. 1 and Darton, 1906a, p. 28). According to personal communication by Dr. Berdan, there follows, at this locality, on top of the massive Bighorn dolomite: (a) red shales ("Red Bighorn") containing a rich fauna of Upper Ordovician invertebrate fossils which seems to correlate with the Maquoketa of Iowa, including, e. g., *Lepidocyclus perlamellosus* (Whitfield), *L.* cf. *rectangularis* Wang, *Sceptropora facula* Ulrich, and *Streptelasma trilobatum* Whiteaves (cf. also the fauna list in Darton, 1906a, p. 28); (b) red and green mottled calcareous siltstones and sandstones; and (c) an upper sandy layer with numerous Ostracoderm remains. The latter is directly overlaid by the Lower Carboniferous (Mississippian) Madison formation. By weathering, the fossiliferous shales above the Bighorn Dolomite disintegrate into soil, and in this soil the vertebrate material was found. Since, however, the plates and scales always are associated with remnants of a coarse-grained sandstone, there is every reason to believe that they did not originally belong to the red shales but are, in fact, derived from the beds above, in all probability from the topmost sandy layer underneath the Madison Limestone or, in other words, from the very youngest part of the Bighorn formation exposed in the Rock Creek section.

There has been some difference of opinion in recent years concerning the correlation of the Bighorn formation with Ordovician strata elsewhere in the United States (see, e. g., Twenhofel et al., 1954). According to what has been said above, however, there can be little doubt with regard to the dating of the red fossiliferous shale which, in the Rock Creek section, follows on top of the massive dolomite members of this formation. Despite the fact that their exact position in the section cannot, at the moment, be made out with certainty, it is clear that the plates and scales of *Pycnaspis splendens*, new genus, new species, are no older than these red shales and that, therefore, they are of an Upper Ordovician age. It is true that there are also outcrops of red vertebrate-bearing sandstone beds underneath the Bighorn Dolomite in the Rock Creek section similar to those further south in the same area (see E. Kirk, 1930, p. 462; Amsden and Miller, 1942, fig. 1) but, according to Dr. Berdan (in litt.), there is no evidence at this locality of tectonic movements of such an order as to bring these sandstone beds in contact with the upper part of the Bighorn formation.

Remarks: In the other material at my disposal, I have been able to identify some plates of *Pycnaspis* sp. indet., to some extent reminiscent of those of *Pycnaspis splendens*, new genus, new species, both in the sandstone and shale of the Winnipeg formation of the Williston Basin in Montana (pl. 2, figs. 1–3) and in a phosphatic conglomerate from the lower portion of the "Icebox" shale member of the Whitewood formation of the Black Hills region in South Dakota (Whitewood Creek section, near Deadwood). On the other hand, *Pycnaspis* plates and scales are missing altogether in all the numerous samples of the Harding Sandstone of Colorado which I have had the opportunity of examining in American and European museums, a circumstance which may be of some importance from the point of view of stratigraphy.

The specific name refers to the shining crown of the tubercles of the exoskeleton.

Description: In the material of *Pycnaspis splendens*, new genus, new species, one may distinguish thick exoskeletal plates and scales of mainly three different categories: (a) polygonal plates from the carapace; (b) ridge-scales, for the most part, at least, from the carapace; and (c) other scales probably belonging to the trunk behind the carapace. The polygonal plates and ridge-scales are in several respects rather reminiscent of those in the carapace of *Astraspis desiderata* (Ørvig, in MS., b), and everything goes to prove that they originally occupied much the same position in relation to each other as in the latter form. Thus, the ridge-scales very likely are detached components of a system of longitudinal crests extending, like in *Astras-*

pis, over the whole post-orbitopineal portion of the carapace (Eastman, 1917, p. 239, pl. 12, figs. 5, 6; Bryant, 1936, pp. 416–417, pl. 1; Ørvig, in MS., b), and possibly continuing backwards on to the trunk behind the carapace, and the polygonal plates probably formed a fairly regular pattern in the interspaces between the crests and anteriorly to them. On the other hand, there are no plates and scales in the material similar to those which, in *Astraspis*, exhibit shallow lateral line grooves on their external face (Ørvig, in MS., b; see also Walcott, 1892, pl. 4, fig. 1). If not purely coincidental, this circumstance may

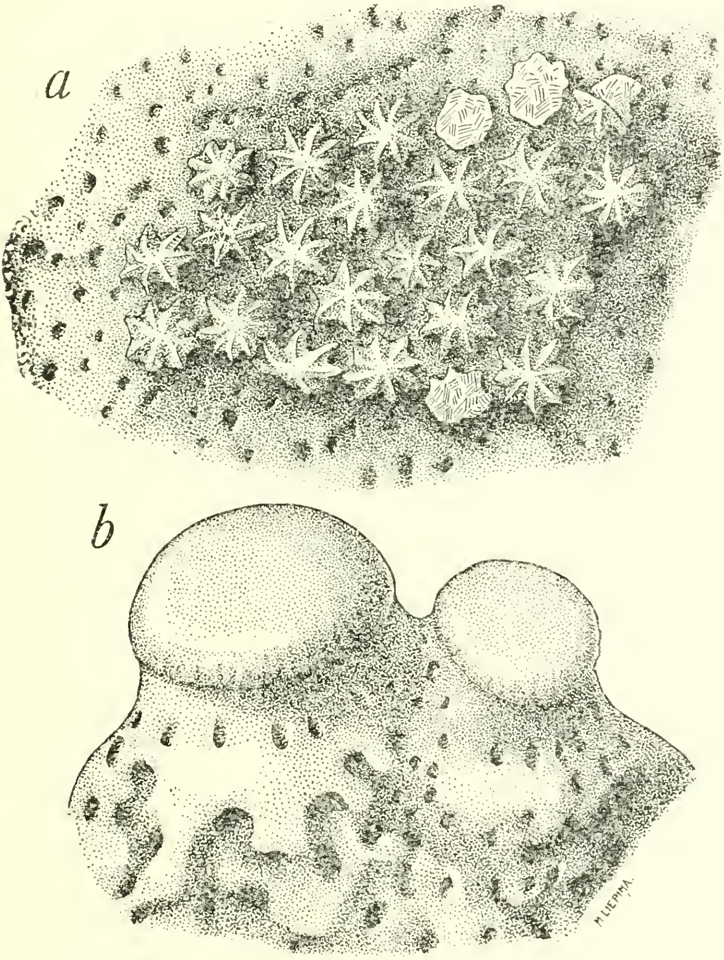

FIGURE 2.—*Pycnaspis splendens*, new genus, new species. Ornamentation of the exoskeleton: *a*, shagreen of small tubercles belonging to an early stage of growth, in superficial view (mainly after USNM 21334, ×30); *b*, large tubercles belonging to a late stage of growth, in oblique lateral view (USNM 21335, ×30).

either mean that the lateral line system was rather incompletely developed as compared with that in *Astraspis*, or, perhaps still more probable, that it was situated to a large extent in canals in the interior of the exoskeletal elements so that it was invisible in external view (cf. in the Eriptychiida, p. 18).

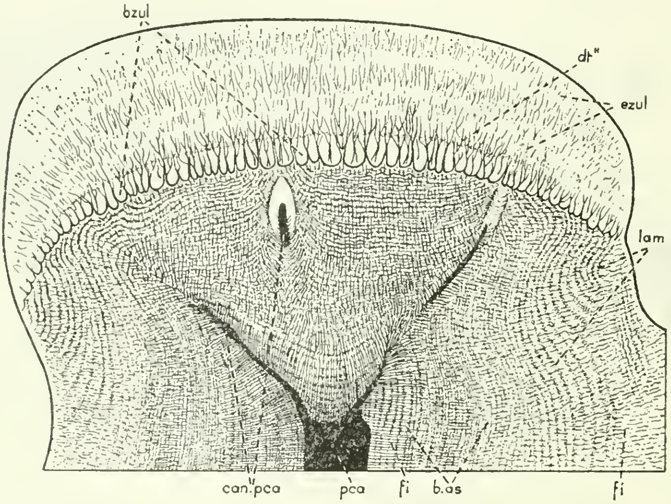

Figure 3.—*Pycnaspis splendens*, new genus, new species. Vertical section of a tubercle of the exoskeleton (section No. S 1477, from Ørvig, in MS., a; ×150). Explanation of symbols: *b.as*, aspidin; *bzul*, inner part of dentinous tissue; *can. pca*, vascular canals issuing from the upper part of the "pulp" cavity; *dt''*, fine ramifications of dentinal tubes; *ezul*, outer part of dentinous tissue; *fi*, fibers of Sharpey; *lam*, concentric lamellation of aspidin; *pca*, "pulp" cavity.

The polygonal plates of the carapace, which are most commonly met with in the material, are generally elongated rhomboid or more or less distinctly pentagonal in shape. They are often somewhat convex externally, but as far as I can find they are not raised upwards into a central cone-like prominence as frequently is the case in *Astraspis*. In some places they overlap each other to some extent, but as a rule they show no imbricating arrangement, being situated beside each other in much the same manner as the exoskeletal units, e. g., in the carapace of *Tesseraspis* (Wills, 1935), in the cephalic shield of certain late Osteostraci (Ørvig, in MS., a), and in the armor of various Ostraciontidae.

The ridge-scales, which are symmetrical, vary to some extent where their shape is concerned. Thus, some of them—which, judging by the condition in *Astraspis desiderata* (Ørvig, in MS., b), quite conceivably occupied a position in the anterior half, or thereabouts, of the longitudinal crests of the carapace—are longer than broad and have a truncated, or slightly rounded, posterior margin (pl. 1, figs. 3–6). Others, which probably were situated further backwards in the crests, are equally as long as broad, and their posterior margin is more or less obtusely V-shaped. In all the ridge-scales one may, just as in those of *Astraspis desiderata*, distinguish the following faces: (a) a convex external face, consisting of an anterior portion which slopes forwards and downwards and which is overlapped by the ridge-scale in front (od_a, pl. 1, figs. 3, 4), and a posterior, exposed portion ornamented with tubercles throughout its extent (pl. 1, figs. 3, 4); (b) a concave basal face having the appearance of a broad, longitudinal groove (*bf*, pl. 1, figs. 5, 6); (c) a concave posterior face overlapping the anterior portion of the external face of the ridge-scale following next behind (og_p, pl. 1, figs. 5, 6); and, finally, (d) a paired lateral face, a little concave and sometimes fairly low, overlapping the adjoining polygonal plates on each side (og_l, pl. 1, figs. 3, 5). As fully evidenced by their structure, the ridge-scales were firmly attached to each other. In the material at my disposal, however, there is no indication whatsoever that they tended to fuse with their fellows in the individual crests in the same manner as in *Astraspis desiderata* (Ørvig, in MS., b).

The scales presumably belonging to the trunk behind the carapace are far less common in the material than the polygonal plates of the carapace and the ridge-scales. They are more or less rhomboid in shape, frequently broader than long, and deeply imbricating. Their external face is made up of a large anterior overlapped portion and a fairly narrow posterior exposed portion ornamented with tubercles. Scales of this particular kind are, as far as I can find, not met with in the *Astraspis* material from the Harding Sandstone or from other formations.

The ornamentation of the plates and scales is subject to considerable variation. Some of the elements that are clearly preserved in early stages of growth show an immature type of ornamentation, made up of a shagreen of fairly small and low tubercles (fig. 2,*a*, cf. t_a, pl. 1, figs. 1, 2, 4), which in superficial view are rather similar to those on the exoskeleton of various Psammosteida and certain Osteostraci as well (see Obrutchev, 1956, pl. 1, fig. 4). These tubercles are highly reminiscent of those in *Astraspis* (fig. 4; Walcott, 1892, pl. 3, figs. 13, 14; Bryant, 1936, p. 418, pl. 2, fig. 2), and are, in fact, only distinguishable from the latter by the circumstance that, in the individual plates and scales, they are remarkably uniform in size and, as a rule, placed close beside each other with about equal interspaces. They consist of a bulbous crown, exhibiting deep grooves radiating in a basal direction from the apex, and a fairly low neck-portion which is somewhat constricted below the crown but otherwise not sharply defined from the latter.

In the great majority of the plates and scales, on the other hand, the early shagreen of starlike tubercles has, during subsequent stages of growth, been supplanted completely by another, mature type of ornamentation consisting only of thick, mushroom-like tubercles (fig. 2,*b*; t_b, pl. 1, figs. 1, 2, 4), frequently of large size, which are in several respects different from those on the exoskeleton of *Astraspis*. In top view the crown of these tubercles is rounded, elongated, or even somewhat kidney-shaped; it is always smooth and shining superficially, and at its basal circumference it is generally more or less crenulated. The neck-portion of the tubercles, which is always well developed, is a little constricted immediately below the crown, and is separated from the latter by a distinct nick. Contrary to what might be expected in view of the state of preservation of the material, the smoothness of the crown is certainly a primary condition. As in *Astraspis* (Bryant, 1936, p. 418, pl. 2, fig. 1), the tubercles were in certain cases subject to some post-mortem abrasion, but, as far as I can find, this cannot possibly account for the fact that in tubercles of different height, situated close together, and sometimes even partly superimposed on each other, the crown invariably shows the same smoothly rounded contour in vertical section.

In the material of *Pycnaspis splendens*, new genus, new species, at my disposal, at a rough estimate only 0.4 percent of the specimens (6 out of a total 1,500, or more) display both the immature and mature types of ornamentation simultaneously (e. g., the holotype, pl. 1, figs. 1, 2). If such specimens were lacking altogether—which might easily have happened in a less comprehensive material—one should no doubt refer the plates and scales, where the ornamentation is of the immature type (fig. 2,*a*), to another species and (in view of the microstructure of the tubercles, see below) probably even to another genus than those where it is of the mature kind only (fig. 2,*b*). It is true that, as far as one can tell, a correspondingly marked and abrupt change in the ornamentation of the exoskeleton with advancing age is not met with in any other representative of the Heterostraci and rarely, if ever, in placoderms and early teleostomians either (cf., e. g., in *Bothriolepis*, Stensiö, 1948, pp. 169–171, 376–386). But the condition of *Pycnaspis splendens*, new genus, new species, referred to above nevertheless shows that in dealing with early Paleozoic bone bed material from the taxonomic point of view one has, at least in certain cases, to allow for a considerable margin of error.

It is worthy of mention, finally, that the ornamentation of the plates and scales was subject to variation not only in different stages of growth but even to some extent in different parts of the body. Thus in the polygonal plates, which presumably lay mainly on the anterior portion of the carapace, all tubercles, large and small alike, rise straight upwards and are blunt on top (fig. 2,*b*, pl. 1, fig. 2). On the other hand, in the ridge-scales of the longitudinal crests and in the polygonal plates which probably occupied a position in the interspaces between these crests on the posterior portion of the carapace, the tubercles are inclined backwards (pl. 1, figs. 3, 4) and are frequently tapering to a point posteriorly. In *Astraspis desiderata* from the Harding Sandstone there is little or no indication of a smilar variation in the shape of the tubercles from one part of the carapace to another (Ørvig, in MS., b).

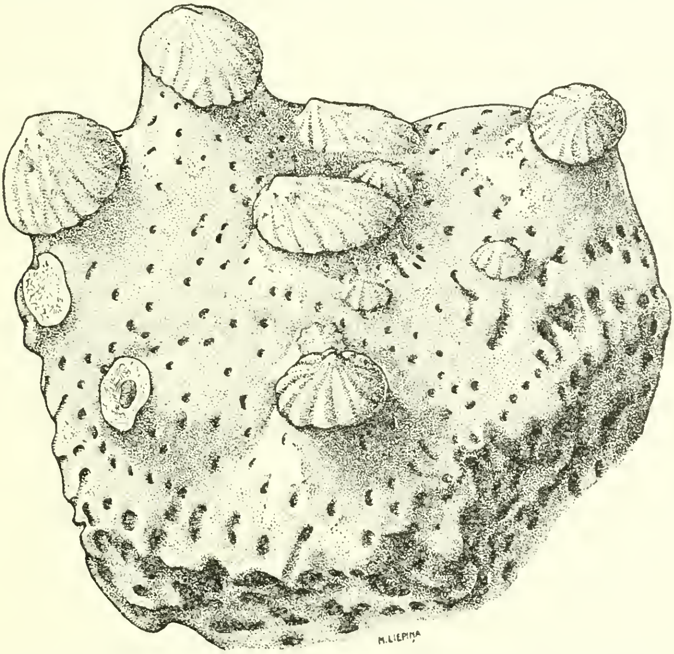

FIGURE 4.—*Astraspis?* sp. Large exoskeletal plate from the *Pycnaspis*-bearing beds of the Rock Creek section, in oblique lateral view. (USNM 21338; ×20.)

The plates and scales of the exoskeleton are all remarkably stout, with their average thickness being, as in *Astraspis* and *Eriptychius*, probably greater in relation to the size of the animals as a whole than in any of the geologically younger members of the Heterostraci. They are built up of three layers—a superficial tubercle-layer; a middle, vascular layer; and a basal layer. In their general proportions these layers correspond closely to the similar layers in the exoskeleton of *Astraspis* (Bryant, 1936, pp. 418–421, pl. 2, fig. 3).

The tubercles are made up of two, sharply defined, histological constituents: (a) a thick upper layer of compact, semitransparent, sometimes faintly bluish white substance (*ezul*, *bzul*, fig. 3) which, as I shall have the opportunity of showing in another connection (Ørvig, in

MS., a), is not enamel, nor in any way enamel-like, but clearly a special variety of dentinous tissue (mesodentine); and (b) a lower part of typical aspidin which forms thick walls around a basal, "pulp" cavity (*b.as*, *pca*, fig. 3). In the tubercles of early stages of growth, the upper layer is, just as in *Astraspis* (Ørvig, in MS., a), devoid of real dentinal tubes similar to those in dentine proper (e. g., in the tubercles and ridges of the exoskeleton in *Eriptychius* and post-Ordovician Heterostraci in general), but it is, however, pierced throughout its height by numerous very fine canals which correspond, in a broad sense, to delicate ramifications of such tubes. In the tubercles of consecutive stages of growth, on the other hand, this layer is to some extent suggestive of the dentinous tissues in the exoskeleton of various early Osteostraci (Ørvig, in MS., a) in that it consists of a thick outer part with the same fine canals as those just referred to (*ezul*, fig. 3), and, in addition, of a thin, inner part containing a system of short, stemlike dentinal tubes or, in some cases, elongated cell-spaces, from which these fine canals issue in a superficial direction (*bzul*, *dt''*, fig. 3). A similar inner part of the dentinous tissue, exhibiting dentinal tubes or cell-spaces, is absent altogether in all tubercles of the exoskeleton in *Astraspis*.

The aspidin in the lower part of the tubercles is perfectly similar histologically to that in the middle and basal layers of the plates and scales. As in *Astraspis*, it is penetrated by fine fibers of Sharpey radiating from the "pulp" cavity (Bryant, 1936, p. 419, pl. 3; pl. 4, fig. 2; pl. 7, fig. 2; Gross, 1954, p. 80, pl. 3, fig. 2; pl. 5, figs. 3, 4). In the tubercles of early stages of growth this cavity is always undivided and completely separated from the upper dentinous tissue by the thick layer of aspidin which forms its roof (see Gross, 1954, pl. 5, figs. 3, 4). In the tubercles of subsequent stages of growth, however, a system of fairly thin, straight vascular canals issue in a radiating manner from the upper part of the "pulp" cavity, terminating close beneath and sometimes almost at the boundary between the aspidin and the outer dentinous tissue (*can.pca*, fig. 3). This system of vascular canals has no connection whatever with the short dentinal tubes or cell-spaces in the inner part of the dentinous tissue. A similar canal system is not developed in the tubercles in *Astraspis*, but may possibly have existed in the predecessors of that form (Ørvig, in MS., a).

The nature of the hard tissues of the tubercles will be dealt with elsewhere (Ørvig, in MS., a) and will not be commented upon further here. Of interest to us in the present connection is above all the fact that, by their microstructure, the tubercles of early stages of growth invariably are sharply distinguishable from those of subsequent stages of growth (clearly shown, e. g., by sections prepared of specimens exhibiting simultaneously both the immature and mature types of ornamentation). This is surprising in view of the condition of the exoskeleton in a great many other lower vertebrates where the dentine tubercles belonging to consecutive generations certainly may show varying degrees of complexity and hence may differ to some extent from each other (see, e. g., Ørvig, 1957, p. 388), but nevertheless are always basically similar in their histological structure.

The middle, vascular layer is thick, and its vascular canals are irregularly distributed except in some of the polygonal plates of the carapace where they may, occasionally, show a more or less distinct "transsutural" arrangement near the marginal faces (see Delpey, 1942, pp. 52–53; Ørvig, in MS., a). Ontogenetically this layer arose as a system of thin, bony trabeculae separated by fairly wide vascular spaces, but later on it became rather compact (more so, in fact, than the corresponding layer of the exoskeleton in most post-Ordovician Heterostraci) by the deposition of thick-walled primary osteons on the margins of the trabecles. The osteons, which are perfectly similar to those in *Astraspis* (Bryant, 1936, pl. 6, pl. 7, fig. 1; Ørvig, 1951, pl. 3, figs. 3, 4) and to those in various Psammosteids as well (Gross, 1954, pl. 5, fig. 11), are penetrated by fine fibers of Sharpey radiating from the vascular canals.

The basal layer was somewhat thin in early ontogenetic stages, but subsequently it increased considerably in thickness by the apposition of new aspidin lamellae on its inner side. As far as one can judge, it is not continuous basally with layers of perichondral bone. As in *Astraspis* and *Eriptychius* (fig. 5, *b*; see Bryant, 1936, pp. 421, 425, pl. 2, fig. 3; pl. 13, fig. 1), but contrary to the case in all Silurian and Devonian Heterostraci, it is penetrated throughout its extent by a great many vascular canals, ascending with about equal interspaces from the subcutaneous (subaponeurotic) vascular plexus beneath the exoskeleton. The presence of this system of ascending vascular canals, whose more or less funnel-like openings are spread all over the basal face of the plates and scales (pl. 1, fig. 5; Bryant, 1936, pl. 5, fig. 2), is no doubt a primitive condition (Ørvig, in MS., a).

It is worthy of mention that the *Pycnaspis* plates from the Winnipeg formation of the Williston Basin in Montana and the Whitewood formation in South Dakota referred to above (p. 8) exhibit stout, mushroom-like tubercles which in shape and microstructure are similar to those belonging to mature stages of growth in *Pycnaspis splendens*, new genus, new species (pl. 2, figs. 1–3). These plates are undoubtedly referable to *Pycnaspis*, new genus, but for the time being, at least, they cannot be determined as to species.

Other vertebrates

The great majority (at least 75 percent) of the plates and scales in the material from the Rock Creek locality at my disposal belongs to *Pycnaspis splendens*, new genus, new species, but there are also several (about 20 percent) referable to the Eriptychiida, probably to a new genus of this group, and some few to *Astraspis*? sp. In addition, the fauna may also include exoskeletal elements of other forms whose systematic position is at present indeterminable. On the other hand, the *Pycnaspis*-bearing beds do not seem to contain pieces of bone tissue with cell-spaces or pieces of globular calcified cartilage, like those met with in the Harding Sandstone of Colorado (Ørvig, 1951, p. 381, fig. 18A) and the Winnipeg formation of the Williston Basin in Montana. To what extent those beds are devoid of other microfossils, such as lingulid shells, conodonts, etc., cannot be decided with any certainty on the basis of the limited material dealt with here.

The plates belonging to *Astraspis*? sp. (fig. 4) are of approximately the same order of size as those of *Pycnaspis splendens*, new genus, new species, with the mature type of ornamentation, but clearly distinguishable from the latter by the shape and microstructure of their tubercles (fig. 2,*b*, pl. 1, figs. 1–4; cf. also pl. 2, figs. 1–3). These tubercles, which vary considerably in size, all consist of a pointed crown with deep, radiating grooves, and a conical neck-portion, which is frequently comparatively high. In their microstructure, they are similar to those in *Astrapis desiderata* (Bryant, 1936, pp. 418–420, pl. 2, fig. 3; pls. 3, 4; pl. 5, figs. 1, 3; Ørvig, 1951, fig. 22B; in MS., a; Gross, 1954, pl. 3, fig. 2; pl. 5, figs. 3, 4) and those belonging to early stages of growth in *Pycnaspis splendens*, new genus, new species.

Most of the material of Eriptychiida gen. and sp. indet. comprises fragments of plates, frequently of large size, whose ornamentation consists of fairly low and broad tubercles. These tubercules (fig. 5,*a*)—which as a rule are considerably coarser than those of the *Eriptychius* plates from the Harding Sandstone of Colorado (Walcott, 1892, pl. 4, figs. 8, 9; Bryant, 1936, pl. 8, fig. 1) and the Winnipeg formation of the Williston Basin in Montana (Ørvig, in MS., a)—are fairly low, elongated pearshaped or irregular in outline, and smooth on top; they have no well-defined neckportion and they are frequently arranged in more or less distinct rows (pl. 2, figs. 4, 5, 7). As in *Eriptychius* (fig. 5,*b*,*c*; Bryant, 1936, pl. 11) and in the post-Ordovician Heterostraci in general, these tubercles consist entirely of ordinary dentine. In their basal part, there is no large pulp cavity but a system of vascular canals from which the dentinal tubes issue in a superficial direction (for further details concerning the microstructure, see Ørvig, in MS., a). In only one of the plates is the position in the cuirass of the living animal determinable with any degree of certainty. This specimen, which is particularly large and well preserved, in all probability represents a branchio-cornual plate, unknown so far in any of the pre-Silurian Heterostraci (pl. 2, figs. 4–7). A second specimen, which may

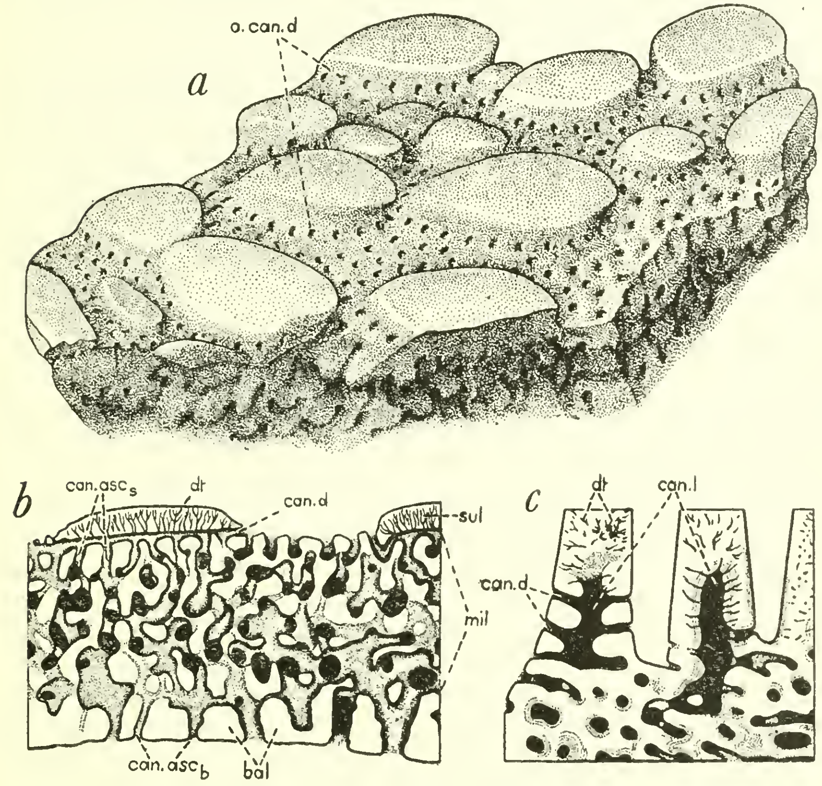

FIGURE 5.—*a*, *Eriptychiida* gen. and sp. indet.: Ornamentation of a plate-fragment from the *Pycnaspis*-bearing beds of the Rock Creek section, in oblique lateral view (mainly after USNM 21339, ×36). *b*, *c*, *Eriptychius* sp., Winnipeg formation, Williston Basin, Mont., sections of scales (from Ørvig, in MS, a): *b*, Vertical section showing the dentine ridges of the external face (cut somewhat obliquely to their axes of length), the middle, vascular layer, and the basal layer (section No. S 1438; ×36); *c*, horizontal section of the dentine ridges and the adjoining part of the middle, vascular layer (section No. S 1454; ×36). Explanation of symbols: *bal*, basal layer of the scales; *can.asc*$_b$, ascending vascular canals piercing the basal layer; *can.asc*$_s$, vascular canals in the upper part of the middle layer of the scales, ascending towards the dentine ridges; *can.d*, short vascular canals extending outwards in the basal part of the dentine ridges and opening to the exterior at the basal circumference of those ridges; *can.l*, longitudinal vascular canals in the basal part of the dentine ridges; *dt*, dentinal tubes; *mil*, middle, vascular layer of the scales; *o.can.d*, the openings of vascular canals at the basal circumference of the dentine ridges; *sul*, superficial layers of the scales.

well be the broken-off anterior part of another branchio-cornual plate, shows a wide canal in its interior that may, perhaps, be a lateral line canal (*llc*?, pl. 2, fig. 8). If this interpretation is correct, there may be some reason to believe that in the Eriptychiida the lateral line system had no such superficial position as in *Astraspis* (Ørvig, in MS., b), but that, like in several younger Heterostraci, it lay partly, or entirely, in the middle, vascular layer of the exoskeleton.

Apart from the plates dealt with here, the material of Eriptychiida gen. and sp. indet. from the *Pycnaspis*-bearing beds also includes a certain amount of scales of much the same kind as those of *Eriptychius americanus* from the Harding Sandstone of Colorado (Walcott, 1892, pl. 4, figs. 5, 6, 11; Bryant, 1936, pp. 423–424, pl. 8, fig. 2; pl. 9, fig. 2) and *Eriptychius* spp. from the Winnipeg formation of the Williston Basin in Montana and the Whitewood formation of South Dakota. These scales, which vary somewhat in size, consist of an anterior overlapped portion without ornamentation and a posterior exposed portion exhibiting a system of roughly parallel dentine ridges. As in the scales of *Eriptychius* from the Harding Sandstone and other formations, the dentine ridges are highly reminiscent of those of the exoskeleton in the Cyathaspida and Pteraspida (see Lindström, 1895, fig. 2; Kiær and Heintz, 1935, pl. 37; Gross, 1935, fig. 5c; and others) in that they contain, in their basal part, a longitudinal vascular canal from which a series of short vascular canals issue with fairly regular interspaces to both sides (*can.l*, *can.d*, fig. 5,*b*,*c;* concerning this canal system see also Ørvig in MS., a). In the material from the *Pycnaspis*-bearing beds there are also a few scales of large size ornamented with fairly coarse tubercles (pl. 3, figs. 5, 6) that are to some extent suggestive of the median dorsal and median ventral ridge-scales of the trunk in several post-Ordovician Heterostraci, e. g. the Cyathaspida, Pteraspida, and Psammosteida (see Kiær and Heintz, 1935, figs. 41–44, *md* and *mv* of fig. 50; White, 1935, figs. 1, 2, 63, 65; Obrutchev, 1945, figs. 2–5; and others). As far as one can tell at present, scales of this particular kind are not met with in the *Eriptychius* material from the Harding Sandstone of Colorado and the Winnipeg formation of the Williston Basin in Montana.

Discussion

There is surely reason to believe that, as they become better known, the Ordovician vertebrates of North America will prove highly useful for correlation purposes, but up to now there has been very little information in the literature as regards their stratigraphical distribution. It may be of some interest in this respect that, according to what has been said in this paper, one may now distinguish two different vertebrate faunas in the Ordovician of the Cordilleran Region, one in the Harding Sandstone of Colorado and another in the *Pycnaspis*-bearing beds of the Bighorn Mountains of Wyoming. In addition, there is probably also a third vertebrate fauna—intermediary, to some extent at least, between the other two—in the material at my disposal from the Winnipeg formation of the Williston Basin in Montana. The latter material has not yet been investigated in detail, but a preliminary examination has shown that it includes plates and scales of *Eriptychius* sp. (possibly a new species), *Astraspis* sp., *Pycnaspis* sp. indet. (see p. 8 and pl. 2, figs. 1–3) and surely also of other forms at present indeterminable as to genus. A particularly interesting specimen from this material is a large, keel-like plate, ornamented on its external face with a system of broad, inosculating dentine ridges (pl. 3, figs. 1–4); it may, perhaps, belong to a new representative of the Eriptychiida.

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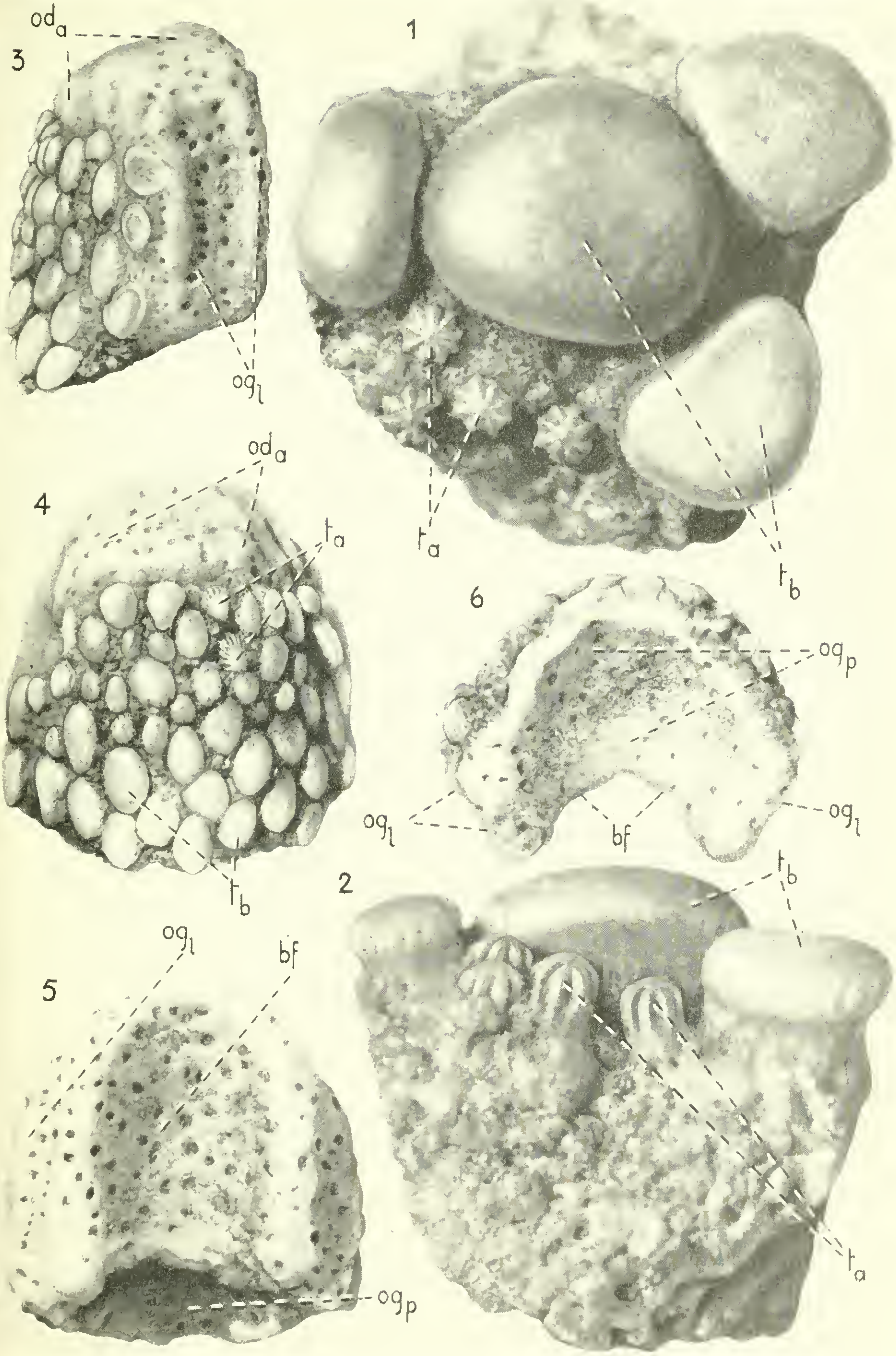
PLATES 1–3

Plate 1

Pycnaspis splendens, new genus, new species. 1, 2, USNM 21333, holotype, from Upper Ordovician, Rock Creek section, Johnson County, Wyo.: 1, detached exoskeletal plate, somewhat incomplete, showing tubercles of early and subsequent stages of growth, superficial view; 2, same, oblique lateral view. 3–6, USNM 21336, from same layer and locality as the holotype, detached ridge-scale oriented (3–5) with its anterior margin upwards: 3, lateral view; 4, external view; 5, basal view; 6, posterior view. Magnification: 1, 2, × 32; 3–6, × 24. Explanation of symbols: *bf*, basal face; od_a, anterior portion of external face, overlapped by the ridge-scale in front; og_l, lateral faces, overlapping adjoining polygonal plates; og_p, posterior face, overlapping the ridge-scale following next behind; t_a, tubercles belonging to early stages of growth; t_b, tubercles belonging to subsequent stages of growth.



Pycnaspis splendens, new genus, new species. Explanation on facing page.

PLATE 2

1–3, *Pycnaspis* sp. indet. USNM 21337 from Middle Ordovician, Winnipeg formation, Shell Pine Unit No. 1 core, depth 9525–9531 feet, sec. 30, T. 12 N., R. 57 E., Wibaux County, Mont.: 1, detached exoskeletal plate, somewhat incomplete, external view; 2, 3, same, lateral views from opposite sides.

4–8, *Eriptychiida* gen. and sp. indet. 4–7, USNM 21340, branchio-cornual plate from the same layer and locality as the holotype of *Pycnaspis splendens*, new genus, new species: 4, lateral view; 5, ventrolateral view; 6, posterolateral view; 7, medial view, showing the basal face of the plate after removal of the matrix. 8, USNM 21341, fragment, possibly of another branchio-cornual plate, from the same layer and locality as the foregoing; a short wide canal in the interior of the plate, which may be a lateral line canal, is shown on the broken-off surface.

Magnification: 1–3, × 12; 4–7, × 2.4; 8, × 4. Explanation of symbols: *br. o*, branchial opening; *llc?*, possibly a lateral line canal.

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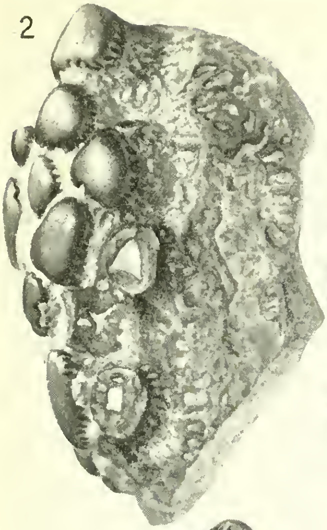

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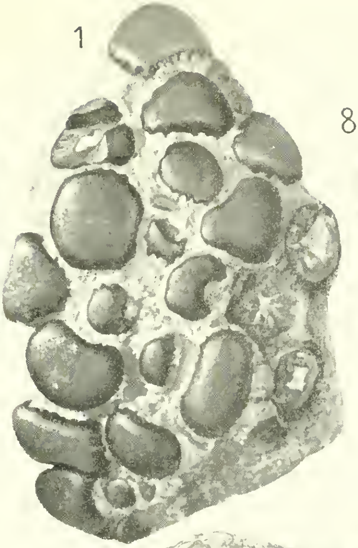

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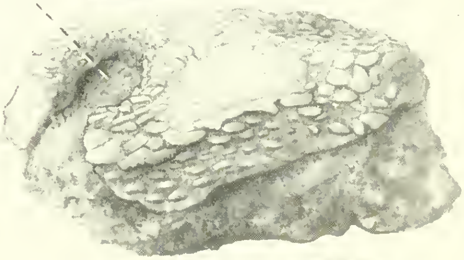

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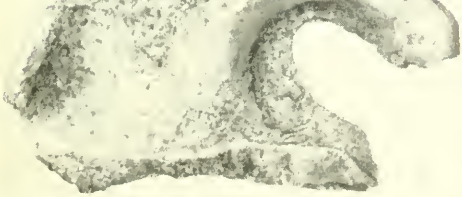

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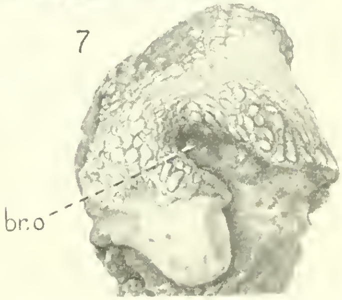

Pycnaspis sp. indet. and *Eriptychiida* gen. and sp. indet. Explanation on facing page.

PLATE 3

Eriptychiida gen. and sp. indet. 1–4, USNM 21342, a detached keel-like plate, presumably belonging to a new genus of the Eriptychiida, from the same core and the same depth as the *Pycnaspis* specimen shown in figures 1–3 of plate 2: 1, external view; 2, 3, lateral views from opposite sides; 4, basal view. 5, 6, USNM 21818, a detached ridge-scale, somewhat incomplete, from the same layer and locality as the holotype of *Pycnaspis splendens*, new genus, new species: 5, external view; 6, anterior view. Magnification: 1–4, × 7; 5, 6, × 6.5.

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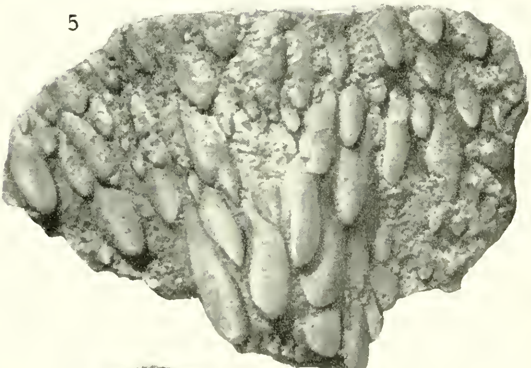

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Eriptychiida gen. and sp. indet. Explanation on facing page.

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BRANCHINECTA CORNIGERA, A NEW SPECIES OF ANOSTRACAN PHYLLOPOD FROM THE STATE OF WASHINGTON

By James E. Lynch[1]

The fairy shrimp described below has been repeatedly collected by the writer since 1935 from numerous ephemeral fresh-water ponds in eastern Washington. The data in the specific diagnosis are based on measurements of ten apparently full-grown individuals of each sex. The specific name, *cornigera*, refers to the dorsolateral protuberances on the head of the female, which remind one of incipient horns.

Genus *Branchinecta* Verrill, 1869

Branchinecta cornigera, new species

Specific diagnosis: *Male:* Total length, from front to end of shaft of cercopods, 29 (25–36.5) mm. Average ratio of length of head and thorax to genital segments, abdomen, and cercopods 1 :1.3. Nuchal organ transversely oblong with rounded corners on top of head. Compound eye in lateral view slightly flattened dorsoventrally, 0.9 (0.75–1.05) mm. by 1 (0.95–1.2) mm. Antennule 2.6 (2–3) mm. long, terminated by three setae and eight aesthetascs. Antenna biarticulate, 7 (6–8) mm. long, extending back to the level of the fifth or sixth thoracic segment if flexed posteriorly. Proximal article 4.5

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[1] School of Fisheries, University of Washington, Seattle, Wash.

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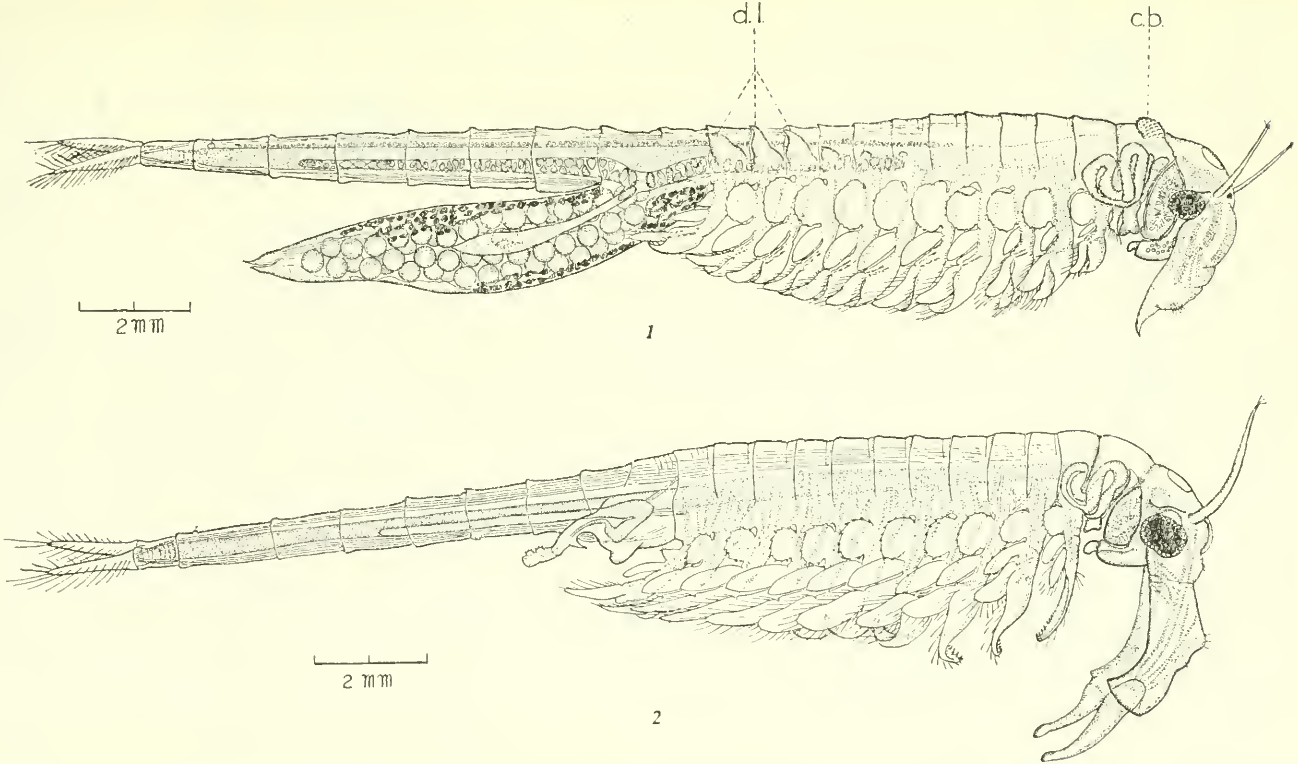
(4–5) mm. long, without apophysis; near its junction with the head an anteromedian bulging area (pulvillus) bearing minute spinules 7–10 microns long; a padlike area of cuticular verrucae on the medioanterior and anteromedian sides of its lower half, with a prominent, uncornified, anterior protuberance near the proximal end of the verrucose area. The proximal article presents a more or less prominent geniculate bend as seen in lateral view, with the uncornified bulge at the angle of the bend. Distal article of the antenna 2.5 (2–3) mm. long, somewhat flattened laterally, curving gently inward to a pointed tip with a roughened area. Thoracic appendages typical of the genus; branchial lamina entire with serrated margins; endopodite produced medially, the heavy spines of the distal end and median border thickly beset on all sides with distally directed spinules. Second genital segment with a pair of hollow eminences on ventral side. The penes bear each a chitinized spur 0.26 (0.22–0.31) mm. high near the tip of the rigid portion; the retractile portions when fully protruded present two distal lobes, each with 6 to 10 pyramidal teeth. Cercopods 2.3 (2–2.75) mm. long, distinctly articulated to the telson, with long, plumose hairs on both lateral and median margins.

Female: Total length, from front to end of cercopods, 29 (21.5–33.5) mm. Average ratio of length of head and thorax to genital segments, abdomen, and cercopods 1:1.48. Transversely oblong nuchal organ on top of head. A retrorse, papillose protuberance, rising 0.35–0.55 mm. above the surface, is located on each side of the head dorsal to the mandibular articulation. Compound eye in lateral view slightly flattened dorsoventrally, 0.62 (0.6–0.7) mm. by 0.76 (0.6–0.85) mm. Antennule 1.8 (1.5–2.5) mm. long, terminated by three setae and eight aesthetascs. Antenna 3 (2.2–3.5) mm. long, cylindrical, with a median spur 0.18–0.35 mm. long at the junction of the middle and distal thirds, distal to which the antenna tapers to a sharp, incurved point. Thoracic segments 6 to 11 each with a right and left dorsolateral, conical protuberance, of which the last four, only, are large enough to be conspicuous. The largest protuberance, 0.5 to 0.9 mm. high, usually on segment 10, occasionally on segment 11. Ovisac fusiform, extending backward for the length of 4.75 (4.3–5.8) abdominal segments; may contain up to 416 eggs. Eggs from preserved specimens 0.29–0.34 mm. in diameter. Cement glands consist of two closely appressed masses of large cells at anterior end of ovisac; from each mass a row of cells extends for from 65 percent to 80 percent of the length of the ovisac on its dorsal side and widens at its posterior end, and similar rows of cells extend posteriorly along the midventral line for about half the length of the ovisac, without the posterior expansion. Shaft of cercopods 2.2 (1.9–2.8) mm. long, with long plumose setae on lateral and median borders.



Figures 1 and 2: *Branchinecta cornigera*, new species. 1, Female 20 mm. long (d.l., dorsalateral lobes on side of thorax; c.b., corneous protuberance on lateral side of head); cement glands are depicted in solid black. 2, Male 20.4 mm. long. (Both × 7.5.)

Smallest specimens which obviously were sexually mature were females 11 mm. long with one or two eggs in the ovisac and males 12 mm. long. In small females, 11–12.5 mm. long, the ovisac is relatively shorter than in full-grown ones, extending only the length of 2½ to 3½ abdominal segments.

Type locality: A pond in Lincoln County, Wash., about 8½ miles southeast of Creston, and about 50 yards north of U. S. Highway 2. Elevation about 2,400 ft. above sea level.

Type specimens: One male holotype (USNM 100912) and 8 male and 8 female paratypes (USNM 100913) have been deposited in the U. S. National Museum.

Differentiating characters: *Male:* The clasping antenna of the male has an extensive verrucose area on its anteromedian and medioanterior sides and a prominent rounded bulge near the upper part of the verrucose area. The proximal article is more or less pronouncedly geniculate in lateral view. The degree of geniculation varies with muscular contractions, but is constant enough to constitute a specific character.

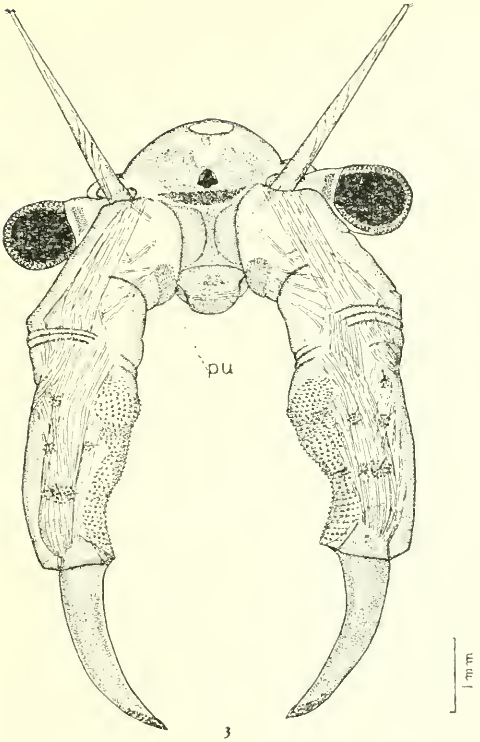
Female: The second antenna of the female, near the junction of the middle and terminal thirds, has a medially directed spur, distal to which the antenna tapers to an inwardly curved point. No North American species described to date has this feature, although it occurs in the South American *Br. pollicifera* Harding, 1940.

The female has a pair of conspicuous papillose protuberances on the dorsolateral sides of the head. This hornlike outgrowth is either absent or rudimentary on other North American species, and has not been recorded from exotic species.

Dorsolateral lobes, of conical shape, occur from thoracic segment 6 or 7 to segment 11, that on segment 10, or sometimes on segment 11, being the largest. Other species lack such lobes, or have them differing as to number, or arranged in different sequences as to size.

Color of living specimens: *Br. cornigera,* new species, is more brightly colored than most species of the genus in western North America. The females are more brightly colored than the males, and their coloration is less variable. Indeed, the variation in shade and intensity of color of the males is so great that it is difficult to describe their colors adequately or briefly.

Male: The over-all color varies from a burnt orange to a pale greenish or gray-green; occasionally they are almost colorless except for the greenish head and pale green appendages. The antennule is pale yellow, the basal article of the clasping antenna may be dark blue-green, yellow-green, or nearly colorless; the distal article yellow to orange with greenish punctations on the lateral side, and gray on the roughened area near the tip. The front and top of the head are



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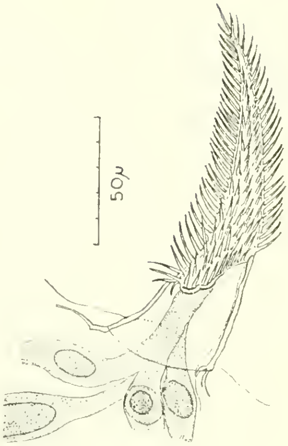

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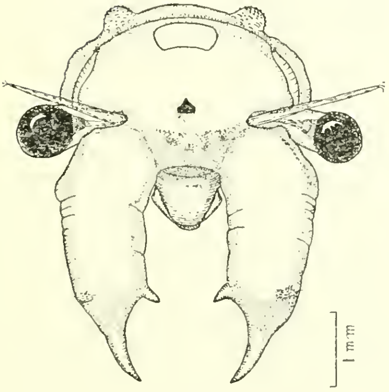

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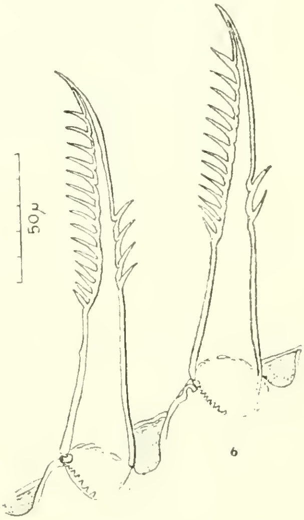

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Figures 3–6: *Branchinecta cornigera*, new species. 3, Anterior aspect of head, male (pu, pulvillus). 4, Same, female. 5, Spine from median border of endopodite of thoracic appendage of a male. 6, Spines from median border of thoracic appendage of a female. (3, 4, × 10; 5, 6, × 340.)

often yellow, but with scattered punctations of green. There is a large bluish spot on the front on each side of the ocellus. The peduncle of the eye is yellow, the corneal portion black. The dorsal side of the thorax is grayish, grayish green, or sometimes faint orange, or colorless. The anterior third of the intestine, as seen through the body wall, is yellow; the posterior two-thirds is black from accumulated food residues.

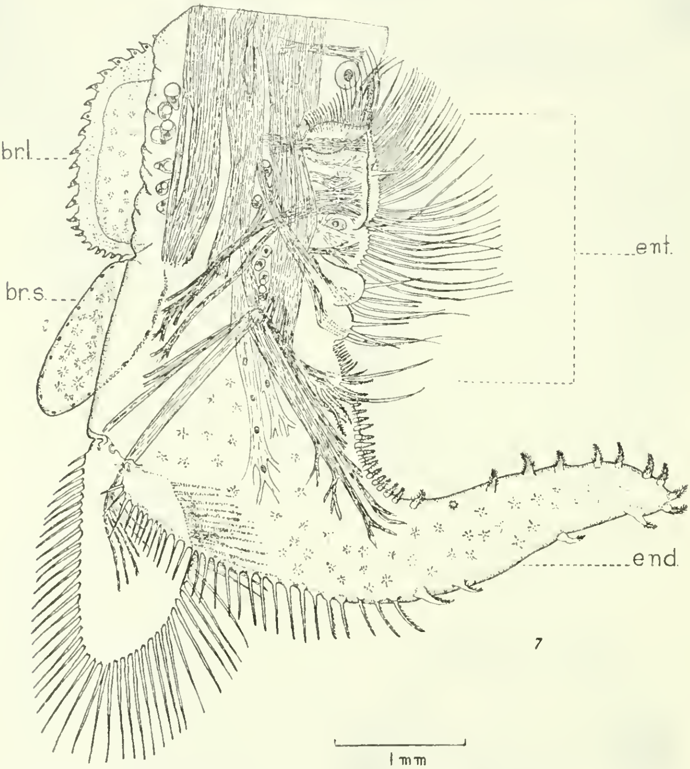

FIGURE 7: Right fifth thoracic appendage of a male, anterior aspect (br.l., branchial lamina; br.s., branchial sac; ent., endites; end., endopodite). (× 18.) See note, figure 8.

The axis or corm of the appendages is pale green, blue-green, or orange-yellow, and contains numerous large cells with colorless, yellow, or orange oil globules. These cells range upward on the sides of the thorax between the appendicular muscles, thus tinting the lower half of the thorax yellowish. The branchial lamina and gill are colorless; the exopodite and endopodite nearly colorless to pale green or dark yellow; the endites pale green bordered with yellow.

The dorsal and lateral sides of the genital segments are like adjacent parts of the abdomen and are nearly colorless; the ventral sides are colorless or yellow. The spur, and border of the penis anterior to it, are dark yellow. The abdomen may be colorless, except for the black, food-packed intestine, but often is pale gray-green or grayish yellow. Cercopods are colorless, to yellow, orange-yellow, or pinkish.

Female: The antennule is colorless to pale yellow or salmon-pink. The antenna is yellow with a greenish wash, or green with a yellow tip. The top of the head is faint blue-green, but often the entire head appears yellow from the yellow digestive caeca. The "horns" on the side of the head may be yellow, blue, or blue-gray. The corneal part of the eye is black. The labrum is greenish, spotted with blue, and may contain large, brownish, internal cells visible through the integument. The dorsal side of the thorax may be colorless, whitish, or faint green; the dorsolateral lobes colorless to faint yellow. The anterior third of the intestine, as seen through the body wall, is yellow to pink; the posterior two-thirds is black with contained food residues. The lateral sides of the thorax, above the appendages, are blue; the blue extends further dorsally in the last four segments. The blue color is

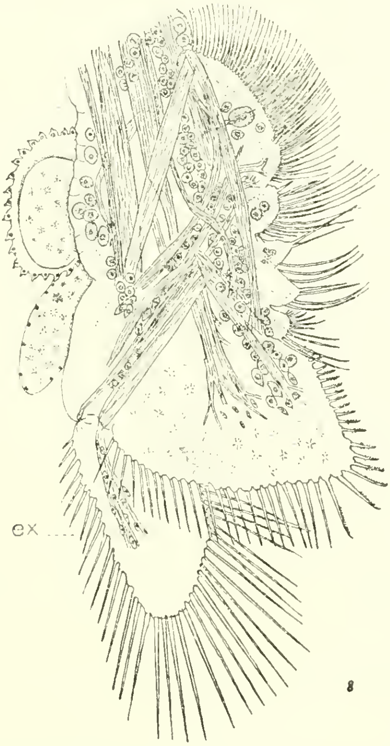

FIGURE 8: Right fifth thoracic appendage of a female, anterior aspect (ex., exopodite). (× 18.) Note: No attempt has been made to represent the setules of the plumose setae which fringe the thoracic appendages. On the ventral border of the endopodite the plumose setae gradually become thicker and assume the character of spines, with spinules replacing the setules.

caused by large, vividly blue cells which occur among the appendicular muscles, and also as a layer applied to the dorsal side of the intestine throughout its length, and to the ventral side in the thoracic region. The axis, or corm, of the appendages is colorless or pale green, sometimes contains blue cells, and in addition has large cells, less numerous than in the male, with yellow, orange, or brown oil globules. Endites, exites, and endopodite and exopodite are colored as in the male.

The ovary appears yellowish white to light blue, depending on the stage of development of the large oöcytes, and can be plainly discerned through the body wall from the fourth or third abdominal segment to the eighth or seventh thoracic segment.

The color pattern of the ovisac is characteristic of the species. The proximal third of its wall is colorless to pale yellow; the middle third yellow, orange, or pinkish yellow; about two-thirds of the posterior third is bright blue, and the tip, about 12½ percent of the total length, is white or faintly blue. In the case of living females, the species can be easily recognized by a conspicuous blue area, which can be seen by the unaided eye, on the posterior half of the ovisac.

The cement glands appear brownish yellow to pale brown under low magnification, and have a characteristic arrangement. Eggs, within the ovisac, vary from dull yellow to yellow-brown.

The walls of the abdomen are nearly colorless except for the black intestine and the conspicuous layer of blue cells along the dorsal side of the intestine.

The cercopods are colorless in most, but sometimes are pale yellow, pale orange, or colorless with yellow or pinkish yellow borders.

Discussion: The number and arrangement of the dorsolateral lobes on the thorax of the female is probably a good specific character in many species of *Branchinecta.* In fact, they are conspicuous in size, shape, and arrangement in many species of other genera, but have rarely been mentioned or depicted in taxonomic descriptions. They have been present in every specimen of *Br. cornigera,* new species, and also in every specimen of *Br. packardi* Pearse and *Br. lindahli* Packard (as revised by Shantz)[2] that I have examined. In *Br. coloradensis* Packard (as revised by Shantz)[2] and in *Br. paludosa* (O. F. Müller) they are conspicuous in populations from some localities and absent in those from other localities.

Other characters of some taxonomic value are the pulvillus and the dorsolateral bosses. The pulvillus, or swollen area on the median side of the basal article of the antenna of the male near its junction with the head, is present and conspicuous in some species of *Branchinecta* and absent, or barely represented, in others. When present, it is covered with minute spinules, verrucae, or denticles

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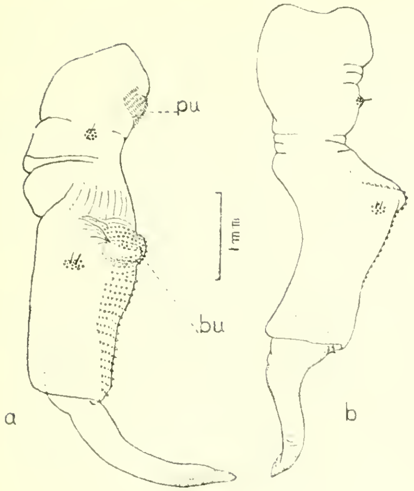
[2] See under heading of "Remarks," page 34.



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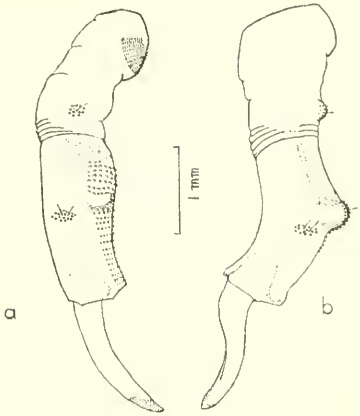

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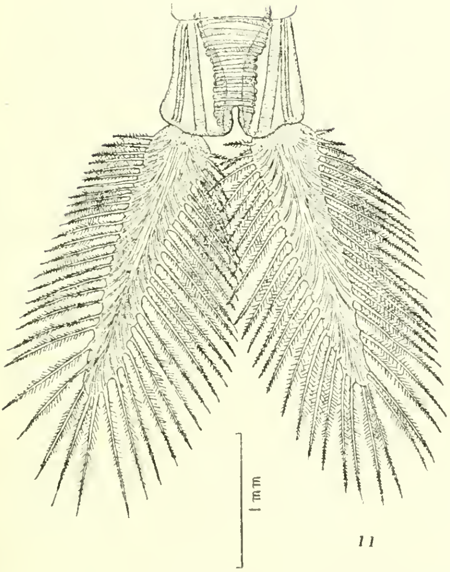

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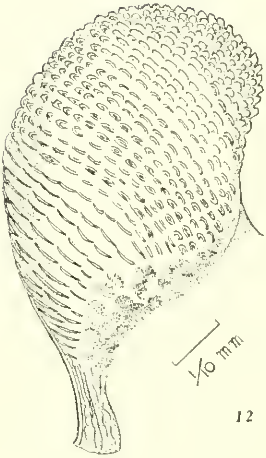

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Figures 9–12: *Branchinecta cornigera.* 9, Right antenna of male: a, anterior view (pu., pulvillus; bu., uncornified protuberance of second antenna); b, lateral view. 10, Right antenna of male (another specimen): a, anterior view; b, lateral view. The right antennae from the two specimens show that although the antennae of the male vary in shape with muscular contractions, nevertheless the uncornified bulge and the angular outline of the anterior border remain evident. 11, Telson and cercopods of a female 27 mm. long. 12, Hornlike protuberance from left side of head of female, lateral aspect. (9, 10, × 11.5; 11, × 18; 12, × 80.)

which differ in shape in each species. Although the pulvillus has been noted and depicted by some specialists on the Anostraca, I can find no description of the cuticular elaborations of its surface.

Most species of *Branchinecta* have, on the dorsolateral sides of the entire trunk, more or less conspicuous rounded elevations, or bosses, covered with cuticular papillae, with one or several sensory hairs near the center (see Linder, 1941, figs. 20 and 22). These papillose bosses are very poorly developed in *Br. cornigera*, new species, and often appear to be absent on one or both sides of some segments.

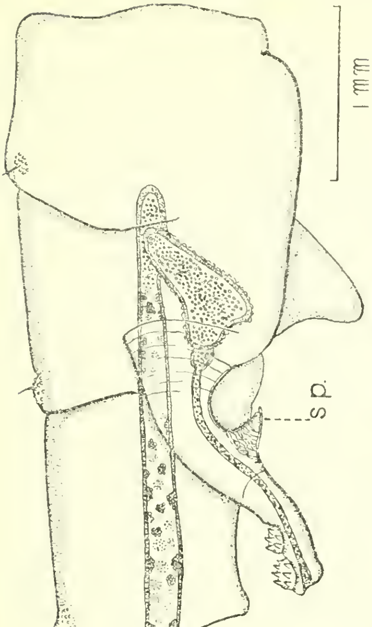
The shape of the endopodite of the thoracic feet and the structure of the spines on its distal end and median border are both strikingly different in the male and female (figs. 7, 8). Such a sexual dimorphism in the endopodites appears to be the rule in the genus, although *Br. gigas*, in which the thoracic feet are practically alike in both sexes, is an exception. The endopodital spines, especially those of the males, constitute a minor specific character (figs. 5, 6).

Distribution and environment: *Branchinecta cornigera*, new species, has been collected from 30 temporary ponds in Grant, Lincoln, Spokane, and Adams Counties in eastern Washington. The total number of separate collections is 43, all of which were made from late March to the middle of May. The species is typically present in clear or slightly turbid water with a variety of other fresh-water organisms, and often is associated with other species of phyllopods. *Br. cornigera* was the sole phyllopod in 25 of the 43 collections; it was associated with *Eubranchipus serratus* 13 times; with *Eu. serratus* and *Lynceus* sp. once; with *Eu. bundyi* once; with *Br. mackini* twice, and with *Br. mackini* and *Br. gigas* once. The temperature of the milieu water ranged from 42° to 59° F. On 15 occasions the pH of the water was ascertained with a Hellige Pocket Comparator. The water was only moderately alkaline, the pH ranging from 7 to 8.8. In the pond where *Br. cornigera* was associated with *Br. gigas* and *Br. mackini* the water undoubtedly was much more alkaline (probably pH 10 or more), but unfortunately the pH was not taken in that case.

Remarks: I have been unable to accept the shuffling of specific names proposed by Dr. J. G. Mackin (1952) for the following reasons:

Packard's (1883) description of *Br. lindahli* is so deficient and brief as to be meaningless, and is not accompanied by illustrations. It is not possible to recognize the species from the description.

Packard's original (1874) description of *Br. coloradensis* is entirely inadequate, and the drawings are so trivial and devoid of essential detail as to be without taxonomic utility. This description was based upon one female from an altitude of 12,500 ft. in the Colorado Rocky Mountains, and about 100 specimens of both sexes from the indefinite locality of "Colorado." Packard's second (1883) description



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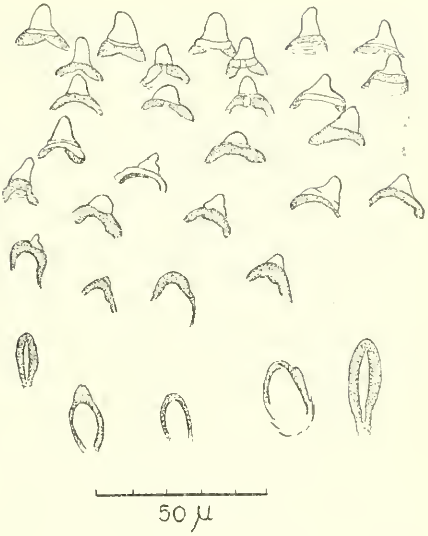

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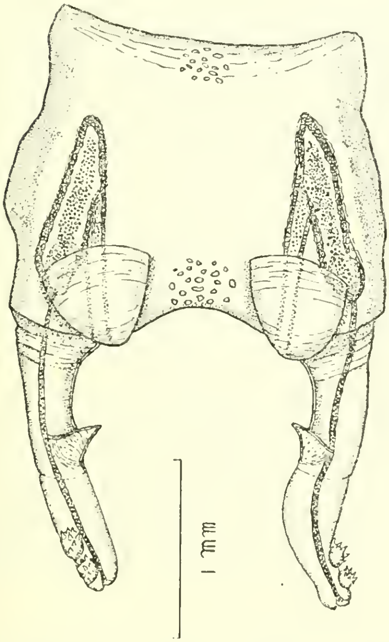
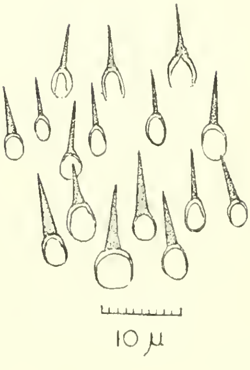


14



16

FIGURES 13–16: 13, Genital segments and first abdominal segment of a male 23 mm. long, lateral aspect (sp., spur on copulatory appendage). 14, Genital segments of a male 23 mm. long, ventral aspect. 15, Cuticular verrucae from the verrucose area of the antenna of a male. 16, Cuticular spinules from the pulvillus of the antenna of a male. (13, 14, × 24; 15, × 460; 16, × 1066.)

of *Br. coloradensis*, accompanied by the drawings of 1874, contains statements contradicted by the drawings and by the first description, as well as internal contradictions and confusions. The material for the second description came from a third locality on Gray's Peak at an elevation of 12,000 ft. On the basis of the second description *Br. coloradensis* remains incognizable, and it is most likely that the two descriptions are based on a careless examination of two species.

It seems appropriate, at this point, to call attention to the untrustworthiness of Packard's work on phyllopods. His descriptions are not only deficient in differential characters, but they also contain errors, contradictions, vague and indefinite comparisons with other species, invalid distinctions, and are replete with blunders and mislabeling in the illustrations. He apparently left no type specimens of any of his species of fairy shrimp. In my opinion, neither of Packard's species of *Branchinecta* can be recognized from his publications, and his specific names should be regarded as nomina dubia.

Dr. Mackin's distinction between alpine, permanent-water species and species inhabiting the plains and foothills at lower altitudes is not in complete accordance with my own experience. I have collected both *Br. coloradensis* and *Br. paludosa* in the Medicine Bow Mountains at elevations above 10,000 ft. and also on the plains in Montana at 4,200 ft. I have in my collection six distinct species of *Branchinecta* collected from the plains regions of Montana and Wyoming. These circumstances make most uncertain any surmises as to the species Packard had before him, based on their supposed occurrence only in an alpine or a plains locality.

Shantz (1905) was the first reviser of Packard's work on *Branchinecta*, and the species he described as being, in his belief, Packard's *coloradensis* and *lindahli* are entitled to stand. Pearse (1912) gave a description adequate for the recognition of a species which up to that time had not been recognizably described, and there is no convincing proof that *Br. packardi* is, in fact, a synonym of one of Packard's species.

As a consequence, *Br. shantzi* Mackin, 1952, must be regarded as an invalid synonym of *Br. coloradensis* Packard (as revised by Shantz, 1905); the *Br. coloradensis* of Mackin's revision is an invalid synonym of *Br. lindahli* Packard (as revised by Shantz, 1905), and the *Br. lindahli* of Mackin's revision is an invalid synonym of *Br. packardi* Pearse, 1912.

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TYPE SPECIMENS OF LICE (ORDER ANOPLURA) IN THE UNITED STATES NATIONAL MUSEUM

By Phyllis T. Johnson[1]

It has been recommended in the Copenhagen Decisions on Zoological Nomenclature (1953) that: "All institutions maintaining zoological collections should prepare and publish lists of type material in their possession." (Recommendation 75, p. 78, par. 150.) The present paper includes the names of all the Anoplura represented by the type in the U. S. National Museum as of Dec. 31, 1956. As a rule, reference is made only to holotypes and syntypes, paratypes being mentioned only where it is necessary to clarify the data or otherwise aid in the fixing of holotypes and lectotypes. The specific name is given under the genus to which it is now assigned, with a brief comment on its present status. If host names given in the type data have been changed since the original description of the Anoplura species, the currently accepted name is placed in brackets following the original form of the name. Appended is an alphabetical listing of the specific names of the Anoplura together with their currently accepted generic names. If the generic name differs from that designated by the author of the species, the original genus is given in brackets.

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[1] Entomology Research Branch, Agricultural Research Service, U. S. Department of Agriculture.

I am grateful to Dr. Henry W. Setzer of the Division of Mammals, U. S. National Museum, who checked the host names used in this paper.

Genus *Enderleinellus* Fahrenholz

***Haematopinus suturalis* Osborn,** U. S. Dep. Agr. Div. Ent. Bull. (old series) 7, p. 27, fig. 15, 1891.

Type data: "Plentiful" on *Spermophilus franklini* [*Citellus franklini*] and *S. 13-lineatus* [*Citellus tridecemlineatus*] at Ames, Iowa.

There is one slide with eight specimens of *suturalis* in the collection with an Osborn label bearing the data "on Spermophilus 13-lineata, 4/24/84, Ames, Iowa." There is no determination on this label. On the opposite side, in H. E. Ewing's handwriting, is given: "Cyclophthirus [Enderleinellus (crossed out)] suturalis (Osborn)," and a sketch of the position of the specimens with one marked "♂ holotype." Osborn did not designate a holotype, and Ewing never published a lectotype selection; therefore, Ewing's label means nothing from a nomenclatural standpoint. Although there is no species determination by Osborn, it was Ewing's habit to rewrite type labels at times with a new determination or a different generic combination. It is therefore accepted that Ewing recognized these to be the type series of *suturalis*, and the male designated by Ewing as "♂ holotype" is here selected as lectotype.

Present status: *Enderleinellus suturalis* (Osborn), 1891.

Genus *Eulinognathus* Cummings

***Eulinognathus americanus* Ewing,** Journ. Washington Acad. Sci., vol. 13, No 8, p. 149, 1923.

Type data: USNM 23761. Holotype female from *Ctenomys brasiliensis* (USNM 1939/3252) taken at Salade River, Paraguay.

Present status: As originally described.

Genus *Haematopinoides* Osborn

***Haematopinoides squamosus* Osborn,** U. S. Dep. Agr. Div. Ent. Bull. (old series) 7, p. 28, fig. 16, 1891.

Type data: Two females from pocket or pouched gopher, *Geomys bursarius*, Ames, Iowa.

There is in the collection a slide bearing data as above, a determination label in Osborn's handwriting, and containing two syntype females. Further labels have been placed on the slide by H. E. Ewing, the type No. 24137 is given and an accessory label gives a sketch of the position of the two females with the one on the right (next to the type label) labeled as lectotype. Ewing did not publish the lectotype selection. The specimen so designated on the slide is the better of the two and is here selected as lectotype.

Present status: As originally described.

Genus *Haemodipsus* Enderlein

Haemodipsus setoni **Ewing,** Amer. Journ. Trop. Med., vol. 4, No. 6, p. 548, 1924

Type data: USNM 23768. One female from *Lepus californicus melanotis* (USNM 123846) and two females and two nymphs from another skin (USNM 123847) of the same host subspecies, collected at Wichita, Kans., by Ernest Thompson Seton, and one male and one nymph from *Lepus c. californicus* (USNM 60907) collected at summit of Coast Range Mountains, San Diego County, Calif., by the International Boundary Commission.

All the syntype specimens listed above are in the collection under USNM 23768. None of the specimens are very well preserved. The single female from USNM 123846, although some of the legs are missing, is best preserved and is designated lectotype.

Present status: As originally described.

Genus *Hoplopleura* Enderlein

Hoplopleura erismata **Ferris,** Stanford Univ. Publ. Biol. Sci., vol 2, No. 2, p. 113, figs. 72b,e,f, 1921.

Type data. USNM 201408. Holotype female, allotype male from *Sciurus ferrugineus cinnamomeus* [*Callosciurus ferrugineus cinnamomeus*], South East Siam.

The type slide, containing a male and a female, bears the following data: "Ferris Col. 457, Type ♂ allot. ♀, Hoplopleura erismata n. sp., from Sciurus ferrugineus cinnamomeus, S. E. Siam. USNM 201408." The holotype is accepted as being the female on this slide, "type ♂ allot. ♀" as written on the slide label being a *lapsus*.

Present status: As originally described.

Haematopinus hesperomydis **Osborn,** U. S. Dep. Agr. Div. Ent. Bull. (old series) 7, p. 26, fig. 14, 1891.

Type data: Male(s) and female(s) from white-footed mouse or deer mouse, *Hesperomys leucopus* [*Peromyscus leucopus* subsp.] at Ames, Iowa.

There is in the collection one slide bearing a label on the right in Osborn's handwriting: "Haematopinus hesperomydis n. sp., from white-footed mouse, H. O. 1885." There are three male and one female syntypes on the slide; a well-preserved male is chosen lectotype and has been circled with a diamond point pencil.

Present status: *Hoplopleura hesperomydis* (Osborn), 1891.

Hoplopleura oryzomydis **Pratt and Lane,** Journ. Parasit., vol. 37, No. 2, p. 141, pl. 1, figs. 1–3.

Type data: USNM 60412. Holotype female and allotype male from *Oryzomys palustris palustris* (Harlan) No. 78, Oatland Island, Chatham County, Ga., Feb. 26, 1948. Both the holotype and allotype are in the collection.

Present status: As originally described.

Genus *Lemurphthirus* Bedford

Lemurphthirus verruculosus **Ward,** Ent. News, vol. 62, No. 6, p. 190, figs. 1, 2, 1951.

Type data: USNM 64237. Holotype female from a mouse lemur (formalin specimen), Bemangidy, Fort-Dauphin district, Tuléar Province, Madagascar, 1948, H. Hoogstraal and R. Alison.

Present status: As originally described.

Genus *Neohaematopinus* Mjöberg

Haematopinus antennatus **Osborn,** U. S. Dep. Agr. Div. Ent. Bull. (old series) 7, p. 25, fig. 13, 1891.

Type data: Collected from a fox squirrel, *Sciurus cinereus* var. *ludovicianus* [*Sciurus niger* subsp.], at Ames, Iowa.

There is in the collection a slide bearing labels as follows: Left: USNM type label, in Ewing's handwriting, "Neohaematopinus antennatus (Osborn), remounted on original slide Nov. 22, '20 by H. E. E., Type No. 24136 U.S.N.M." Right Label: In Osborn's handwriting, "H. [sphaerocephalus (crossed out)] antennatus n. sp., on Fox Squirrel, 5/1/82, S. K. Chauri 10/5/[?]." There are three female syntypes in a row on this slide. I select as lectotype the best preserved female, in the middle of the row, and have circled it with a diamond point pencil.

Present status: A junior homonym of *Haematopinus antennatus* Piaget, 1880. Earliest available name: *Acanthopinus sciurinus* Mjöberg, 1910, now known as *Neohaematopinus sciurinus* (Mjöberg), 1910.

Haematopinus columbianus **Osborn,** Canad. Ent. vol. 32, No. 7, p. 215, 1900.

Type data: Described "from a number of specimens taken from the Columbian Spermophile, *Spermophilus columbianus* [*Citellus columbianus* subsp.], at Pullman, Washington, by Prof. C. V. Piper in July, 1896. Type material in USNM."

In the collection are two slides which must be considered in lectotype selection. The first has on the left, in Ewing's handwriting, on a USNM type label: "=Linognathoides laeviusculus (Grube)" and on the right: "[8526, Linognathoides montanus (Osb.) (in Ewing's handwriting)], Haematopinus columbianus Osb., type material.

Type No. 5178, U. S. N. M." There are five poorly preserved females on the slide. The second slide has on the left-hand label in Osborn's handwriting: "8526 (80/13), Haematopinus columbianus Osb., on Spermophilus columbianus, Pullman, Wash., July '96, C. V. Piper," and contains eight females and six nymphs. The best preserved female on this second slide has been chosen as lectotype and has been circled with a diamond point pencil.

Present status: A junior synonym of *Neohaematopinus laeviusculus* (Grube), 1851.

Neohaematopinus mathesoni **Rubin,** Proc. Ent. Soc. Washington, vol. 48, No. 5, p. 121, figs. 1, 8, 10, 12, 1946.

Type data: USNM 57685. Holotype female from *Citellus v. couchi* (Baird) [*Citellus variegatus couchi*], at Nuevo León, Mexico, August 12, 1938, collected by H. Hoogstraal.

The holotype female bears the following host and locality data: "Citellus v. couchi, Ojo de Aqua, Municipio de Galeand, N. L., Mexico, Aug. 11, 1938," (not Aug. 12). The localities are properly Municipio Galeana and Agua del Oro.

Present status: A junior synonym of *Neohaematopinus marmotae* Ferris, 1923, new synonymy. One would expect *Neohaematopinus laeviusculus* (Grube) rather than *N. marmotae,* which is a normal parasite of *Marmota* and *Cynomys,* to occur on *Citellus.* However, the type and paratypes of *N. mathesoni* agree with Ferris's figures and description of *N. marmotae* and with specimens from the normal hosts.

Haematopinus montanus **Osborn,** U. S. Dep. Agr. Bull. 5, new. ser., p. 184, fig. 107, 1896.

Type data: On western gray squirrel, Fort Collins, Colo. (Baker).

There is in the collection a slide containing two males and two females and labeled as follows: Left label: "Linognathodes [montanus Osb. (crossed out)] laeviusculus (Grube)." Right label: "Near Ft. Collins, Colo., 9–11–92, Stannard. From Spotted grey squirrel." These labels are both in Ewing's handwriting. Although the above specimens may be type material, the absence of a label in Osborn's handwriting and the disparity in host names and the difference in what may be the collector's names do not allow them to be considered as such. Apparently no type material of *H. montanus* is in existence.

Present status: A junior synonym of *Neohaematopinus laeviusculus* (Grube), 1851.

Neohaematopinus patiki **Rubin,** Proc. Ent. Soc. Washington, vol. 48, No. 5, p. 121, figs. 2, 5, 7, 11, 1946.

Type data: USNM 57686. Holotype female, 11 paratype females, from *Citellus* (*Ammospermophilus*) sp., Delta, Utah, Apr. 27, 1938, Nual Walter collector. Eight paratypes are in the Cornell collection, the rest are in the U. S. National Museum (No. 57686).

The type slide is in the collection, but there are two female specimens on it and no designation as to which should be considered the holotype. Therefore, both female specimens on this slide must be considered syntypes. The female nearest the right-hand label on the slide marked "type" is here designated lectotype, and circled with a diamond point pencil.

PRESENT STATUS: A junior synonym of *Neohaematopinus laeviusculus* (Grube), 1851, NEW SYNONYMY.

***Neohaematopinus traubi* Rubin,** Proc. Ent. Soc. Washington, vol. 48, No. 5, p. 120, figs. 3, 4, 6, 9, 13, 1946.

TYPE DATA: USNM 57684. Holotype female from *Citellus adocetus* (Merriam), Michoacan, Mexico, Aug. 3, 1941, R. Traub collector.

The holotype female bears the additional locality data: Apatzingan, Michoacan; and the date is given as "21 Aug. 1941," not Aug. 3, 1941.

PRESENT STATUS: As originally described.

Genus *Pecaroecus* Babcock and Ewing

***Pecaroecus javalii* Babcock and Ewing,** Proc. Ent. Soc. Washington, vol. 40, No. 7, p. 199, figs. 1–3, 1938.

TYPE DATA: USNM 52758. Males, females, nymphs, and eggs from *Pecari angulatus* [*Pecari tajacu angulatus*], collared peccary, western Texas, between Juno and Pecos River, Jan. 29, 1932, O. G. Babcock collector.

In the collection are numerous specimens with the data similar to the above. Only two males and two females bear the type number (USNM 52758). A well-preserved male bearing the following data has been chosen and labeled as lectotype: Left label: "Peccary, Juno, Texas, 1–29–1932, Bishopp No. 14093"; right label: "Pecaroecus javalii Babc. & E., Type No. 52758 U. S. N. M., Long-nosed Peccary-louse, O. G. Babcock coll."

PRESENT STATUS: As originally described.

Genus *Pediculus* Linnaeus

***Pediculus (Parapediculus) atelophilus* Ewing,** Proc. U. S. Nat. Mus., vol. 68, No. 19, p. 9, figs. 4A, 5, 1926.

TYPE DATA: USNM 28105. Holotype male from *Ateles geoffroyi* [*Ateles geoffroyi* subsp] (gray form, or melanochir type of coloration), type locality ?.

PRESENT STATUS: Ferris (1951, Mem. Pacific Coast Ent. Soc., vol. 1, p. 273) presumes this species to be the same as *Pediculus lobatus* Fahrenholz, 1916, but does not actually synonymize it.

***Pediculus (Parapediculus) chapini* Ewing,** Proc. U. S. Nat. Mus., vol. 68, No. 19, p. 13, text figs. 2, 4B, 5, pl. 1, figs. 3, 4, 1926.

TYPE DATA: USNM 28106. Described from males and females from *Ateles ater* [*Ateles paniscus paniscus*], locality unknown.

The only slide with the above data contains two syntype specimens, a male and a female. The male is designated lectotype.

Present status: Probably the same as *Pediculus atelophilus* Ewing, 1926.

Pediculus (Parapediculus) pseudohumanus **Ewing,** Journ. Parasit., vol. 24, No. 1, p. 23, figs. 3, 5a, 6a, 1938.

Type data: USNM 51451. Type specimens taken from a saki monkey (*Pithecia monachus*) [*Pithecia monacha* subsp.] that died at the National Zoological Park, Washington, D. C. Original home of the type host is the Upper Amazon.

There are four slides in the collection labeled essentially as above and containing (1) 4 eggs, (2) 4 nymphs, (3) 4 males, and (4) 4 females. A well-preserved female has been chosen lectotype. This female is the one farthest from the type label (i. e., farthest to the right) on the slide containing four females and has been circled with a diamond point pencil.

Present status: *Pediculus pseudohumanus* Ewing, 1938.

Pediculus (Paenipediculus) simiae **Ewing,** Proc. Biol. Soc. Washington, vol. 45, p. 117, 1932.

Type data: USNM 44327. Holotype female from chimpanzee, *Pan* sp., London Zoological Gardens.

Present status: A junior synonym of *Pediculus shäffi* Fahrenholz, 1910.

Genus *Phthirpediculus* Ewing

Phthirpediculus propitheci **Ewing,** Journ. Washington Acad. Sci., vol. 13, No. 8, p. 150, 1923.

Type data: USNM 23762. Two females and one male (on the type slide) from female skin (USNM 63352) of *Propithecus edwardsi* [*Propithecus diadema edwardsi*] taken at Ambodiasy, eastern Madagascar, and two males from male skin (USNM 63354) of same host, taken at same place.

The above syntype specimens are in the collection. A well-preserved male is chosen lectotype. The lectotype is on the type slide which bears data as in the original description and a USNM type label.

Present status: As originally described.

Genus *Phthirus* Leach

Phthirus gorillae **Ewing,** Proc. Ent. Soc. Washington, vol. 29, No. 5, p. 120, 1927.

Type data: USNM 40161. First stage nymphs and eggs from two *Gorilla beringeri* [*Gorilla gorilla beringei*] (USNM 239883, 239884), eastern Belgian Congo.

In the collection are five slides labeled "*Phthirus gorillae.*" Three of the slides contain only eggs, and since Ewing described just the first stage nymph the eggs need not be considered in type selection. Of the two nymphs, one bears the following data: Left; "Type No. 40161 U. S. N. M., Phthirus gorillae n. sp., Ist nymph"; Right: "Belgian Congo, 1923, by Benj. Burbridge, from young gorilla, U. S. N. M. 239884." The other slide has, on the left, "Phthirus gorillae Ewing, Ist nym.," and, on the right, "Belgian Congo, Rec'd Jan., 1924, Benj. Burbridge, from skin of young ♂ gorilla (U. S. N. M. 239884)." Although this second specimen is not marked as a type, Ewing mentions "nymphs" in his description, making the selection of a lectotype necessary. The nymph with the type label USNM 40161 is selected as lectotype.

Present status: The taxonomy of the genus *Phthirus* is in a chaotic state. Ferris (1951, Mem. Pacific Coast Ent. Soc., vol. 1, p. 281) has pointed out that the description of this species merely demonstrates the occurrence of a species of *Phthirus* on the gorilla.

Genus *Polyplax* Enderlein

Polyplax alaskensis **Ewing,** Proc. Ent. Soc. Washington, vol. 29, No. 5, p. 118, 1927.

Type data: USNM 40159. Holotype male from *Microtus* sp. from Alaska.

Present status: As originally described. Figures of the holotype of *P. alaskensis* have been published elsewhere (Scanlon and Johnson, Proc. Ent. Soc. Washington, vol. 59, p. 282, fig. 3, 1957).

Polyplax dentaticornis **Ewing,** Proc. Biol. Soc. Washington, vol. 48, p. 207, fig. c, 1935.

Type data: USNM 44905. Holotype male and a last nymph from the skin of *Cricetulus andersoni* [*Cricetulus longicaudatus andersoni*] (USNM 172610), Shansi, China.

The holotype male and last stage nymph are on separate slides and both bear the above data.

Present status: Until more specimens from the type host are examined, the status of this species must remain in doubt. In the holotype, most of the paratergal plate setae are missing, and the third pair of legs is missing. The shape of the thoracic sternal plate and the fact that one seta on paratergal plate four is longer than the plate suggest that *P. dentaticornis* is closely related to *P. serrata* (Burmeister) and might be an aberrant specimen of this species. It should be noted that Ewing's figure of the third antennal segment of the holotype (loc. cit., p. 203, fig. c) pictures the apical spine as a lobe rather than a spine. This mistake was probably due to the fact that the entire head is flattened, changing normal relationships of the various parts.

Eremophthirius eropepli **Ewing,** Proc. Biol. Soc. Washington, vol. 48, p. 209, fig. B, 1935.

TYPE DATA: USNM 44906. Two male and two female cotypes from *Eropeplus canus* (USNM 219711), Celebes.

The four syntype specimens are mounted in a horizontal line on a single slide, and the label bears the data given above. All the specimens are in poor condition; however, one of the two males has most of the leg segments and the majority of the paratergal plate setae are still present. I select as lectotype this male (second from the right on the slide) and have circled it with a diamond point pencil. The third antennal segment of the lectotype was figured by Ewing (fig. B). Ferris (Mem. Pacific Coast Ent. Soc. vol. 1, p. 207, 1951) presumed the host to be *Eriopeplus incanus*, which he states is now known as *Cricetulus longicaudatus*, and ememded the species name of *eropepli* to *eriopepli*. However, Ewing's description properly lists the host (USNM 219711) as *Eropeplus canus*.

PRESENT STATUS: *Polyplax eropepli* (Ewing), 1935. This species would key to couplet 19 of Ferris' (Mem. Pacific Coast Ent. Soc., vol. 1, p. 204, 1951) key to *Polyplax* species. A redescription and figures of *eropepli* will be published elsewhere.

Polyplax tarsomydis **Ewing,** Proc. Biol. Soc. Washington, vol. 48, p. 206, fig. D, 1935.

TYPE DATA: USNM 44904. Holotype male from *Tarsomys apoensis*, Mindanão, Philippine Islands.

PRESENT STATUS: As originally described.

Genus *Proenderleinellus* Ewing

Proenderleinellus africanus **Ewing,** Journ. Washington Acad. Sci., vol. 13, No. 8, p. 148, 1923.

TYPE DATA: USNM 23760. Holotype male from *Thryonomys gregor pusillus* [*Thryonomys gregorianus pusillus*] (USNM 184180), taken at Maji-ya-Chumvi, British East Africa.

PRESENT STATUS: A junior synonym of *Proenderleinellus calvus* (Waterston), 1917.

Genus *Prolinognathus* Ewing

Prolinognathus ferrisi **Fahrenholz,** Ztschr. Parasitenk., vol. 11, No. 1, p. 12, 1939.

Prolinognathus leptocephalus (Ehrenberg), Ferris, Stanford Univ. Publ. Biol. Sci., vol. 2, No. 5, p. 142, figs. 250B, 251C (*err. det.*), 1932.

TYPE DATA: USNM 184247. Holotype female from *Procavia brucei rudolfi* [*Heterohyrax syriacus rudolfi*], British East Africa.

Fahrenholz used Ferris' (1932) figures and description of "*leptocephalus*" as a basis for his name *ferrisi*, and did not see the specimens.

Ferris (Mem. Pacific Coast Ent. Soc., vol. 1, p. 251, 1951) accepted the type of *ferrisi* as being the female from *Procavia brucei rudolfi*, and stated that this specimen should be in the U. S. National Museum. There is in the collection a female with the following data on the label in Ferris' handwriting: "Ferris Col. 474, Prolinognathus leptocephalus (Eh.), from Procavia brucei rudolfi, Marsabit Road, B. E. Africa, U. S. N. M. 184247." This specimen is the holotype of *Prolinognathus ferrisi* Fahrenholz and has been so labeled.

PRESENT STATUS: As originally described.

Genus *Scipio* Cummings

***Scipio longiceps* Ewing,** Proc. Helm. Soc. Washington, vol. 4, p. 81, fig. 29, 1937.

TYPE DATA: USNM 49919. Holotype male from *Thryonomys gregor pusillus* [*Thryonomys gregorianus pusillus*] (USNM 184180), British East Africa, Maji-ya-Chumvi.

PRESENT STATUS: A junior synonym of *Scipio aulacodi* (Neumann), 1911, NEW SYNONYMY. Ferris (Mem. Pacific Coast Ent. Soc., vol. 1, p. 154, 1951) expressed the opinion that *S. longiceps* Ewing was probably a synonym of *Scipio aulacodi* (Neumann). The holotype male of *S. longiceps* and a female with the same data as the holotype, and a second male from the same locality and host, differ in no way from Ferris' (Stanford Univ. Publ. Biol. Sci., vol. 2, No. 3, p. 170, figs. 113, 114A, B, C, 1922) description and figures of *aulacodi*. Ewing's supposed differences were due partly to the fact that the abdomen of *longiceps* holotype is telescoped and therefore smaller in relation to the length of the legs. The head is not longer than in Ferris' drawings, nor is the shape of the tarsal claws different. In Ewing's specimen the claws are more extended than in Ferris' drawings, leading to his mistaken impression. Geographically, the distribution of *aulacodi* is such that one would expect to find it in the type locality of *longiceps*. (Maji-ya-Chumvi is in southeast Kenya.)

Genus *Solenopotes* Enderlein

***Linognathus panamensis* Ewing,** Proc. Ent. Soc. Washington, vol. 29, No. 5, p. 119, 1927.

TYPE DATA: USNM 40160. "Described from a few females which are a part of a lot of six specimens," from *Odocoileus chiriquensis* [*Odocoileus virginianus chiriquensis*] (origin, Panama), which died at National Zoological Park on Jan. 28, 1925 (USNM 240843).

There is in the collection a slide with six females, all of which are accepted as being syntypes, since there is no way of knowing which "few" females of the lot of six Ewing referred to in his original description. These syntype females are all the same species. A well-preserved specimen has been designated lectotype and circled with a diamond point pencil.

Present status: *Solenopotes panamensis* (Ewing), 1927. Ferris (Stanford Univ. Publ. Biol. Sci., vol. 2, No. 5, p. 131, 1932) has placed *panamensis* as a synonym of *binipilosus* (Fahrenholz), 1916. A re-examination of Ewing's type series shows that *panamensis* is a recognizable species, differing from *binipilosus* in having the posterolateral margins of the head much more strongly convergent posteriorly and the apical lobes of the female abdomen with a short slender terminal portion as in *Solenopotes capillatus* (Enderlein), 1904, not with the apical lobes gradually constricted into long, tapering lobes. *S. panamensis* is separable from *capillatus* in that the abdominal spiracles are not protuberant, and the anterior part of the head is narrower and more elongate. There appears to be doubt as to the true hosts and geographical distribution of *binipilosus* and *panamensis*. There are specimens of *binipilosus* in the U. S. National Museum collection from "deer" from Guatemala, and from *Odocoileus* species from Arizona, Florida, and Texas. *Binipilosus* has also been recorded from *O. virginianus chiriquensis*, Panama, by Ferris (Stanford Univ. Publ. Biol. Sci., vol. 2, No. 5, p. 131, fig. 245, 1932). It is highly possible that the occurrence of *panamensis* on *Odocoileus virginianus chiriquensis* was accidental, the true host being some other ungulate with which the deer had come in contact while in the zoo.

List of Species

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A NEW NORTH AMERICAN BIRD-FLEA

By F. G. A. M. Smit[1]

Dr. Phyllis T. Johnson, of the Entomology Research Division, U. S. Department of Agriculture, Washington D. C., most kindly invited me to describe a new bird-flea, material of which was found in the collections of the U. S. National Museum. The specimens of the new flea were collected from the nest of a barn swallow and are part of a series which constitutes the first record of fleas from the North American subspecies of this host. It is a subspecies of *Ceratophyllus affinis* Nordberg, 1935, and the host record is a valuable indication as regards the true host of the little-known nominate subspecies.

I am much indebted to the authorities of the U. S. National Museum for the donation of one pair of paratypes of the new flea to the British Museum collection of fleas at Tring.

***Ceratophyllus affinis neglectus*, new subspecies**

FIGURES 1, 2, 5–10

TYPE MATERIAL: Male holotype, female allotype, and 2 ♂, 2 ♀ paratypes from Smithfield, northern Utah, U. S. A., from nest of barn swallow *Hirundo rustica erythrogastra*, June 6, 1951, collected by

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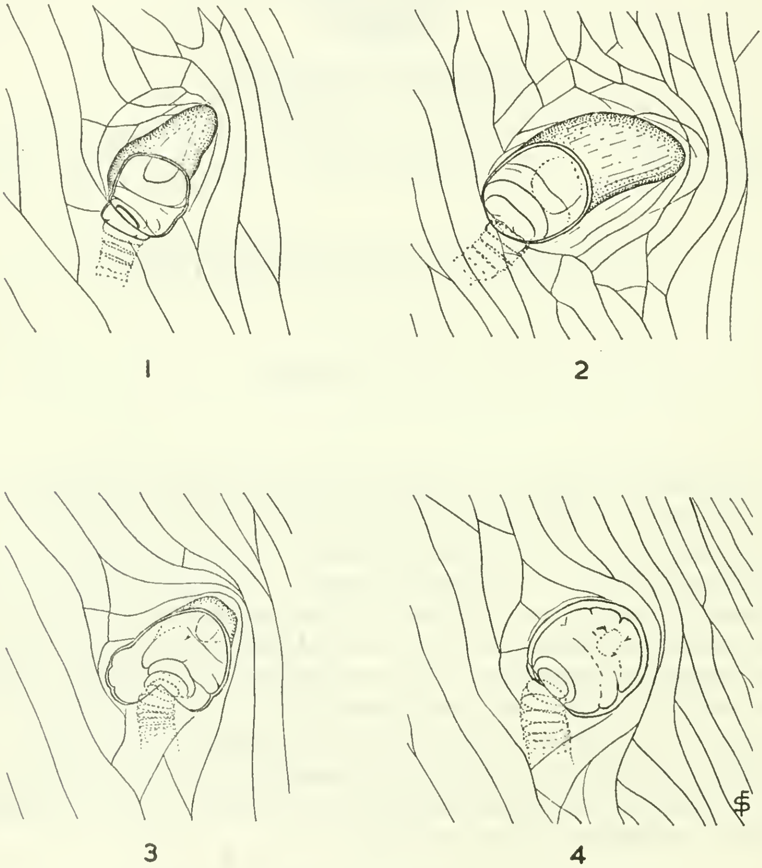
[1] British Museum (Natural History), The Zoological Museum, Tring, Herts.

T. Tibbetts.[2] Holotype, allotype and two paratypes (1♂, 1♀) in the collection of the U. S. National Museum, and two paratypes (1 ♂, 1 ♀) in the British Museum collection of fleas at Tring.

Diagnosis: The new subspecies differs from all known representatives of the genus *Ceratophyllus* by the great development of the postspiracular area of the spiracular fossa on terga ii–vii (figs. 1, 2); in the nominate subspecies the postspiracular areas are somewhat less



Figures 1–4.—Spiracular fossa of tergum vii of: 1, *Ceratophyllus affinis neglectus*, new subspecies, male, holotype; 2, *C. a. neglectus*, female allotype; 3, *Ceratophyllus niger* C. Fox, male, from Essington, British Columbia; 4, *C. niger*, female, from Essington, British Columbia.

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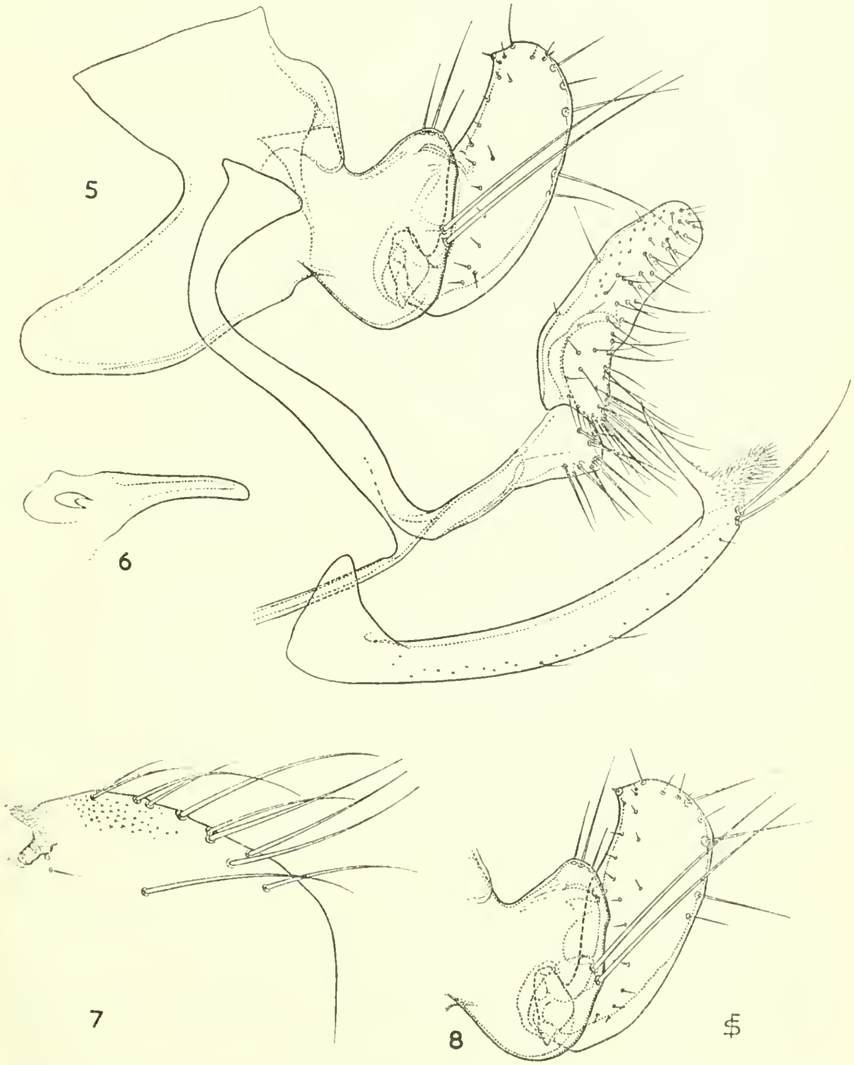
[2] Cross and Knowlton (1953) recorded material with virtually identical data, but determined as *Ceratophyllus garei* Roths., "collected from nests of the barn swallow, *Hirundo erythrogaster*, by T. Tibbets and L. Dale Haws at Smithfield, Utah, June 7, 1951." Although *C. garei*, a flea of damp birds' nests, is known to occur in Utah, it is very likely that the specimens recorded by Cross and Knowlton will also prove to be representatives of *C. affinis neglectus*. One pair of the USNM specimens was misdetermined as *Ceratophyllus niger*, while the other two pairs had not been determined.

well developed, though still very conspicuous and larger than in any other species of the genus. The new subspecies differs from the nominate form in the male by the longer movable process of the clasper (fig. 5) and the much more weakly developed spiculose area of tergum VIII (fig. 7); in the female by the slightly less prominent lateral lobe of sternum VII (figs. 9, 10) and a somewhat zigzag-shaped sclerotized portion of the ductus obturatus (if this latter characteristic proves to be constant, which seems doubtful). For figures of pertinent struc-



Figures 5–8.—*Ceratophyllus affinis neglectus*, new subspecies, male: 5, clasper, sternum IX and sternum VIII, holotype; 6, aedeagal crochet, holotype; 7, dorsal part of tergum VIII, holotype; 8, processes of clasper, paratype.

tures of *C. a. affinis* see Darskaya (1950) and Smit (1956). The polytypic species *C. affinis* appears to be related to *Ceratophyllus idius* Jordan and Rothschild and, more distantly, to *C. niger* C. Fox.

DESCRIPTION: Head with a moderately developed frontal tubercle; preantennal region with a frontal row of six or seven setae in the male, in the female the frontal row is vestigial and consists of only a few minute setae; ocular row with three setae in both sexes; postantennal region of head with three or four setae above the antennal fossa and a posterior row of five or six setae each side. The long setae of the antennal pedicel reach to about the seventh segment of the club in the male, and well beyond the apex of the club in the female. Labial palp not quite reaching the apex of the fore coxa.

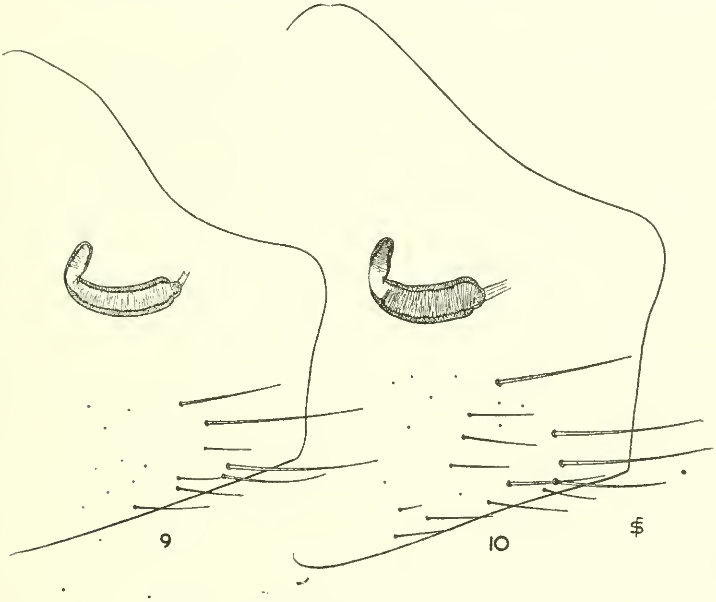
Pronotum with a ctenidium of 31–33 spines, the most dorsal of which are about as long as the pronotum anterior to the upper spines (as in *C. idius;* in *C. niger* the pronotum is dorsally much longer than the pronotal spines). Mesepimeron with one or two setae on the middle of the surface though fairly close to the mesopleural rod, apart from the few ventral and posterior setae (these median setae are usually also present in *C. idius*, but absent in *C. niger*). Pleural arch of metathorax well developed; squamulum of metasternum short and broad. Fifth tarsal segment of all legs with numerous minute setae scattered over the plantar surface.

Terga I–V in the male with the following numbers of marginal spinelets per side: 2, 3 (4), 2 or 3, 2, 1 (2); in the female: 2 or 3, 3 or 4, 2 (3), 1 or 2, and 0 respectively. Spiracular fossae of terga II–VII usually with large postspiracular areas, the largest for any species in the genus (figs. 1, 2; cf. figs. 3, 4), although there is considerable variation in the size of these areas on individual segments.

In other respects the structure and chaetotaxy of the head, thorax, legs, and unmodified abdominal segments are as in related species.

Male (figs. 5–8): Tergum VIII (fig. 7) with a weakly developed and rather narrow spiculose area, a row of 9–13 strong setae along the dorsal margin and two or three setae on the lateral surface. Sternum VIII (fig. 5) long and narrow, distinctly curved upwards, with a triangular basal portion, two slender apical setae, and a long and narrow apical membranous process which bears a posteriorly directed, rather narrow, spiculose basal lobe, as in the nominate subspecies. Manubrium of clasper fairly broad basally; fixed process almost quadrangular, with a broadly rounded apex; the two acetabular setae are situated not far below the middle of the posterior margin of the clasper (fig. 5). Movable process (figs. 5, 8) elongate, its smoothly convex posterior margin bearing several slender setae along the upper half, while the anterior margin is angulate at about the middle. Apical lobe of the distal arm of sternum IX (fig. 5) narrowing very little towards the truncate apex; chaetotaxy of this arm as shown in figure 5. Aedeagal crochet with a fairly long, narrow, and blunt tipped apical portion (fig. 6).

Female (figs. 9, 10): This sex resembles that of *C. a. affinis* very closely and the main differences, apart from the average size of the postspiracular areas, are that in the new subspecies the lateral lobe of sternum VII projects to a lesser degree and the margin below the lobe is almost straight (figs. 9, 10), not markedly concave as in *C. a. affinis*, and the heavily sclerotized basal part of the ductus obturatus is somewhat zigzag-shaped in the three females studied (this may be an abnormality), while this duct is smooth (as is normal) in *C. a. affinis*. The length of the cylindrical bulga of the spermatheca (figs. 9, 10) appears to be fairly variable, but the shorter of the two drawn (fig. 10) is like that of the nominate subspecies and is therefore presumably the normal type.



FIGURES 9, 10.—*Ceratophyllus affinis neglectus*, new subspecies, female: 9, sternum VII and spermatheca, allotype; 10, sternum VII and spermatheca, paratype.

Length: Male, 3 mm; female, 3.5 mm.

REMARKS: We know as yet extremely little about the range of distribution or true host of *C. a. affinis;* the specimens (2♂, 4♀) from southwest Finland are from an unknown host (Smit, 1956), but it is most significant that the specimens (11♂, 20♀) recorded by Darskaya (1950) from the Vologda oblast (roughly 450 km. north of Moscow) came from the nest of *Hirundo rustica* [*rustica*], for *C. a.*

neglectus was collected from the nest of another subspecies of the Holarctic *H. rustica,* namely *H. r. erythrogastra.* Both subspecies of barn swallow build similar nests in similar places, and it may well be assumed now that *H. rustica* is the true host of *C. a. affinis.*

The differences in structure between these two forms of barn swallow fleas are fairly pronounced, and some workers would perhaps consider them to be full species. However, the differences between, e. g., *Ceratophyllus styx styx* Rothschild and *C. s. jordani* Smit, which are certainly subspecies and are parasites of the sand martin *Riparia riparia* in Europe, are even more pronounced than those between the two subspecies of *C. affinis.* Both barn swallow and sand martin build very isolated nests and they live in a considerable degree of isolation from other hosts. It is an acknowledged fact that isolation favors evolution and this may explain why the differences between subspecies of fleas which live in identical isolated ecological habitats (e. g., the fleas of the swallow and the sand martin) are greater than those between subspecies of fleas infesting hosts which occupy less isolated ecological habitats (e. g., the two subspecies of the tree-squirrel flea *Tarsopsylla octodecimdentata, T. o. octodecimdentata* (Kolenati) in the Palaearctic region, and *T. o. coloradensis* (Baker) in the Nearctic region). Thus the degree of differences between *C. a. affinis* and *C. a. neglectus* might be interpreted as being the result of the occurrence of these fleas in isolated habitats and therefore strengthens the assumption that *C. a. affinis,* as well as *C. a. neglectus,* is a parasite of *Hirundo rustica.* If the true host (and the ecological factors concerning its nest) of one of the subspecies should prove to be different, it would be necessary to regard *affinis* and *neglectus* as full species, for, apart from considerations of geographical, morphological, and reproductive isolation, it seems that in fleas we must usually also stipulate that subspecies of a certain species must occupy almost identical ecological niches, since it seems extremely probable that if two fleas have diverged so much as to be able to occupy substantially different niches they will also have become too distant to have retained the capacity to interbreed without impairment of fertility. Thus, though the structural differences between *Xenopsylla ramesis* (Rothschild) (a parasite of gerbils) and *X. cunicularis* Smit (infesting the rabbit in Morocco) are very small, and the two forms appear not to be sympatric, I regard them as full species because of the very different nesting habits of their hosts.

It may be that another form, more or less intermediate between *C. a. affinis* and *C. a. neglectus,* occurs in eastern Siberia. Since barn swallows are widely distributed and travel over great distances, it seems likely that the distribution of the subspecies of *C. affinis* will also be found to cover a large area, and it is to be hoped that collectors will turn their attention to the usually easily collected nests of barn swallows. In Europe the nests of *H. rustica,* which are now usually built inside barns and other outbuildings, are obviously too dry to form a suitable environment for the development of flea larvae; the same may apply to the nests of the North American subspecies. *Ceratophyllus affinis* must have become associated with the barn swallow long before this bird adopted man-erected shelters for nesting sites, and it seems possible that it has not been able to adapt itself to this relatively new macro-habitat, that it survives mainly in the relatively few nests which are still built in natural sites (e. g., in roofs of caves, in little rock-pockets in wild ravines, in sea-washed caverns) and that from these natural sites occasional specimens are introduced to nests in barns. This is a rather speculative suggestion and it is only by collecting fleas from large numbers of barn swallow nests from natural and man-made sites, both in the Nearctic and Palaearctic regions, that we shall learn something about this intriguing question.

After the above was written I looked through those tubes in the alcoholic portion of the Tring collection which were labeled as having been collected from *Hirundo rustica,* and to my delight found in a tube containing four males and ten females of *Ceratophyllus gallinae* (Schrank) and one male of *C. garei* Rothschild (the occurrence of all of which must be regarded as casual) a single female of *C. a. affinis* Nordberg. The fleas in the tube in question were collected from *Hirundo rustica* (presumably from a nest) at Wulfsdorf, 7 km. south of Lübeck, Germany, in 1923 by W. Blohm, and the record gives some support to my assumptions about the host and distribution of the flea. Unfortunately the Wulfsdorf specimen is somewhat abnormal (e. g., it has only two antesensilial setae each side instead of three, several setae of one midtibia are malformed, and the anal tergum seems to be shortened), so I do not feel justified in figuring any part of it, but its sternum VII and spermatheca agree perfectly with those of Finnish specimens and with the figure published by Darskaya.

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A REVIEW OF SOME GALERUCINE BEETLES WITH EXCISED MIDDLE TIBIAE IN THE MALE

By Doris H. Blake

Unlike the Alticini, many of the Galerucini do not have outstanding characters. This is particularly true of such genera as *Diabrotica*, *Neobrotica*, and *Luperodes*, and has led to many really diverse beetles being included under these generic names. Yet any attempt to create a better classification is bound to result in a somewhat artificial arrangement because these beetle groups overlap in certain peculiarities and in other ways possess traits common to most Galerucini. There is one approach that can be used, which Horn (1893, p. 124) suggests when he remarks concerning *Phyllecthrus:* "Too many genera of Galerucini have been described from uniques without any published reference to sexual peculiarities which are often a guide to relationships when other characters cause doubt by their double indication."

There is a somewhat miscellaneous series of Galerucine beetles in which the male character is a cut-out area on the inner margin near the apex of the middle tibiae similar to the emargination in the front tibiae of Carabidae. Some of these beetles have been allocated to that all-embracing genus, *Diabrotica*, in spite of not having bifid claws, others to *Neobrotica*, others to *Phyllecthrus* and *Oroetes*, and I have described under the name *Ectmesopus* a group of West Indian beetles—two of which had been described as species of *Luperus*—that have this character in the male. In the case of the majority of these beetles not only is there the male character of the cut-out middle tibiae, but also there is an abnormality of the antennal joints. All over the world there are Galerucini with queer male antennae, but the combination of these leg and antennal abnormalities in the male serves to make these particular beetles stand out from the bulk of the Galerucini closely resembling them in the female sex, in which the males and females are essentially identical. This paper is an attempt to bring together these beetles and consider their likenesses as well as differences.

In describing the genus *Phyllecthrus*, LeConte (1865) states that he took the name from the Dejean (1837, p. 406) catalog. He used Dejean's form, *Phyllecthris*, in his key in the first mention of the name, but two pages later, in his description of the genus, he used *Phyllecthrus*, and subsequently described other species under that spelling, and that form of the name has persisted. LeConte listed the old Olivier species, *Galleruca dorsalis* Olivier (1808), given under *Phyllecthris* in the Dejean catalog as *Phyllecthrus dorsalis*, and added Say's *Galleruca atriventris*, now regarded as a color phase of *dorsalis;* he also described a smaller species, *P. gentilis.* In 1868 he added another species, *Phyllecthrus nigripennis*, now regarded as a color form of *gentilis.* In 1884 he described *Phyllecthrus texanus*, which is closely related to *gentilis* and considered by Horn as a variety of it. All of these species that LeConte described, as well as the original *dorsalis* of Olivier and Say's *atriventris,* have one point in common—the antennae in the male are 10-jointed.

In 1891 Jacoby described a new genus *Luperosoma* for an Ecuadorean species, *Luperosoma marginatum.* This had thickened antennal joints of the normal number (11) in the male. It resembled LeConte's species in the cut-out middle tibiae of the male. Later, Weise (1924) in the Junk catalog, synonymized it with *Phyllecthrus.* Meanwhile, Horn (1893, 1896) described three species under *Phyllecthrus, parallelus, schwarzi,* and *subsulcatus,* all with thickened antennal joints, 11 in number, and cut out middle tibiae in the male, as in Jacoby's genus, *Luperosoma.* In 1940 I described a group of tiny West Indian beetles, all very closely related to each other, with cut out middle tibiae in the male, as *Ectmesopus.* All but two of these species had abnormal antennal joints in the male, sometimes only thickened, but usually deformed in some way. One of the two that did not have the abnormal antennal joints had a slight difference in the length of the joints in the sexes, and in the other there seemed to be no difference at all, yet both of these species in color and structure were very close to the rest of this homogeneous little group, so that the lack of these sex characters seemed only incidental and not at all comparable with the marked differences between the species of LeConte's genus *Phyllecthrus* and Jacoby's *Luperosoma*. H. S. Barber, in fact, suggested to me putting Horn's much larger species, *subsulcatus*, *schwarzi*, and *parallelus*, into my West Indian *Ectmesopus*. But not only is there the much smaller size of *Ectmesopus* species, but also the shape of the prothorax is unlike that of LeConte's, Horn's or Jacoby's genera, in that the West Indian beetles have a smoothly convex prothorax without any hint of transverse depression. They form a distinct little group of beetles probably endemic in the West Indies, and it seems best to keep them separate. As above indicated, Horn's species fit better into Jacoby's genus *Luperosoma*.

In dealing with the Galerucini it has been my experience that in the sex characters of the males there is an infinite variety of forms, many so unusual as to merit generic recognition. Note the monotypic genus *Oroetes* described by Jacoby. In common with *Phyllecthrus* and *Ectmesopus*, *Oroetes flavicollis* has notched middle tibiae in the male, but the male antennae somewhat resemble those of *Cerotoma* in being cut out, but in a different way from *Cerotoma*. Like *Cerotoma*, too, is the excavation of the face. This excavation of the face is also found in certain beetles at present ascribed to the genera *Neobrotica* and *Eucerotoma* as well as in species of the Asiatic and African genus *Palpoxena*. The prothorax in *Oroetes* in addition has a peculiar median tubercle in the male.

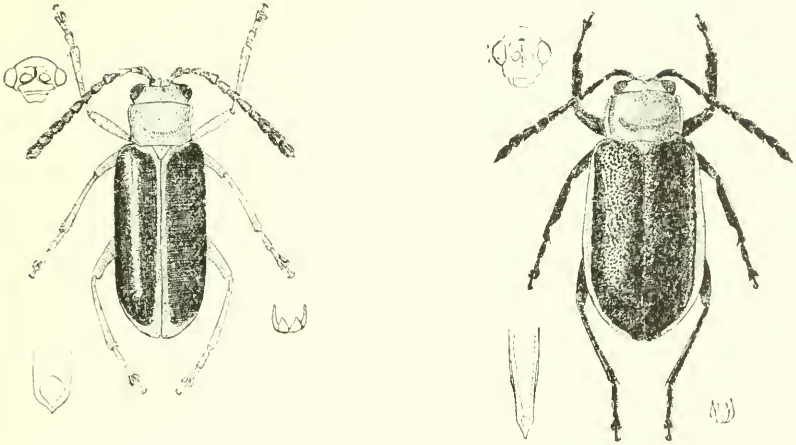
Another peculiar beetle is *Diabrotica cyanospila* Suffrian, which has both enlarged antennal joints and cut out middle tibiae in the male, and does not have bifid claws, the one character that always distinguishes the *Diabrotica* group. There is still another male character in *cyanospila* that I have not found in any of the others with notched middle tibiae, and that is a greatly enlarged hind femur in the male, so that it would seem almost like an alticid. I have found one other instance of such enlargement of the hind femora in the male, that is in *Leptoxena eximia* Baly, a monotype from the Andaman Islands. In this species also the male antennae are dilated. There are no notched middle tibiae, however, and the beetle itself has a quite different aspect. Suffrian describes *cyanospila* as an *Altica*-like beetle, although he does not mention the enlarged femora nor the dilated antennal joints, leading me to believe that he had examined no males. In his description of *Diabrotica semicyanea*, which follows the description of *D. cyanospila*, he stated that one specimen had a quite abnormal build of the last joints of the antennae in that the last joint is spoon-shaped and the preceding broadened. He believed it was a male of *semicyanea*. He did not mention in either case the excised middle tibiae or enlarged femora. Although I have not seen any male specimen of this species, I think it is not unlikely another of this group, closely related, as Suffrian stated, to *D. cyanospila,* and possibly also with enlarged hind femora.

On searching through the list of species under section "P" in Gahan's (1891a, p. 418) table of *Diabrotica,* which is composed of species that may be distinguished by the peculiar structure of the antennae of the male, I have found two that have excised middle tibiae in the male. One of these, *D. amplicornis* Baly, seems to be another of the *Luperosoma* group in which Horn and Jacoby described species. In the other species, *D. dilaticornis* Baly, both the anterior and middle tibiae are widely emarginate, the emargination being unlike that of the group under consideration, but it has bifid claws, as in a true *Diabrotica,* and therefore cannot be considered one of the group of genera under discussion.

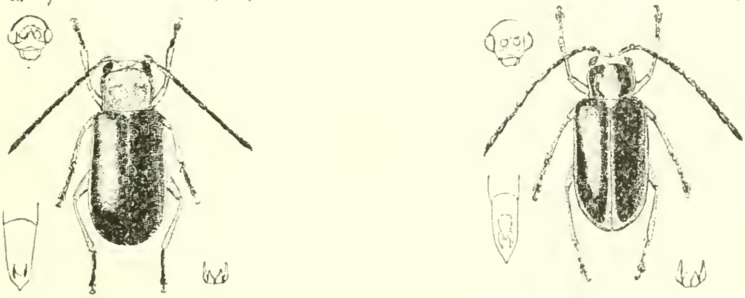
Among species of that heterogeneous genus *Neobrotica* occur several that differ from the type of the genus, *Neobrotica variabilis* Jacoby, in being smaller, oblong in shape, and more slender and with excised middle tibiae in the male. They do not have any peculiarity of the male antennal joints, in this respect being unlike most of the rest of this group. These species are *Neobrotica ruatanae* Jacoby and a closely related and undescribed beetle, and *Neobrotica sexplagiata* (Jacoby), the latter related to *Diabrotica nymphaea* Jacoby. The name *N. sexplagiata* covers a number of closely related species. Besides these are others from South America, so far undescribed, that fall into this group.

Jacoby has described still another genus with at least one species, *Platymorpha smaragdipennis,* having excised middle tibiae. In his other species, *P. variegata,* I am unable to detect any such character. In both, however, the male antennae are peculiar in that the third joint is very short and truncate.

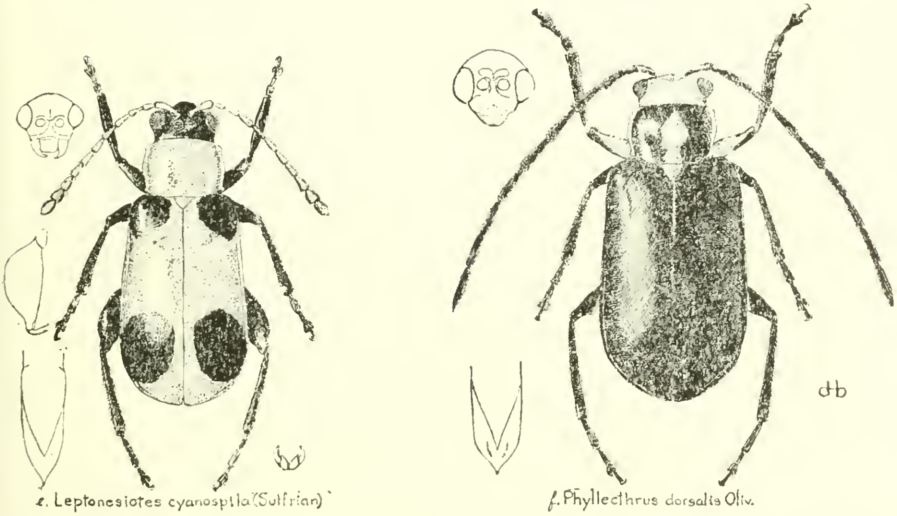
Chapuis (1875, p. 163) included *Phyllecthrus* with *Phyllobrotica* in his treatment of *Phyllobroticides,* and separated them in his key by the epipleural characters. He stated that in *Phyllecthrus* the epipleura are very narrow. LeConte rightly described the elytra as distinctly margined with the epipleura narrow and not extending to the tip. In *Phyllobrotica* the epipleura are either very narrow or wholly lacking. The genus *Phyllobrotica,* in spite of its worldwide range in the temperate Northern Hemisphere, is exceedingly homogeneous, the species all being closely related and rather uniform in markings. The chief points of likeness between the two genera lie in the semicircular depression across the prothorax and the appendiculate claws. In at least one species, *Phyllobrotica limbata* (Fabricius), the male antennal joints are thickened, but the middle tibiae show no emargination, and there is no thickening of the anterior tibiae in the male or short first



a. Phyllobrotica limbata (Fab) b. Diabrotica dilaticornis Baly



c. Phyllecthrus texanus Lec. d. Phyllecthrus gentilis Lec.



e. Leptonesiotes cyanospila (Suffrian) f. Phyllecthrus dorsalis Oliv.

FIGURE 1.—*a*, *Phyllobrotica limbata* (Fabricius); *b*, *Diabrotica dilaticornis* Baly; *c*, *Phillecthrus texanus* LeConte; *d*, *Phyllecthrus gentilis* LeConte; *e*, *Leptonesiotes cyanospila* (Suffrian); *f*, *Phyllecthrus dorsalis* (Olivier).

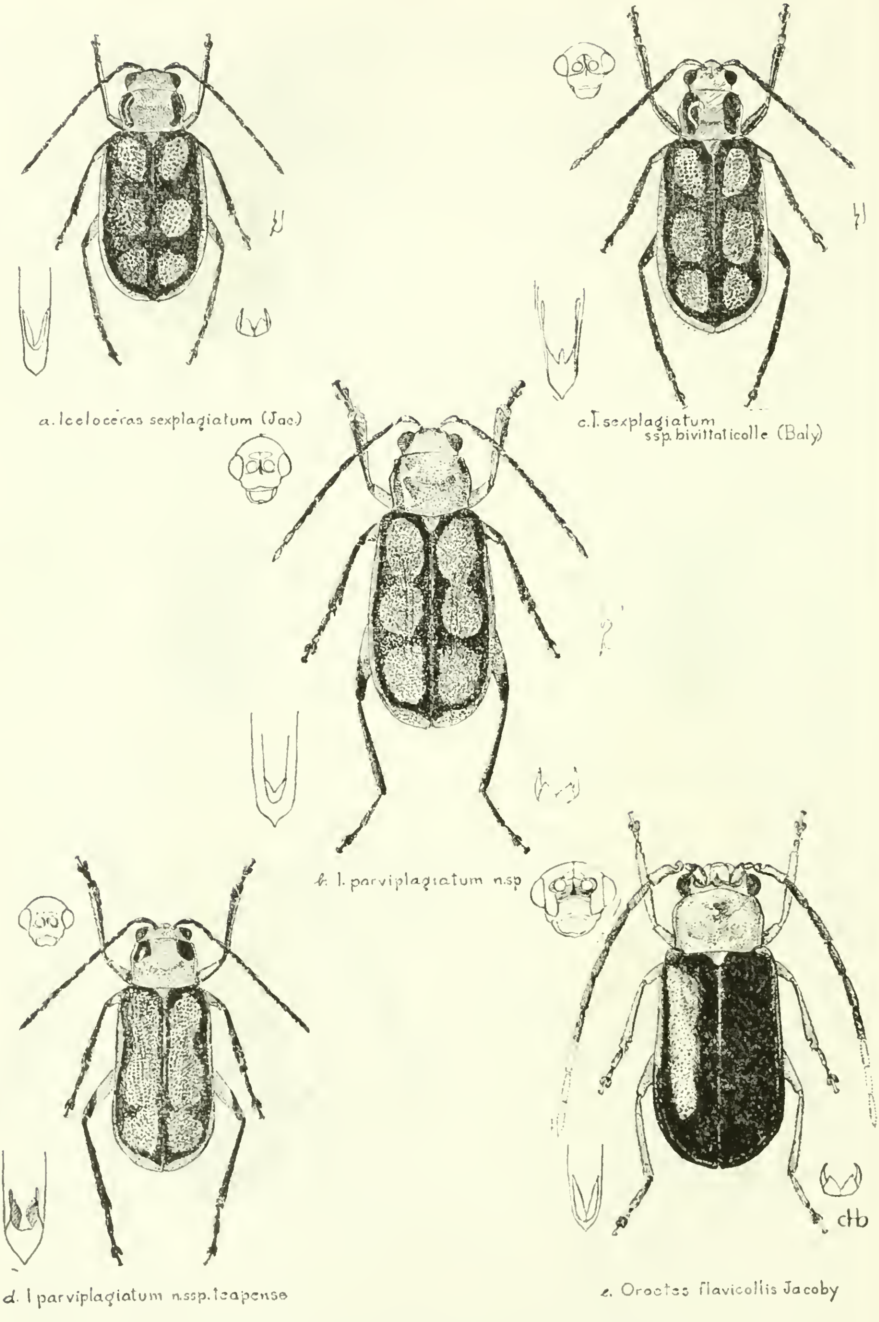
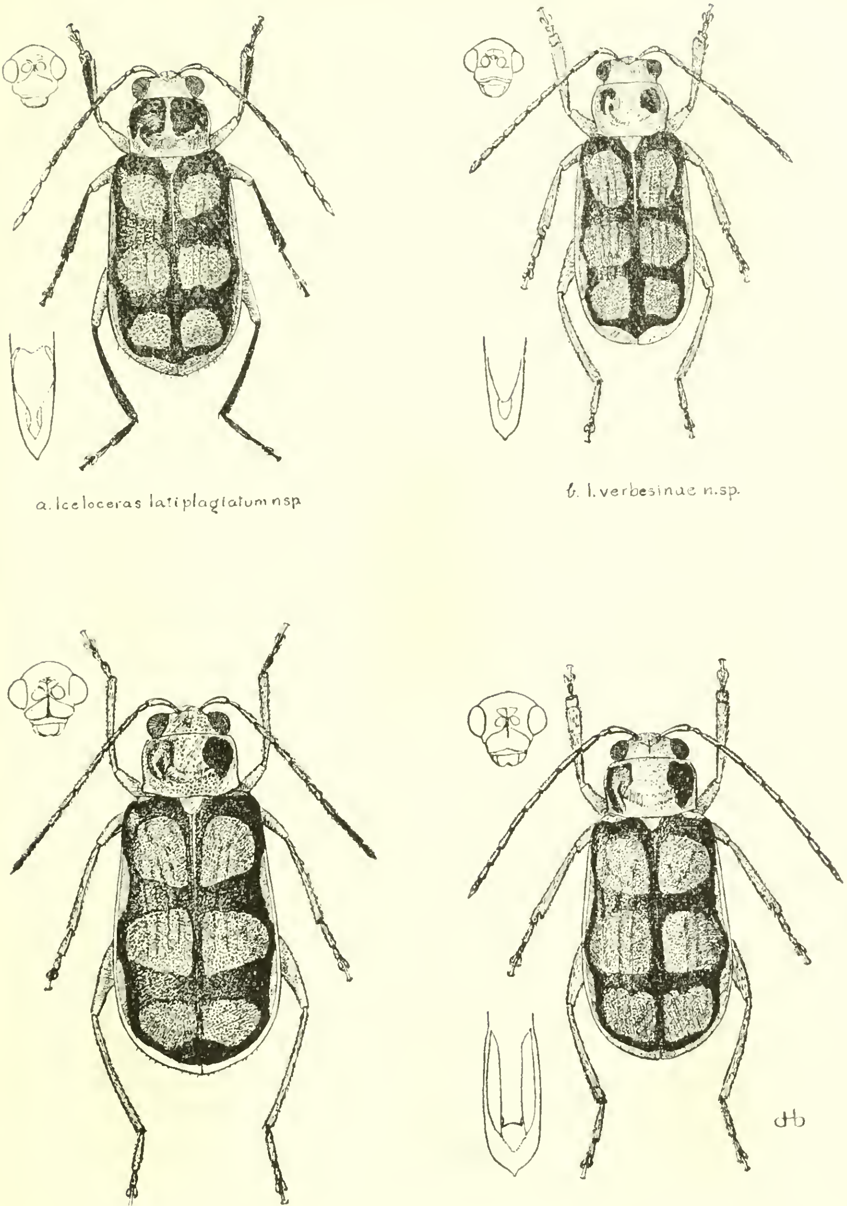


Figure 2.—*a, Iceloceras sexplagiatum* (Jacoby); *b, I. parviplagiatum*, new species; *c, I. sexplagiatum bivittaticolle* (Baly); *d, I. parviplagiatum teapense*, new subspecies; *e, Oroetes flavicollis* Jacoby.



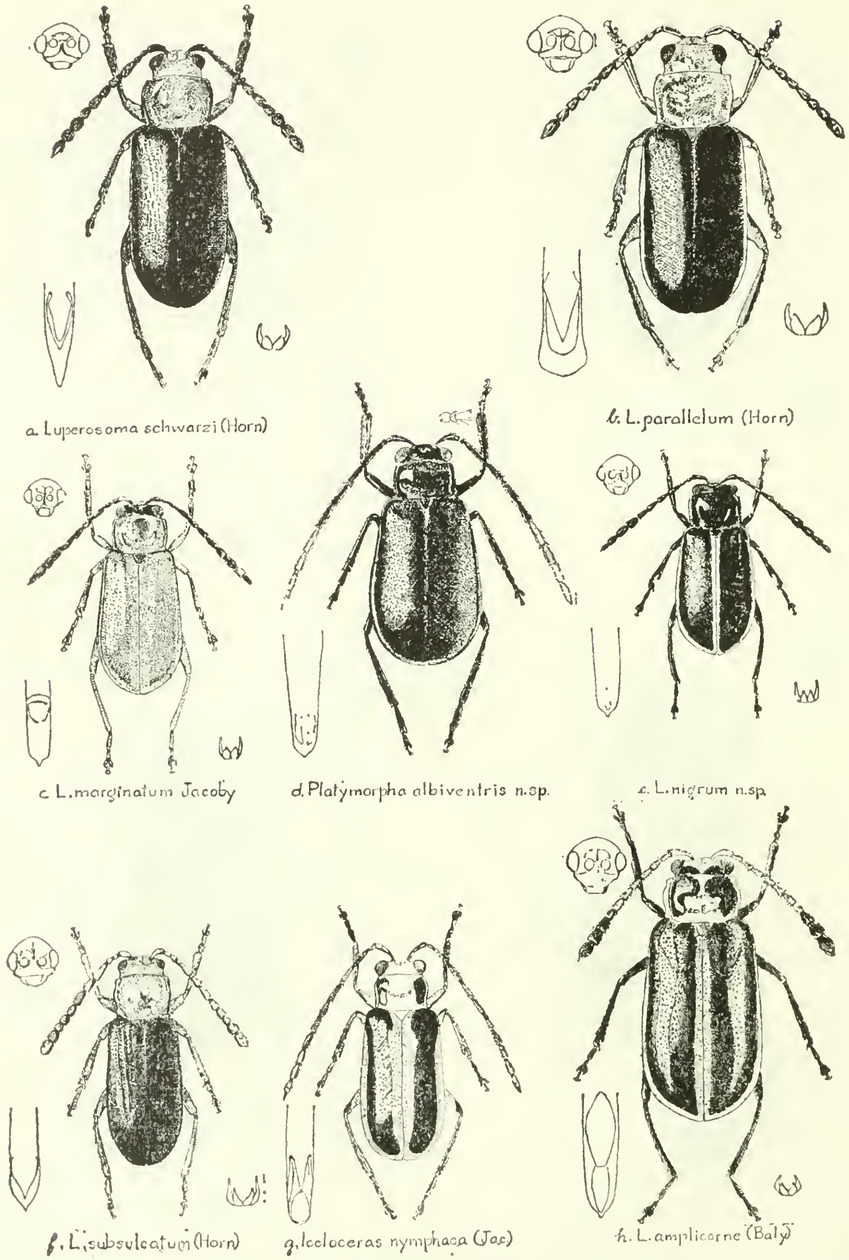
a. Iceloceras latiplagiatum n.sp.

b. I. verbesinae n.sp.

c. I. maximum n.sp.

d. I. flavipes n.sp.

FIGURE 3.—*a*, *Iceloceras latiplagiatum*, new species; *b*, *I. verbesinae*, new species; *c*, *I. maximum*, new species; *d*, *I. flavipes*, new species.



a. Luperosoma schwarzi (Horn)

b. L. parallelum (Horn)

c. L. marginatum Jacoby

d. Platymorpha albiventris n.sp.

e. L. nigrum n.sp.

f. L. subsulcatum (Horn)

g. Iceloceras nymphaea (Jac)

h. L. amplicorne (Baly)

Figure 4.—*a, Luperosoma schwarzi* (Horn); *b, L. parallelum* (Horn); *c, L. marginatum* Jacoby; *d, Platymorpha albiventris*, new species; *e, Luperosoma nigrum*, new species; *f, L. subsulcatum* (Horn); *g, Iceloceras nymphaea* (Jacoby); *h, Luperosoma amplicorne* (Baly).

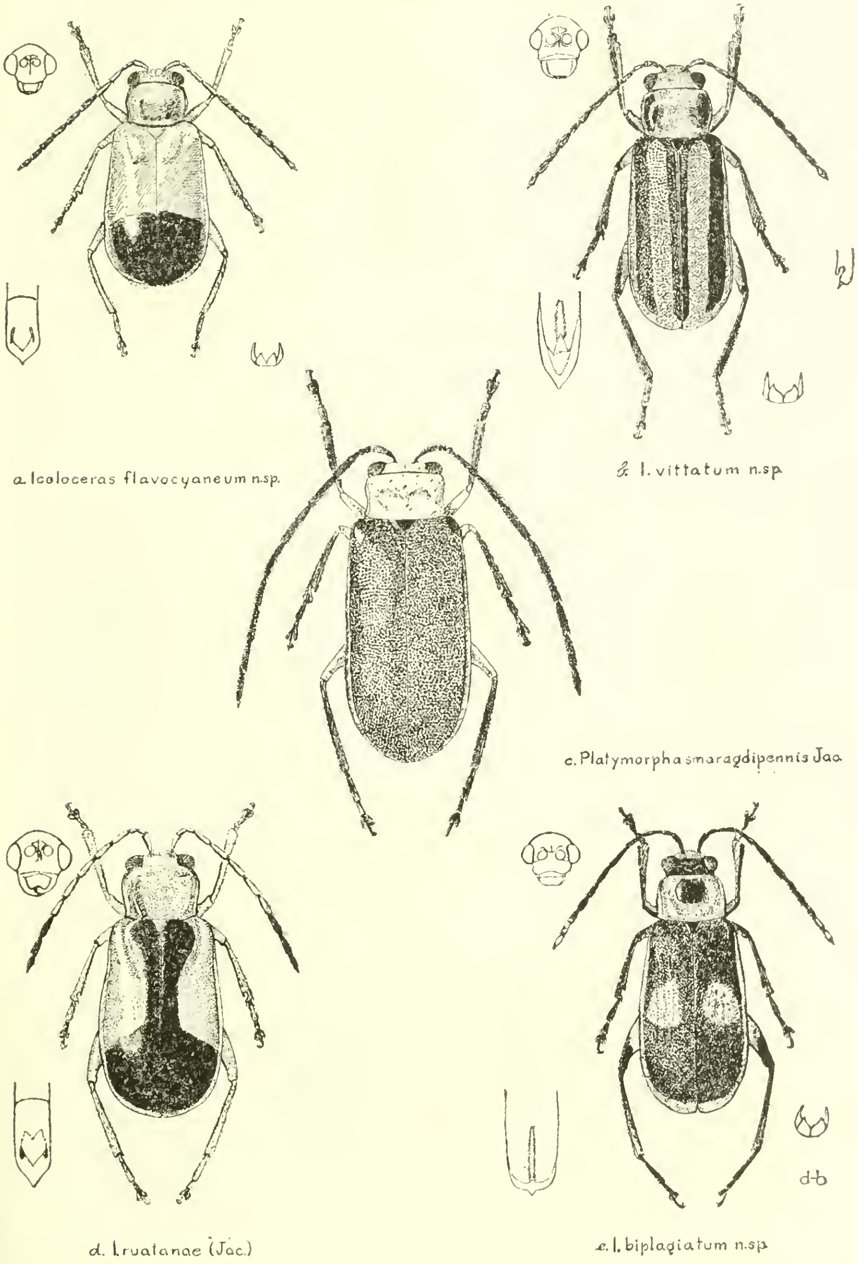


FIGURE 5.—*a, Iceloceras flavocyaneum,* new species; g, *I. vittatum,* new species; *c, Platymorpha smaragdipennis* Jacoby; *d, Iceloceras ruatanae* (Jacoby); *e, I. biplagiatum,* new species.

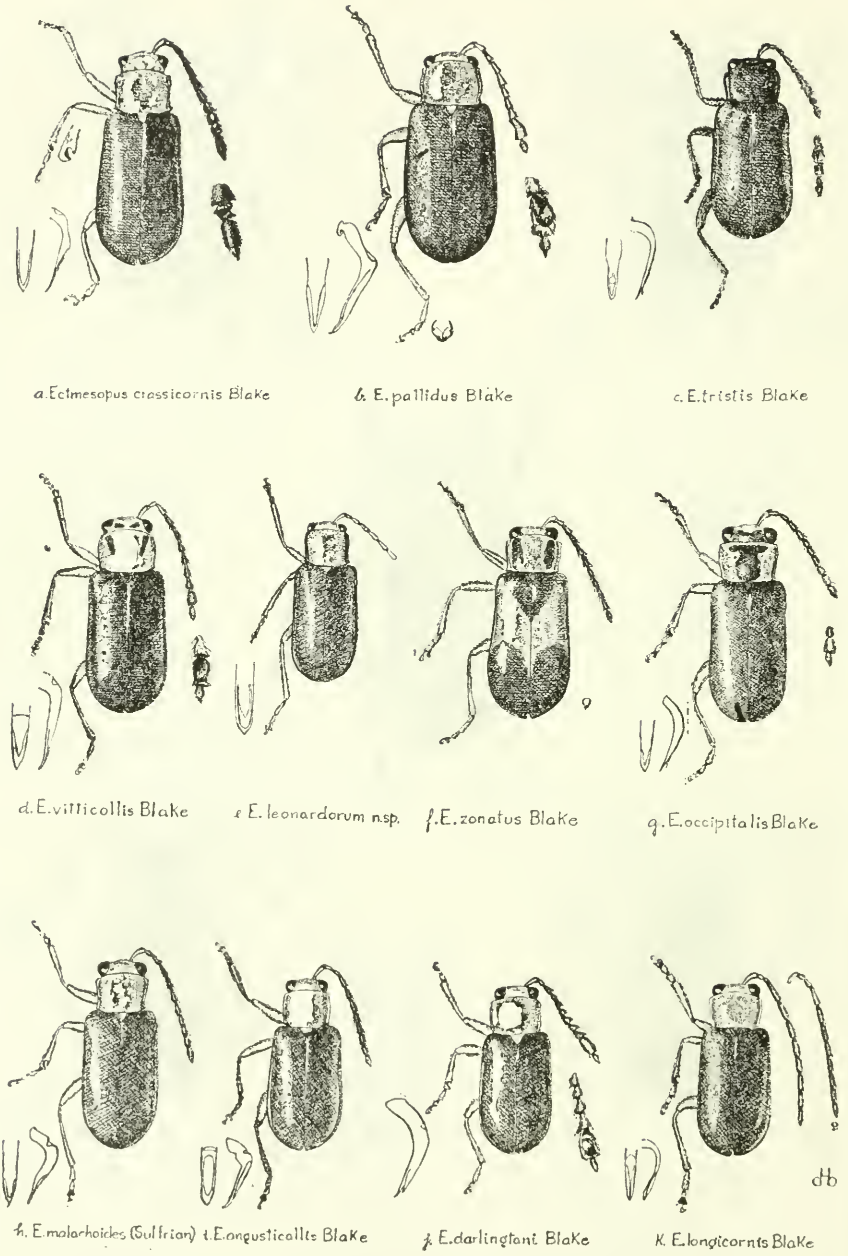


FIGURE 6.—*a*, *Ectmesopus crassicornis* Blake; *b*, *E. pallidus* Blake; *c*, *E. tristis* Blake; *d*, *E. vitticollis* Blake; *e*, *E. leonardorum*, new species; *f*, *E. zonatus* Blake; *g*, *E. occipitalis* Blake; *h*, *E. malachoides* (Suffrian); *i*, *E. angusticollis* Blake; *j*, *E. darlingtoni* Blake; *k*, *E. longicornis* Blake.

tarsal joint as in the group with the excised middle tibiae. In short, *Phyllobrotica* is not much more closely related to *Phyllecthrus* than is *Diabrotica*.

I wish to acknowledge my indebtedness to the U. S. National Museum and the Museum of Comparative Zoology for the material on which this study is based. Mr. G. E. Bryant of the British Museum (Natural History) has kindly made comparisons of types there and loaned me other specimens. Dr. Floyd Werner has sent me specimens from Arizona, and Mr. H. J. Grant has sent me notes on the Horn types. Dr. J. A. Wilcox has sent me a specimen with excised tibiae that he found in the Cornell University collection together with notes on other species, and called my attention to others in the Bowditch collection.

Key to genera of Galerucini here treated

1. Elytra without epipleura or the epipleura so narrow as to be inconspicuous, middle tibiae not excised in male . . . . **Phyllobrotica**
   Elytra with epipleura. Middle tibiae in male excised 2
2. Two anterior pairs of tibiae in male shallowly and broadly emarginate. Distal four joints of antennae in male greatly enlarged; claws bifid. **Diabrotica dilaticornis** Baly
   Middle tibiae alone deeply and narrowly excised. Claws appendiculate . . 3
3. Antennae 10-jointed in male. . . . . **Phyllecthrus**
   Antennae 11-jointed in male 4
4. Face excavated in male, third antennal joint much deformed, a nodule in middle of pronotum . . . . **Oroetes**
   Face in male not excavated 5
5. Hind femora in male greatly swollen . . . . **Leptonesiotes**
   Hind femora in male not swollen 6
6. Disk of pronotum not depressed . . . . **Ectmesopus**
   Disk of pronotum with transverse semicircular depression 7
7. Antennae in male with the distal joints thickened . . . . . . **Luperosoma**
   Antennae in male with the distal joints not thickened 8
8. Third antennal joint in male very short, cup-shaped, truncate at apex. **Platymorpha**
   Third antennal joint in male usually much longer than second, not cup-shaped at all, or truncate at apex . . . . **Iceloceras**

Genus *Phyllecthrus* LeConte

Phyllecthrus LeConte, Proc. Acad. Nat. Sci. Philadelphia, p. 207, 1865.

The original generic description is as follows:

> Body elongate, glabrous and nearly smooth above. Head transversely impressed between the eyes, and with a short median impressed line; acutely carinate between the antennae, which are very long, 2nd and 3rd joints together shorter than the 4th, nearly equal in size in the female, 2nd connate with the 3rd, and nearly obsolete in the male. Maxillary palpi stout, the last joint shorter than the preceding, slender, subsulcate, acute at tip. Prothorax quadrate, truncate at the apex with a lunate dorsal impression more or less distinct. Elytra with

the lateral margin distinct, epipleurae very narrow, not extending to the tip. Anterior coxae conical, contiguous; legs slender, tibiae not sulcate externally, middle tibiae of the male incised at the extremity on the inner margin; ungues with a large angular basal dilation. Abdomen with five ventral segments nearly equal in length and alike in both sexes.

I have adopted the generic name proposed in Dejean's Catalogue for *Gall. dorsalis* Oliv.

TYPE OF GENUS: *Phyllecthrus dorsalis* (Olivier).

Key to species of *Phyllecthrus*

1. Large, from 5 to 6.5 mm. in length . . . . **dorsalis** (Olivier)
   Small, from 3 to 4 mm. in length 2
2. Prothorax with wide dark lateral markings . . . . **gentilis** LeConte
   Prothorax entirely pale or with at most faint brown lateral spotting. Texas . . . . **texanus** LeConte

***Phyllecthrus dorsalis* (Olivier)**

FIGURE 1,*f*

Galleruca dorsalis Olivier, Entomologie, vol. 6, p. 646, 1808.
Phyllecthris dorsalis Dejean, Catalogue des Coléoptères, ed. 3, p. 406, 1837.
Galleruca atriventris Say, partim, Journ. Acad. Nat. Sci. Philadelphia, vol. 3, pt. 2, p. 461, 1824.
Phyllecthrus dorsalis LeConte, Proc. Acad. Nat. Sci. Philadelphia, p. 207, 1865.

Between 5 and 6.5 mm. in length, elongate oblong oval, alutaceous but moderately shiny, finely punctate; head, prosternum, breast and femora yellowish brown, the last with a dark streak; prothorax with wide dark piceous lateral markings, the lateral margin and middle of disk yellow-brown; in some Kansas, Nebraska, and Missouri specimens the pronotum entirely pale; scutellum pale, elytra, tibiae and tarsi piceous. In male the antennae 10-jointed and middle tibiae notched.

Head with interocular space half width of head, smoothly rounded over occiput, finely and sparsely punctate, frontal tubercles well marked, a short bulging carina between antennal sockets, lower front moderately long, with scattered punctures. Antennae in male 10-jointed, 2d joint alone short, rest long, black and hairy and extending well below middle of elytra, the terminal joint often reddish brown. Antennae in female 11-jointed, 2d and 3d joints short, with the 3d a little longer, but together not so long as 4th, remainder a littler shorter than 4th and slender, not so long or wide as in male and deep brown, not black. Prothorax wider than long with only slightly curved sides and a shallow depression in lower half, in some specimens faint; shiny, impunctate; dark piceous with pale lateral margin and a pale median area varying in size and shape from a central roundish spot to an elongate pale line; in some Nebraska, Kansas, and Missouri specimens the pronotum entirely pale. Scutellum pale. Elytra widened toward apex with well-marked humeri and short intrahumeral sulcus, distinctly alutaceous although shiny, and finely punctate, entirely dark piceous. Epipleura disappearing after middle. Body beneath pale with abdomen dark, femora pale except for dark streak and apex of middle and posterior legs, tibiae and tarsi piceous. Anterior coxal cavities open, middle tibiae of male notched near apex, tibiae with inconspicuous spine, claws appendiculate, front tibiae in male thickened and first tarsal joint swollen with tympanum-like underpart. Length 5–6.5 mm.; width 2.3–3 mm.

TYPE: Perhaps in Paris, described by Olivier from "Caroline."

DISTRIBUTION: *District of Columbia:* Washington, Hubbard and Schwarz; *Maryland:* Glen Echo, J. C. Bridwell; Plummers Island, W. L. McAtee, F. Knab; Great Falls, F. Knab. *Virginia*: Falls Church, Wm. Middleton; Rosslyn, F. H. Chittenden, F. Knab, Glencarlyn, F. Knab, J. C. Bridwell. *Pennsylvania:* Fall collection. *Illinois:* Southern Illinois; Monroe County, H. Soltau. *West Virginia:* White Sulphur Springs. *North Carolina:* Raleigh. *South Carolina:* Near Charleston (Olivier's type probably collected here by Bosc). *Georgia:* Fall collection. *Missouri:* Crevecoeur Lake, F. Knab. *Nebraska:* West Point; Kenosha, Elliott. *Kansas:* Topeka, Popenoe; Ashton; Onaga, F. F. Crevecoeur.

REMARKS: In Illinois, Kansas, Nebraska, and Missouri occur specimens with the pronotum entirely pale. However in a series of four specimens from Crevecoeur Lake, St. Louis County, Mo., all collected June 7, two specimens have the pronotum entirely pale, two are typically dark marked. In a series of seven from Onaga, Kansas, five have entirely pale pronotum, two are dark marked. Similarly, in a series from southern Illinois, while the majority are with an entirely pale pronotum, a few have typically dark-marked pronotum. Hence this pale coloration would seem merely a color phase.

***Phyllecthrus gentilis* LeConte**

FIGURE 1,*d*

Phyllecthrus gentilis LeConte, Proc. Acad. Nat. Sci. Philadelphia, p. 208, 1865.

Phyllecthrus nigripennis LeConte, partim, Trans. Amer. Ent. Soc., vol. 2, p. 58, 1868.

Phyllecthrus gentilis var. *nigripennis*, Horn, Trans. Amer. Ent. Soc., vol. 20, p. 127, 1893.

About 3 mm. in length, elongate oblong oval, shining although finely alutaceous, pale yellow with dark antennae except the three basal joints, and with wide dark lateral markings on pronotum, the elytra dark except for the lateral margins and sutural edges; in some western specimens (*nigripennis*) the entire elytra dark; tip of abdomen dark; in male the antennae 10-jointed, and middle tibiae notched.

Head smooth and shiny over occiput with punctures above the distinctly marked frontal tubercles, interantennal area narrow and flat, the labrum wide, lower front paler than upper. Antennae in male 10-jointed, basal three joints pale with dark edges, the remainder piceous, joints 3–5 long, rest gradually diminishing in length. In female, antennae 11-jointed, joints 2, 3 short, subequal, remainder longer and subequal. Prothorax a little wider than long with nearly straight sides, disk with a faint semicircular depression in basal half, sides widely piceous, margins, base and median space pale yellow, shiny, punctate on sides. Scutellum pale. Elytra with small humeri, elongate and narrow, alutaceous but shiny, piceous except for pale lateral and sutural margins; in some western specimens (*nigripennis*) elytra entirely dark. Body beneath, except tip of abdomen, and legs pale; middle tibiae of male notched near apex, and tibiae with fine spine, claws appendiculate. Length 3–4 mm., width 1.4–1.8 mm.

TYPE: A male in the LeConte collection, bearing a pale scarlet round locality label signifying the Southern States. There are two others with similarly colored labels, a male and female. The type of *Phyllecthrus nigripennis* is a male from "Ks." Two others, bearing a similar locality label, are females (?).

DISTRIBUTION: *New York:* C. V. Riley. *Pennsylvania:* Alleghany, Wickham. *Maryland:* Beltsville, W. L. McAtee; Plummers Island, W. L. McAtee; Chesapeake Beach, H. S. Barber. *District of Columbia:* Washington, Hubbard and Schwarz on *Pinus virginiana*, W. L. McAtee; Rock Creek Park, Heidemann. *Virginia:* Glencarlyn, F. Knab; Kanawha, on *Robinia*, A. D. Hopkins. *Ohio:* Cincinnati, H. Soltau. *Illinois:* Heyworth, Wolcott; Starved Rock State Park, F. G. Werner. *Iowa:* Iowa City, Wickham. *Missouri:* St. Louis County, F. Knab.—Distribution of *P. nigripennis: Nebraska:* Fillmore. *Iowa:* Lake Okoboji, Buchanan. *Kansas:* Onaga, F. F. Crevecoeur; Wickham; Riley County, F. Marlatt.

REMARKS: Horn reduced *P. nigripennis* LeConte to a variety of *P. gentilis.* Comparison of the two types in the LeConte collection shows that the two are very much alike except that *nigripennis* is darker in coloring, having the elytra entirely dark, and the abdomen dark, the breast not so dark, the epipleura pale. The aedeagus of a dissected specimen from Kansas appears like that of *gentilis.* This darker coloring of the western specimens may be analogous to that of western specimens of *dorsalis*, Say's *atriventris.* Horn gives a record of *P. gentilis* being taken on *Robinia pseudacacia* by Dr. Hamilton.

Phyllecthrus texanus LeConte

FIGURE 1,*c*

Phyllecthrus texanus LeConte, Trans. Amer. Ent. Soc., vol. 12, p.28, 1884.
Phyllecthrus gentilis var. *texanus* Horn, Trans. Amer. Ent. Soc., vol. 20, p. 58, 1893.

About 3 mm. in length, elongate oblong, shining although the elytra are alutaceous, finely punctate, prothorax with a semicircular depression in basal half, in the male the antennae 10-jointed and the middle tibiae notched near apex; antennae dark, head, prothorax, undersurface, legs (except tarsi), and margin of elytra pale yellow-brown, elytra otherwise piceous.

Head entirely pale, smoothly rounded over occiput down to the frontal tubercles with an area over tubercles on each side of distinct, closely placed punctures, tubercles not swollen but distinctly marked, interantennal area narrow, not much produced, labrum wide. Antennae dark and in male 10-jointed, joints 3–10 long and subequal; antennae in female 11-jointed, the 3d joint short and equal to 2d in length. Prothorax almost as long as wide with sides only slightly curved, a semicircular depression in lower half, entirely pale yellow-brown except in two or three specimens a faint brownish spotting on each side; shining. Scutellum yellow-brown. Elytra smoothly rounded, without depression, shining although alutaceous and with fine, not dense punctures becoming invisible towards apex; piceous with pale yellow-brown explanate margin from apical curve on becoming piceous. Epipleura indistinct after middle. Body beneath pale yellow-brown, lightly pubescent; legs pale with tarsi deeper in color; middle tibiae of male notched near apex; tibiae with fine spine at apex; claws appendiculate. Length 3.3 mm.; width 0.9 mm.

TYPE: Female, in the LeConte collection, and four paratypes (two males, two females) collected by Belfrage in Texas. In the collection of the U. S. National Museum are 30 more specimens labelled "Texas, Belfrage, Eutopotypes" by H. S. Barber, which are evidently from the same series as the LeConte specimens.

REMARKS: This is one of the species described by LeConte and published after his death by Horn who later synonymized it with *P. gentilis*, as a color form like *P. nigripennis*. It is probably a distinct species as the aedeagus is somewhat different and the prothorax has no distinct dark markings as in *gentilis*, and the elytral markings are unlike either *gentilis* or *nigripennis*. I have seen no other specimens besides those taken by Belfrage.

Genus *Oroetes* Jacoby

Oroetes Jacoby, Biologia Centrali-Americana, Coleopt., vol. 6, pt. 1, p. 600, 1888.

The original generic description is as follows:

> Head broad, the penultimate joint of the palpi incrassate; antennae filiform, deformed in the male, the second and third joints short; thorax transversely subquadrate, the surface deeply depressed; elytra irregularly punctured, their epipleurae obsolete below the middle; the posterior tibiae with a short spine (this is present on all tibiae); the intermediate tibiae notched near the apex in the male; the first joint of the posterior tarsi rather longer than the following three joints united; claws appendiculate; the anterior coxal cavities open.
>
> This new genus, which should be placed near *Luperus*, is separated from any of the genera composing this section by the broad head and the depressed thorax,

and by the elytral epipleurae being obsolete below the middle; the male insect is further distinguished by the structure of the antennae, and by the intermediate tibiae being notched near the apex.

TYPE OF GENUS: *Oroetes flavicollis* Jacoby.

Oroetes flavicollis Jacoby

FIGURE 2,*e*

Oroetes flavicollis Jacoby, Biologia Centrali-Americana, Coleopt., vol. 6, pt. 1, p. 600, 1888.

About 5 mm. in length, oblong oval, shining, the elytra finely punctate; pale reddish yellow, antennae with basal joints pale, rest piceous, elytra a violaceous blue except for a pale margin in basal half. In male the 3d antennal joint long and with a rounded excision, 4th joint flattened and curved, in female the 3d joint short; in male the face excavated and a spine in the middle of the lower front, the pronotum with a median tubercle; middle tibiae notched near apex.

Head in female smoothly rounded over occiput and down front, with little sign of frontal tubercles or interantennal carina, lower front flat, interocular space more than half its width; in male, the lower front excavated between antennae and below this a transverse ridge with a median spine, two flat side pieces extending from below antennal sockets to labrum. Antennae nearly as long as beetle, in female filiform, slender, pubescent, first two joints pale yellow, 3d, also pale, and 4th short and subequal, rest much longer and dark. In male the first four basal joints pale, the first joint swollen, 2d short, 3d long and flattened below and broadened with a cut out excision near the base, 4th joint flattened below and a little swollen and long, remainder long and hairy and dark. Prothorax almost rectangular with sides only slightly curved, in male the anterior margin roundly produced in middle over occiput of head, in female straight across; in male, a median tubercle on anterior half with a fovea in front of it; in both sexes a semilunate transverse depression in basal half. Surface shining, impunctate, pale reddish yellow. Scutellum pale. Elytra shining violaceous with the anterior explanate margin pale, distinctly and moderately densely punctate. Epipleura becoming indistinct before apical curve. Body beneath and legs entirely pale, anterior coxal cavities open, tibiae with fine spine, middle tibiae of male notched near apex, first tarsal joint of anterior legs in male slender and cylindrical with tympanum-like covering underneath; in posterior legs first tarsal joint long, claws appendiculate. Length 5–5.4 mm.; width 2.4 mm.

TYPE: Probably in British Museum (Natural History), described from specimens from Chontales, Nicaragua, and Bugaba and David, Panama.

Other localities: Escocia (Costa Rica?), Nevermann; Piedras Negras, Costa Rica, Schild and Burgdorf.

Remarks: The extraordinary development of the antennae, head, and pronotum in the male bewilders a taxonomist trying to place this beetle in a genus. The excavation of the head and abnormal antennae are suggestive of *Cerotoma*, but the depressed pronotum, the notched middle tibiae in the male, and the *Luperus*-like shape place it near *Phyllecthrus*. It deserves generic standing. Jacoby describes the Nicaragua and Panama specimens as having four pale basal antennal joints in the male. In the specimens I have examined from Costa Rica, only three basal joints are pale in the male and only the first two in the female. Otherwise the description fits.

Leptonesiotes, new genus

Elongate oblong oval, glabrous and without conspicuous punctation, the head with well-marked frontal tubercles, with a short carina between the antennal sockets, jaws large; antennae 11-jointed, not extending much below the middle of the the elytra, in the male, joints 10 and 11 enlarged, joint 3 barely twice as long as joint 2 and a little shorter than joint 4, joints 3–9 subequal. Prothorax a little wider than long with slightly curved sides, somewhat narrowed towards base, disk convex, without depressions. Elytra a little broader behind, the humeri well developed with an intrahumeral sulcus. Epipleura extending to about the middle of the elytra; anterior coxal cavities open; in the male a thickening of the front tibia, the first joint of the front tarsi short and thick with the undersurface having a flat tympanum-like appearance; middle tibiae with a notch on the inner margin near apex; hind femora much enlarged but narrowed at apex, no apical spine discernible, posterior first tarsal joint longer than the rest together; claws appendiculate.

Type of genus: *Diabrotica cyanospila* Suffrian.

Remarks: The name is derived from the Greek "leptos," delicate, and "nesiotes," islander.

Leptonesiotes cyanospila (Suffrian)

Figure 1,*e*

Diabrotica cyanospila Suffrian, Arch. Naturg., vol. 33, No. 3, p. 313, 1867.

About 5.5 mm. in length, elongate oblong oval, shining, the elytra conspicuously punctate, yellow (? reddish in life) with dark head and dark humeral and apical spot on each elytron shining with a purplish or violaceous lustre, last two abdominal segments deep violaceous, the femora and tibiae also dark, tarsi reddish brown, antennae pale, and in the male with the two distal joints enlarged, in the male also the middle tibiae notched near the apex.

Head smooth and shining, with a shallow depression over the well-marked frontal tubercles, space between antennal sockets slightly produced in a short carina down front; labrum wide, jaws large, lower front deep reddish brown, upper part of head dark with a violaceous lustre. Antennae entirely pale, not extending to middle of elytra, 3d joint shorter than 4th, joints 3–9 subequal, the two distal joints in the male enlarged and somewhat distorted. Prothorax a little wider than long, with slightly curved sides and oblique basal angles, moderately convex, the disk without depressions, shiny yellowish. Scutellum pale. Elytra shiny, pale with dark violaceous spot covering humerus and extending almost to scutellum, another larger dark spot below middle extending from the margin nearly to the suture, but not reaching apex. Body beneath pale except the last two ventral segments, which are deep violaceous. Femora and tibiae dark, the tarsi reddish brown. Middle tibiae of male with notch near apex, no spurs discernible on tibiae. Claws appendiculate. Length 5.5 mm.; width 2.4 mm.

Type: Perhaps in Gundlach collection in Havana, Cuba. Collected in Cuba.

Other localities: *Cuba:* Havana, Baker; Taco Taco, S. C. Bruner, A. Acuña, C. H. Ballou.

Remarks: I know of no other galerucid beetle that has the enlarged hind femora, notched middle tibiae, and antennal enlargement in the male. *Leptoxena eximia* Baly from the Andaman Islands, also a galerucid beetle, has similar enlargement of the hind femora and dilated antennal joints in the three distal joints, but not the notched middle tibia. It is an entirely different looking beetle and in no way related to the present one.

Iceloceras, new genus

Elongate oblong oval, glabrous, confusedly punctate, antennae filiform, not enlarged in male, the 3d joint sometimes subequal to 2d, sometimes twice as long; prothorax subquadrate, wider than long, with slightly curved sides; a semicircular depression in lower half. Elytra little widened apically, epipleura vanishing at apical curve; anterior coxal cavities open; anterior front tibiae in male swollen and first tarsal joint short and wide with undersurface having tympanum-like covering; middle tibiae of male notched near apex; middle and hind tibiae with small spur; first tarsal joint of posterior legs long, nearly equalling the rest of joints together; claws appendiculate.

Type of genus: *Diabrotica sexplagiata* Jacoby.

The type of the genus *Neobrotica*, as has been so designated by Weise, is *N. variabilis* Jacoby. The several species that have been confused under the name of *N. sexplagiata* (Jacoby) bear little resemblance to *N. variabilis.* They are differently shaped, being oblong instead of widened at the apical end. They have longer heads and smaller eyes. The sex character of the excised middle tibiae in the male, found in them, is not found in *variabilis.* In short, they fit better into the group with notched middle tibiae than into that miscellany of species called *Neobrotica,* although there is no antennal difference between the sexes. Besides *sexplagiata* are other species, one of which has been also described under *Neobrotica, N. ruatanae* Jacoby from Honduras. There is another undescribed species from Mexico closely related to *ruatanae.* In both of these the middle tibiae of the male are notched and the antennae not enlarged in the male. But they differ from *sexplagiata* in the length of the 3d antennal joint, which is short and subequal to the 2d, whereas in *sexplagiata* it is long. In this regard these two form a connecting link with the genus *Luperosoma.* Besides these is another undescribed species from South America that is more closely related to *sexplagiata.* All of these species are a little different from the other groups having for the male character the notched middle tibiae in that they do not have any enlarged or otherwise deformed antennal joints in the male; consequently, the genus *Iceloceras,* is here erected for them.

The name is from the Greek "ikelos," like, and "keras," horn.

Key to species of *Iceloceras*

1. Third antennal joint short 2
   Third antennal joint fully twice as long as second 3
2. Elytra with a wide dark sutural marking curving down and widening to cover apex of elytra except margin . . . . **ruatanae** (Jacoby)
   Elytra with only apical third dark . . . . . . **flavocyaneum,** new species
3. Elytra vittate. 4
   Elytra not vittate 5
4. Elytra with a sutural and a lateral vitta, not joined at apex. **vittatum,** new species
   Elytra with a wide median dark vitta . . . . **nymphaea** (Jacoby)
5. Elytra piceous with a single pale spot in the middle of each elytron. **biplagiatum,** new species
   Elytra piceous with three pale spots on each, sometimes confluent 6
6. Legs entirely pale 7
   Tibiae, tarsi and usually femora at apex dark 9
7. Orange-brown with dark brown or piceous markings. South America. **maximum,** new species
   Pale yellow with piceous markings 8
8. Pronotum nearly impunctate, a dark spot on either side not extending below middle. Costa Rica . . . . **verbesinae,** new species
   Pronotum distinctly and rather densely punctate, the dark spot on either side extending nearly entire length. Panama . . . **flavipes,** new species
9. Femora entirely pale, tibiae and tarsi dark, the large dark spot on each side of pronotum extending nearly to middle. Panama. **latiplagiatum,** new species
   Femora with a dark streak at apex, tibiae and tarsi dark 10

10\. Pronotum with vittate piceous mark on each side. Panama, South America. **sexplagiatum** (Jacoby)

Pronotum with a spot on each side 11

11\. Large, 5–6 mm., an inconspicuous dark spot on each side of pronotum, sometimes lacking. Guatemala, Nicaragua, Honduras, Costa Rica. **parviplagiatum,** new species

Smaller, 4–5 mm., a dark spot on anterior sides of pronotum usually conspicuous. Mexico . . . . . **parviplagiatum teapense,** new subspecies

Iceloceras sexplagiatum (Jacoby)

FIGURE 2,*a*

Diabrotica sexplagiata Jacoby, Proc. Zool. Soc. London (1877), p. 151, 1878; Biologia Centrali-Americana, Coleopt., vol. 6, p. 527, 1887.

Neobrotica sexplagiata (Jacoby), Gahan, Trans. Ent. Soc. London (1891), p. 524, 1891.—Jacoby, Biologia Centrali-Americana, Coleopt., vol. 6, Suppl., p. 331, 1892.

Between 3.5 and 5 mm. in length, elongate oblong oval, the elytra densely and moderately coarsely punctate, shining, pale yellow with brown to piceous antennae and legs with a dark streak on the upper femora, dark tibiae and tarsi, and on the pronotum a dark vitta on each side, and the elytra with six yellow spots and a pale margin, the rest piceous black; middle tibiae of the male with a small notch near apex.

Head with interocular space a little more than half width of head; deep orange on occiput, pale yellow on lower front, smoothly rounded with fine punctures on occiput and a fine median line extending down lower front between frontal tubercles and a thin carina down lower front. Antennae entirely dark, 3d and 5th joints a little shorter than 4th. Prothorax about a third wider than long, sides slightly curved and a semicircular depression on lower half of disk; shining although finely alutaceous and finely punctate; pale yellow with a lateral piceous vitta on each side extending from anterior margin nearly to basal margin. Scutellum pale. Elytra dark piceous with three pale yellow spots on each and a pale margin; surface densely and coarsely punctate, shining. Epipleura extending to apical curve; in the female the last abdominal segment dorsally conspicuously black-edged, and the one before with a dark spot on each side. Body beneath entirely pale, with pale pubescence; femora pale with a dark streak above, posterior tibiae and tarsi dark, the notching on the middle tibiae of the male very small. Length 3.5–5 mm.; width 1.5–2 mm.

TYPE: Probably in the British Museum (Natural History).

DISTRIBUTION: *Panama:* Bella Vista, Nathan Banks, Aug. 8, 1924; Paraíso, C. Z., E. A. Schwarz, A. H. Jennings; Porto Bello, August Busck; Summit, N. L. H. Krauss; Miraflores, A. H. Jennings; Tobago Island, H. F. Dietz; Pueblo Nuevo, Papaya plantation, H. Morrison;

El Cermino, J. Zetek; Pedro Miguel, N. L. H. Krauss; Volcán de Chiriquí, 2500–4000 ft., Champion.

Remarks: In 1878 Jacoby described as *Diabrotica sexplagiata* a beetle whose habitat he gave as Peru and Panama. In 1887 he stated that the Peruvian specimens were a different species from the Panama ones and used the name *sexplagiata* for the Panama species. Gahan in 1891 called attention to the fact that the claws of *D. sexplagiata* were appendiculate and referred the species to the genus *Neobrotica.* This emendation Jacoby (1892) accepted in his Supplement to the Biologia. Meanwhile, Baly had described as *D. bivittaticollis* a similar form from Magdalena River, Colombia, which Jacoby (1892) referred to synonymy under his Panama species. In the material examined from Panama that I have tried to match with Jacoby's description of *sexplagiata,* I have found four distinct species. There are many of Jacoby's specimens in the Bowditch collection of the Museum of Comparative Zoology, and Mr. G. E. Bryant has kindly sent me other material from the British Museum, but in all this I have not found specimens that Jacoby originally had from Panama for his first description. In the Bowditch collection are three specimens from Volcán de Chiriquí, Panama, collected later by Champion, and the specimens from the British Museum are of this same series collected by Champion. Possibly Jacoby had earlier specimens collected by Salvin. But these Champion specimens match Jacoby's description. However, the two figures given later for this species in the Biologia Centrali-Americana Supplement are of beetles collected elsewhere, the first from Belize, British Honduras, with an entirely pale pronotum (in the original description the pronotum is given as having a lateral piceous vitta on each side extending from the anterior margin nearly to the basal margin), and the second from Tapachula, Chiapas, Mexico, which Mr. Bryant has sent me, with sutural and lateral elytral vittae, distinctly different from his description of the three large yellow spots on each elytron. It seems quite evident that Jacoby was confused by the wealth of his material, all of which he tried to include in his later account of *sexplagiata* in the Biologia. In reality there are a number of closely related species having the 6-spotted elytra, but differing in many other less obvious ways. These range from Mexico to Bolivia and Brazil.

In my interpretation of *sexplagiatum* I am considering these specimen from the Volcán de Chiriquí as typical as they correspond with Jacoby's original description. In Central America this species seems not to occur north of Panama. In South America, however, is found a beetle very similar to the Panama species in markings. Baly (1886a) described specimens from Magdelena River, Colombia, as *Diabrotica bivittaticollis.* Mr. Bryant has sent me a paratype of Baly's species which closely resembles the Volcán de Chiriquí specimens and may be identical with them. The Baly specimen unfortunately is a female. The only other specimens that I have seen from that region are two females collected by P. J. Darlington at Aracataca, Magdalena Province.

Specimens closely resembling these have been collected in Venezuela, Trinidad, Brazil, Peru, and Bolivia. On the whole, these South American specimens may be a little longer, the pale spots on the elytra larger, and the last three antennal joints, instead of being piceous, are generally pale. Because of these and some other minor differences, including the aedeagus, I am resurrecting Baly's name *bivittaticollis* for a South American subspecies. Future collections and study will contribute more knowledge to the subject.

Iceloceras sexplagiatum bivittaticole (Baly)

Figure 2,*c*

Diabrotica bivittaticollis Baly, Journ. Linn. Soc. Zool., vol. 19, p. 257, April 1885.

Neobrotica sexplagiata (Jacoby), Jacoby, in part, Biologia Centrali-Americana, Coleopt., vol. 6, Suppl., p. 331, 1892.

The only differences between this and typical *Iceloceras sexplagiatum* are in the somewhat larger size (length 4–5.5 mm., width 2–2.5 mm.), the larger pale spots on the elytra, and the wider and longer black vittae on the pronotum. The last three joints of the antennae, instead of being black, are usually pale brown. The aedeagus (at least of Tingo Maria specimen) is slightly different. The tip of the abdomen dorsally is darker. The small notch of the middle tibiae of the male is like that in typical *I. sexplagiatum*, these two forms differing from all the rest by having a much tinier notching.

Type: In British Museum (Natural History), collected on the Magdalena River, Colombia.

Distribution: *Colombia:* Aracataca, Magdalena Province, P. J. Darlington; Río Dagua, W. Rosenberg. *Peru:* Tingo María, Dieguez; Río Charapa, C. H. T. Townsend. *Venezuela:* Caracas, Panduze; San Esteban, E. Simon, 1st Jacoby collection (? Colombia or Venezuela). *Trinidad:* G. E. Bryant. *Brazil:* Bahia, P. G. Russell; Ceara; Independencia, Parahyba, W. M. Mann and Heath; Jataky, Goiaz Province; Bonito, Pernambuco Province, Dr. Brauns, 2d Jacoby collection; Santa Catharina. *Bolivia:* Rurrenabaque, Río Beni, W. M. Mann; Guanay, Mapire River, 1500 ft., Stuart.

Iceloceras maximum, new species

Figure 3,*c*

Approximately 7.5 mm. in length, elongate oblong oval, alutaceous, only faintly shining, head and prothorax densely and finely punctate, the elytra more coarsely and densely punctate; deep yellowish or orange-brown, the prothorax with a broad piceous spot on each side coming about half way down, elytra piceous with six pale yellow-brown spots and pale margin, legs and undersurface entirely pale and antennae pale with the three distal joints a bit deeper brown in color.

Head with interocular space about half width of head, alutaceous and finely punctate, a well-marked narrow carina running from between antennal sockets down lower front. Antennae pale with the last three joints brownish. Prothorax approximately one-third wider than long with somewhat rounded sides, disk with a semicircular transverse depression; alutaceous and distinctly and rather densely punctate; yellow-brown with a broad piceous spot on each side extending just below the middle of pronotum. Scutellum pale. Elytra distinctly alutaceous, and densely and shallowly punctate with a tendency to ridging, producing a semicostate appearance; three large, dull, yellow-brown spots and pale margin on piceous background. Epipleura extending to apical curve; legs and undersurface and last two abdominal segments dorsally entirely pale. Length 7–7.5 mm.; width 3.5–3.7 mm.

TYPE: Female, USNM 63355, Territorio Federal Amazonas Randal Salas, Aug. 15, 1951, Exp[edicion] F[ran]co Vene[zolana], Alto Orinoco.

OTHER LOCALITIES: One female from King Frederick William Falls, Couratryne River, Dutch Guiana, J. G. Myers; one female from "Culebra, N. Duida Territory, Amazons, 1950, J. Maldonado Capriles"; one female from Bogotá, Colombia.

REMARKS: This is the largest of the *sexplagiatum* group of beetles, and, unlike the rest, is dull deep orange-brown in its pale markings instead of pale yellow. Unfortunately, no male specimen has been collected.

***Iceloceras flavipes*, new species**

FIGURE 3,*d*

From 5–6.5 mm. in length, elongate oblong, somewhat shiny although distinctly alutaceous; prothorax rather densely punctate, elytra densely punctate with semicostate ridging; head, antennae, legs, and body beneath entirely pale, prothorax with wide piceous spot on each side wider anteriorly and extending nearly entire length; elytra piceous with three large pale spots on each elytron, the margin pale.

Head with interocular space about half width of head, shining, pale yellow, the occiput finely punctate, frontal tubercles distinctly marked, a narrow carina running down lower front from between antennal sockets. Antennae entirely pale, 3d joint shorter than 4th. Prothorax about one-third wider than long, with slightly rounded sides and semicircular transverse depression; surface shiny, more or less alutaceous, and with moderately coarse punctures. Scutellum pale. Elytra faintly alutaceous and densely and coarsely punctate, with irregular ridges giving it a semicostate appearance; piceous with three large pale yellow spots on each elytron, margin pale. Epipleura vanishing at apical curve; last two abdominal segments pale above. Body beneath and legs pale. Length 5.2–6.5 mm.; width 2.4–3.2 mm.

TYPE: Male and three paratypes (2 females, 1 male), USNM 63356 from Colima, Panama, collected by August Busck.

OTHER LOCALITIES: *Panama:* Pedro Miguel, A. H. Jennings; Barro Colorado, Canal Zone, May 1929, P. J. Darlington; Ft. Davis, Canal Zone, Nathan Banks, July 5, 1924. *Colombia:* Río Frío, Magdalena Province, P. J. Darlington.

REMARKS: Of the Central American species having pale legs and antennae, this one is the largest of the *sexplagiatum* group, and is characterized by having longer spots on the side of the pronotum extending nearly to the base. In addition, the pronotum is distinctly punctate. It approaches in size the South American species, *I. maximum,* but the coloring is different, and the mark on the pronotum is longer. In the Bowditch collection at the Museum of Comparative Zoology is a specimen from the first Jacoby collection with the label Peru and a name label "*D. bivittaticollis* Baly" (in Jacoby's handwriting?). The specimen is similar to the above specimens from Panama in its markings. It is a male but the abdomen is shrivelled and the specimen so old that I have not ventured to dissect it. Possibly this is the specimen from which in part Jacoby originally drew up his first description of *Diabrotica sexplagiata,* since the locality is Peru. Until further specimens from Peru can be obtained, I believe this specimen should be considered the same as *Iceloceras flavipes.*

***Iceloceras verbesinae*, new species**

FIGURE 3,*b*

Between 5 and 6 mm. in length, elongate oblong oval, shining, the elytra coarsely punctate and semicostate appearing; head, prothorax, body beneath, antennae, and legs pale yellow, the prothorax with a large piceous spot on each side in anterior half, elytra piceous with six pale yellow spots and margin pale.

Head with interocular space approximately half width of head, pale yellow, shining, a few fine punctures over occiput, tubercles well marked, carina between antennal sockets narrow and short, not extending down front. Antennae entirely pale, 3d joint shorter than 4th. Prothorax about one-third wider than long with slightly curved sides, a semicircular depression across disk, nearly impunctate, shining, pale yellow with a large piceous spot on each side in anterior half. Scutellum pale. Elytra shining, sometimes faintly alutaceous, densely and coarsely punctate, the punctures forming irregular ridges, giving the elytra a semicostate appearance; piceous with three pale yellow spots on each elytron, the margin pale. Epipleura extending to apical curve, last two abdominal segments entirely pale above, legs and undersurface entirely pale. Length 4.8–6 mm.; width 2–2.5 mm.

Type: Male, USNM 63357, and three paratypes, from Tucurrique, Costa Rica, Schild and Burgdorf; two paratypes in Museum of Comparative Zoology (No. 29612).

Other localities: *Costa Rica:* Juan Vineas, collected by C. H. Ballou on *Verbesina turbacensis* H. B. K.; Turrialba, Schild and Burgdorf, 2d Jacoby collection; Port Limón, P. J. Darlington; San José, Schild and Burgdorf.

Remarks: In this species with entirely pale legs and antennae, the pronotal spots are near the anterior margin of the prothorax and extend barely to the middle of the pronotum.

***Iceloceras latiplagiatum*, new species**

Figure 3,*a*

About 5.5 mm. in length, elongate oblong oval, shining although faintly alutaceous; head and prothorax finely and elytra coarsely punctate; pale yellow, the antennae brown with the four distal joints pale, pronotum with a large piceous spot on each side in anterior half nearly meeting in center; elytra dark with six pale yellow spots, margin pale; all femora pale, middle and posterior tibiae dark, anterior tibiae dark on one side; last two segments of abdomen entirely pale on dorsal side.

Head with interocular space half its width; smooth and shiny with a few fine punctures on occiput, frontal tubercles distinctly marked, a short carina between antennal sockets. Antennae brown with the four distal joints pale. Prothorax a little wider than long, with slightly curved sides, disk with deep semicircular depression; shiny although alutaceous, finely punctate; pale yellow with a broad piceous mark on each side of anterior half of pronotum, in two of the four specimens nearly meeting in the middle. Scutellum pale. Elytra piceous with three large pale yellow spots on each elytron, the margin pale, densely punctate, faintly costate. Epipleura vanishing at apical curve; last two segments of abdomen dorsally entirely pale. Body beneath entirely pale, anterior tibiae dark on one side, middle and posterior tibiae and all tarsi dark. Length 4.8–5.5 mm.; width 2.2–2.6 mm.

Type: Male and two paratypes, USNM 63358, collected at Porto Bello, Panama, Mar. 3, 1911, by August Busck. One paratype in Museum of Comparative Zoology (No. 29613).

Remarks: This species is characterized by having bicolored antennae, entirely pale femora, dark tibiae and tarsi, and very large dark spots on the anterior half of the pronotum.

***Iceloceras parviplagiatum*, new species**

Figure 2,*b*

Between 5 and 6 mm. in length, elongate oblong oval, somewhat shiny, although finely alutaceous, the head and pronotum finely and the elytra densely and coarsely punctate, pale yellow-brown, the spots and margin of piceous elytra pale yellow, the pronotum with a very small dark spot near lateral margin anteriorly, sometimes lacking; antennae dark with the basal and three distal joints tending to be paler, tibiae and tarsi more or less dark, and femora with a dark streak.

Head with interocular space more than half width of head, pale yellow in lower front, deeper in color on occiput, the occiput finely punctate, frontal tubercles somewhat swollen, a short carina not extending more than half-way down front. Antennae brownish or piceous with the three basal and three terminal joints tending to be paler. Prothorax approximately one-third wider than long, with slightly curved sides and a transverse semicircular depression; surface alutaceous and finely punctate, bright yellow with a small lateral piceous spot near anterior margin, not extending beyond the middle, sometimes very faint or even lacking. Scutellum pale. Elytra alutaceous, densely and coarsely punctate, the punctures often confluent and with semicostate ridging; piceous with three large pale spots on each elytron, the upper two sometimes confluent, the margin pale. Epipleura vanishing at apical curve, last ventral segment usually entirely dark on dorsal side. Body beneath pale, legs with anterior tibiae streaked with dark on upper surface, femora pale with a dark streak, middle and posterior tibiae and tarsi dark. Length 5–6 mm.; width 2–2.5 mm.

Type: Male, USNM 63359, and 22 paratypes, from El Salvador, E. J. Hambleton, collector, on yams and corn.

Other localities: *Guatemala:* San Geronimo, Champion; "Salagar, El Chico, Ven. Jicama." *British Honduras:* Belize, Blancaneaux, 2d Jacoby collection. *Honduras:* Tela, W. M. Mann; La Ceiba, F. J. Dyer; Río Hondo, Blancaneaux, 2d Jacoby collection. *El Salvador:* La Ceiba, K. A. Salman. *Costa Rica:* Port Limón, P. J. Darlington, May 9, 1929.

Remarks: Of the species with dark antennae, tibiae, and tarsi, this one is distinguished by the spot, sometimes lacking entirely, on the anterior side of the pronotum being small and near the anterior margin. This spot, located on each side of the pronotum, is half hidden when viewed from above and is usually much smaller than in the other closely related species. The antennae tend to have pale brown tips. This is one of the two species figured by Jacoby (1892) under *Diabrotica sexplagiata*, the drawing having been made from a specimen from Belize, British Honduras, having no pronotal spots.

Iceloceras parviplagiatum teapense, new subspecies

FIGURE 2,*d*

About 4.5 mm. in length, elongate oblong oval, somewhat alutaceous, faintly shining, head and pronotum almost impunctate, elytra with dense coarse punctures; pale yellow, the pronotum with a black spot (usually small) on anterior lateral half on each side, the spot never extending as much as half-way down, in one specimen entirely lacking; elytra dark with three pale yellow spots and a pale margin on each, the pale spots sometimes confluent; antennae entirely dark, middle and posterior tibiae and tarsi dark, and femora dark at apex.

Head with interocular space half its width; smooth, impunctate, frontal tubercles distinct, a very short elevated line between antennal sockets not extending down front. Antennae usually entirely dark, but in two specimens the last two or three joints paler, 3d joint shorter than 4th. Prothorax wider than long with slightly curved sides and semicircular transverse depression across disk; alutaceous, very finely punctate; pale with a dark piceous spot on each side, in anterior half barely reaching half-way down, and usually small, in one specimen entirely lacking. Scutellum pale. Elytra densely and coarsely punctate with faint sign of longitudinal ridging; piceous with three large pale spots, often confluent, on each elytron, the margin pale. Epipleura disappearing at apical curve; last two ventral segments entirely dark on upper side; femora pale with dark apex; tibiae of anterior legs dark on one side, middle and posterior tibiae and tarsi entirely dark. Length 4.3 mm.; width 1.8 mm.

TYPE: Male, in Museum of Comparative Zoology (No. 29611), and six paratypes, from Teapa, Tabasco, Mexico, H. H. Smith, in 2d Jacoby collection, Bowditch collection. Also one specimen taken at Teapa by Salle, 1st Jacoby collection.

REMARKS: This subspecies is smaller and darker than the more southern race, having entirely dark antennae and usually larger side spots on the pronotum, although they are sometimes lacking. In both races is found the tendency for the elytral pale spots to be confluent.

***Iceloceras vittatum*, new species**

Figure 5,*b*

About 4 mm. in length, elongate oblong oval, faintly shining, head and pronotum smooth, very finely punctate, elytra coarsely and densely punctate; pale yellow, the pronotum usually with a piceous vittate lateral marking on each side, variable in length, sometimes lacking, elytra with sutural and lateral deep brown vittae not joined at apex, femora pale with a dark streak, tibiae and tarsi in middle and posterior legs dark, tibiae of anterior pair with dark line, first three or four antennal joints pale, remainder dark.

Head smooth, shining, with distinctly marked frontal tubercles and short elevated line running down from between antennal sockets; entirely pale. Antennae with four basal joints paler than the piceous or brown outer joints, 3d joint shorter than 4th. Prothorax a little wider than long; with sides slightly curved; a semicircular transverse depression on disk; surface faintly alutaceous and finely punctate; pale yellow with reddish brown or piceous lateral vitta, sometimes lacking. Scutellum pale. Elytra pale with sutural and lateral brown vittae not united at the apex; surface densely and coarsely punctate, with no sign of costation. Epipleura vanishing at apical curve, last two ventral segments dorsally black with a pale median area. Femora pale with dark streak, anterior tibiae dark on one side, middle and posterior tibiae and tarsi entirely dark, and tibiae with tiny terminal spine. Middle tibiae in male notched. Length 4–4.5 mm.; width 1.7–2 mm.

Type: Male, USNM 63360, and nine paratypes, from San Marcos, Nicaragua, C. F. Baker collection (through Knab).

Other localities: *Nicaragua:* Chinandega, Baker collection. *Mexico:* Jicaltepec, Vera Cruz; Tapachula, Chiapas, Höge; San Rafale; "Mexique."

Remarks: This species is characterized by having vittate elytra, with the vittae not united at the apex. There is no sign of the elytral costation so common in the 6-spotted species. The specimen (one of two) figured by Jacoby (1887) under *Diabrotica sexplagiata* and sent to me by G. E. Bryant from the British Museum is this species, but it does not have the usual dark piceous vittate marking on each side of the pronotum, although there is a faintly marked vitta there.

***Iceloceras nymphaea* (Jacoby)**

Figure 4,*g*

Diabrotica nymphaea Jacoby, Biologia Centrali-Americana, Coleopt., vol. 6, pt 1. p. 541, 1887.

About 4 mm. in length, elongate oblong, shining, the elytra strongly and densely punctate, pale yellow brown with brown antennae having three apical joints pale; pronotum with a dark brown vitta on each side, elytra with a broad median dark brown vitta, apex of femora, tibiae and tarsi deeper brown.

Head shining, entirely pale brown, with well-marked frontal tubercles and carina extending down lower front. Antennae very long and slender, 3d joint half as long as 4th, brown with the three terminal joints pale. Pronotum a little broader than long with nearly straight sides, only shallowly depressed on each side in lower half; shining, impunctate, pale yellow-brown with a wide dark brown vitta on each side extending nearly the entire length. Scutellum pale. Elytra narrow and long, with small humeral prominences, densely and strongly punctate; pale yellow brown with a broad median dark brown vitta on each, wider at base and curving inwards toward the suture near apex. A few scattered hairs near apex of elytra. Body beneath entirely pale, femora with dark streak or apex dark, tibiae and tarsi deep brown. Anterior coxal cavities open, tibiae with terminal spine, first tarsal joint on hind legs about equal to remaining joints together, middle tibiae of male very deeply excised, claws appendiculate. Length 3.8–4.4 mm.; width 1.7–1.8 mm.

Type localities: *Panama:* Bugaba, Volcán de Chiriquí, Boquete, Caldera, collected by Champion.

Remarks: This is another species described as a *Diabrotica* that has appendiculate claws and in the male deeply excised middle tibiae. It belongs near the *Iceloceras sexplagiatum* group.

Iceloceras biplagiatum, new species

Figure 5,*e*

About 5 mm. in length, narrowly oblong oval, head and prothorax smooth and shining, elytra densely and coarsely punctate and with faint median costae, prothorax with semicircular transverse depression; pale yellow with head from tubercles upwards piceous, antennae piceous except the two pale distal joints, the tips of these being dark, prothorax pale with a large median dark spot, elytra piceous with pale margin and a roundish pale median spot on each elytron, body beneath with breast and abdomen brown, femora dark on upper side and at apex on posterior femora, tibiae and tarsi piceous, middle tibiae of male with notch near apex.

Head with interocular space about half width of head, eyes large, antennal sockets contiguous, tubercles distinctly marked, a shallow semicircular depression above tubercles, this upper portion of head shining piceous and finely punctate, below antennal sockets the front broad, moderately long and pale, a shallow depression in middle, coarsely and densely punctate, labrum short. Antennae long and slender, with joints 3–11 subequal with 4th and 5th joints longest, piceous except the two distal joints and these with a darker tip. Prothorax approximately one-third wider than long with nearly straight sides, only slightly tapering apically; a semicircular transverse depression on disk, shining, impunctate, pale yellow with a large median dark brown spot nearest anterior margin and extending to below middle. Scutellum dark. Elytra widening slightly towards apex, densely and coarsely punctate, with faint costae not reaching either base or apex; piceous with a pale margin, wider at apex, and a large, pale, roundish spot in middle of each elytron. Epipleura pale, vanishing at apical curve. Body beneath with breast and abdomen brown, the former with pale sides and the latter having tip of each segment pale, lightly pubescent. Legs with the pale femora bearing a dark streak on top, and hind femora dark at apex, tibiae and tarsi dark; middle tibiae of male with a notch near apex; claws appendiculate. Length 4.8 mm.; width 2 mm.

TYPE: Male, USNM 63361, from Isiamas, Bolivia, W. M. Mann, Mulford Biological Expedition, 1921–1922.

REMARKS: This is clearly closely related to *I. sexplagiatum,* although with only one pale spot on each elytron, and a median dark spot on the pronotum.

Iceloceras ruatanae (Jacoby)

FIGURE 5,*d*

Neobrotica ruatanae Jacoby, Biologia Centrali-Americana, Coleopt., vol. 6, Suppl., p. 335, 1892.

About 6 mm. in length, elongate oblong oval, shining, the elytra obsoletely punctate, prothorax with a wide transverse depression; elytra with deep incurving intrahumeral sulcus extending nearly a third of the way down; pale yellow, the antennae deepening in color towards apex, elytra with a violaceous brown median marking, beginning about scutellum and curving down to cover whole width of elytra before apex, leaving the margin pale; middle tibiae of male notched.

Head with interocular space half width of head, shining, finely punctate on occiput, frontal tubercles distinctly marked, a slight median elevation in lower front, labrum wide; entirely pale except the brown tips of mandibles. Antennae long and slender, the 2d and 3d joints short and subequal, rest long, the joints gradually becoming a little shorter near apex and deeper in color. Prothorax somewhat wider than long with only slightly curved sides, not much narrower anteriorly; a wide transverse depression across disk; surface entirely pale, shining, impunctate. Scutellum pale. Elytra a little wider towards apex, with wide explanate margin, a well-marked intrahumeral sulcus curving towards suture; surface obsoletely punctate, shining, pale with a violaceous brown sutural mark that is wide about suture, curving down to a narrow stretch in middle of elytra and again widening beyond the middle to cover all but margin in apical third. Epipleura vanishing before apical curve. Body beneath and legs entirely pale. Middle tibiae in male notched, a fine spine on tibiae; claws appendiculate. Length 6 mm.; width 2.4 mm.

Type: In British Museum (Natural History), from Ruatan Island, Honduras.

Other localities: *Honduras:* Puerta Castilla, Jos. Bequaert, April (MCZ); "Roatan Id.," F. J. Dyer, Mar. 28, 29, 1916.

Remarks: In the short third antennal joint this species resembles *Luperosoma*, but there is no enlargement of the antennal joints.

Iceloceras flavocyaneum, new species

Figure 5,*a*

Between 4 and 5 mm. in length, elongate oblong oval, shining, nearly impunctate, the elytra very finely punctate, yellow with posterior part of elytra violaceous; antennae pale with the last five joints a little darker; middle tibiae notched in male.

Head with interocular space half its width, smooth, shining, impunctate, pale yellow; frontal tubercles not very distinct, a median line from between antennal sockets. Antennae with 2d and 3d joints short, 4–11 long and subequal, the five basal joints pale, the remainder reddish brown. Prothorax a little wider than long with slightly curved sides, shallowly depressed in lower half, shining, impunctate, pale yellow. Scutellum pale. Elytra shining, very finely punctate, pale yellow with a violaceous spot covering apical third, leaving margin pale (in one specimen from Panama the suture also pale). Epipleura vanishing before apical curve. Body beneath entirely pale, tibiae with tiny terminal spine; claws appendiculate, middle tibiae notched in male. Length 4–5.3 mm.; width 1.8 to 2.2 mm.

Type: Male, USNM 63362, from Santa Lucretia, Tehuantepec, Mexico, W. M. Mann; one paratype in Museum of Comparative Zoology.

Other localities: Santa Lucretia, Vera Cruz, Mexico, F. Knab; XX Plantation, Panama.

Remarks: This species is closely related to *I. ruatanae* (Jacoby) with the same short 2d and 3d antennal joints, and is intermediate in the matter of generic placing between *Iceloceras* and *Luperosoma*.

Genus *Luperosoma* Jacoby

Luperosoma Jacoby *in* Whymper, Travels amongst the Great Andes of the Equator, Supplementary Appendix, p. 87, 1891.

The original generic description is as follows:

> Male. Body elongate; eyes entire; third joint of palpi robust, swollen; frontal tubercles very swollen, transverse; antennae subfiliform, incrassate towards the apex, second and third joints very short, subequal, fourth as long as the two preceding joints together; thorax square-shaped, transversely depressed at the disk; apex of the scutellum obtuse; elytra irregularly punctured, their epipleurae indistinct below the middle; tibiae without spine "(not true)," the intermediate emarginate at the apex; the inner margin produced in shape of a spine; posterior first tarsal joint as long as the two following ones united; claws appendiculate; anterior coxal cavities closed. Female. Intermediate tibiae without emargination, prosternum not visible.
>
> Type (of genus) *Luperosoma marginata.*
>
> I am obliged to erect this genus for the reception of a small species of *Galeruca* having the appearance of *Diabrotica* or *Luperus*, and distinguished from either and other genera by the unarmed tibiae [there is a small spine on the middle and posterior tibiae]; short second and third joints of antennae and the other characters given above. The curious structure of the tibiae in the male is another peculiarity of the genus which would enter Chapuis' 26th group, the Platyxanthinae.

Key to species of *Luperosoma*

1. North American 2
   South American 4
2. Elytra distinctly costate . . . . **subsulcatum** (Horn)
   Elytra not distinctly costate 3
3. Elytra piceous with pale margin . . . . **parallelum** (Horn)
   Elytra entirely piceous . . . . **schwarzi** (Horn)
4. Thorax entirely dark . . . . **nigrum,** new species
   Thorax pale with dark markings 5
5. Large, 5 mm., last three antennal joints in male enlarged, pronotum with heavy lateral dark markings . . . . **amplicorne** (Baly)
   Smaller, 3–3.5 mm., joints 8–10 in male enlarged, pronotum pale with median dark spot . . . . **marginatum** Jacoby

Luperosoma marginatum Jacoby

Figure 4,*c*

Luperosoma marginata Jacoby, *in* Whymper, Travels Amongst the Great Andes, Supplementary Appendix, p. 87, 1891.

Phyllecthrus marginatus Weise, *in* Junk, Coleopterorum catalogus, pt. 78, p. 109, 1924.

From 3–3.5 mm. in length, oblong oval, shining, the elytra very faintly punctate, pale yellow-brown with piceous antennae and deep brown occiput of head, a dark brown median area on pronotum, the elytra sometimes with a wide brown median vitta on each elytron, in other specimens this vitta so pale as to be nearly indistinct; body beneath dark, legs for the most part pale, middle tibiae in male notched, and antennal joints 8–10 swollen.

Head with interocular space half its width, frontal tubercles swollen, and interantennal area carinate, upper part of head deeper brown than lower. Antennae fully half as long as beetle, the basal joints a little paler, rest piceous, 2d and 3d joints short and together barely as long as 4th, remainder shorter than 4th and subequal, joints 8–10 swollen in male. Prothorax wider than long with nearly straight sides, a faint semicircular depression in lower half, nearly impunctate, shining, dirty yellow-brown with a roundish piceous median area in anterior half. Scutellum dark. Elytra wider towards apex and with small humeral prominences and short intrahumeral sulcus; shining, very faintly punctate, dirty yellow-brown, in some specimens a wide piceous vitta, in others this vitta pale reddish brown and indistinct. Epipleura extending to middle of elytra. Body beneath dark, legs pale, the two anterior tibiae with a pale reddish brown area in middle, in the male the anterior tibiae somewhat swollen and the first tarsal joint cylindrical and short, the middle tibiae notched near apex, the middle and posterior tibiae (contrary to Jacoby's description) with a very fine, inconspicuous spine; claws appendiculate. Length 3–3.5 mm.; width 1.5 mm.

TYPE: Probably in the Bowditch collection, Museum of Comparative Zoology, where there are three specimens (named in Jacoby's description) from Quito, Ecuador, alt. 9500 ft., Ed Whymper collector, bearing an old label "*Luperosoma marginata*," written by Jacoby, 2d Jacoby collection.

REMARKS: These three specimens in the Bowditch collection are probably the three original ones described by Jacoby (1891) although in the text of his description the locality is given as "Panecillo Quito, 10,000 ft."

***Luperosoma nigrum*, new species**

FIGURE 4,*e*

Approximately 3 mm. in length, oblong oval, shining, the elytra distinctly punctate; entirely black except for a narrow pale sutural and marginal edging on the elytra; antennal joints 8–10 enlarged and the middle tibiae notched in the male.

Head with interocular space a little more than half its width, polished, impunctate, entirely black, the frontal tubercles distinct and a broad carina between antennal sockets not much produced. Antennae entirely black, in male joints 8–10 swollen, joints 2, 3 short and together about equal to 4. Prothorax wider than long with nearly straight sides, obsoletely and faintly punctate, shining, a semicircular depression across disk; entirely black. Scutellum black. Elytra moderately densely and distinctly punctate, shining black with pale yellow sutural stripe and pale margin. Epipleura pale, extending to apical curve. Body beneath entirely black and shining; anterior tibiae in male somewhat thickened, middle tibiae widely emarginate with prominent hook near apex, tibiae with small spine at apex. Length 3 mm.; width 1.3 mm.

TYPE: Male in Museum of Comparative Zoology (No. 29610); one paratype, from "Colombien" (USNM 63363).

REMARKS: The wide emargination of the middle tibiae in the male is greater than in any of the rest of the species with excised tibiae, but it is only a matter of degree. The enlargement of the antennal joints is the same as in *L. marginatum* Jacoby. In fact, except for the wider notching of the tibiae and the darker color, which has the same pattern on the elytra as in *marginatum*, this species closely resembles *L. marginatum* and might be only a color phase.

Luperosoma amplicorne (Baly)

FIGURE 4,*h*

Diabrotica amplicornis Baly, Trans. Ent. Soc. London, p. 446, 1886.

About 5 mm. in length, oblong oval, the pronotum and elytra distinctly punctate, shining, pale yellow-brown, the head with two dark spots on occiput and dark labrum, antennae with joints 9–11 dark and in the male thickened, prothorax with broad dark lateral areas, elytra with median and lateral dark vittae joined at apex, legs and undersurface, except prosternum, dark. Middle tibiae of male notched.

Head with interocular space half its width; occiput impunctate, with wide dark areas on either side narrowly separated by pale median line; front brownish, the frontal tubercles much swollen, the interantennal area with a carina down front, labrum dark. Antennae in male with joints 9–11 dark and enlarged in the male, no female examined. Prothorax wider than long with slightly curved sides and semicircular depression in lower half, surface shining and distinctly punctate, yellow-brown with wide black area on either side extending from anterior nearly to basal margin. Scutellum brown. Elytra moderately shining, quite densely and rather coarsely punctate, a depression from intrahumeral sulcus down about one-fourth the length of the elytra; yellow-brown with a wide dark median and lateral vitta uniting shortly before the apex, leaving the suture and the lateral margin narrowly pale, and a slightly broader median pale vitta. Epipleura disappearing before apical curve, body beneath (except prosternum) and legs deep brown, middle tibiae of male notched near apex; tibiae with fine terminal spine; anterior tibiae swollen in male, first tarsal joint of anterior legs cylindrical, first tarsal joint of hind legs as long as remaining joints. Claws appendiculate. Length 4.8 mm.; width 2.2 mm.

TYPE: In British Museum (Natural History), collected at Paraná, Brazil.

REMARKS: What appears to be a paratype of this is in the Bowditch collection, 1st Jacoby collection, Museum of Comparative Zoology. No females have been examined.

***Luperosoma parallelum* (Horn)**

FIGURE 4,*b*

Phyllecthrus parallelus Horn, Trans. Amer. Ent. Soc., vol. 20, p. 126, 1893.

About 5 mm. in length, elongate oblong oval, rather flat, moderately shiny although alutaceous, and with shallow, not dense elytral punctation; head reddish brown, deeper brown over occiput, prothorax pale yellowish brown, elytra piceous with pale margin, legs and antennae pale, the former with dark streaks, abdomen and part of breast piceous; antennae in male enlarged at end, and middle tibiae notched near apex.

Head with deeper reddish brown color over occiput becoming pale yellow down front, alutaceous and obsoletely punctate, with swollen frontal tubercles and slightly produced carina between antennal sockets. Antennae pale except basal joint, with a deeper brown on upper surface, 2d and 3d joints short, 4th longest of all, thence gradually diminishing in length to terminal joint, which in male is enlarged. No female examined. Prothorax about a third wider than long with sides nearly straight, only slightly curved, anterior angles toothed, basal angles obliquely cut, disk with semicircular depression in basal half and a smaller one in middle of anterior half; pale yellow, often with spot or widely brown or piceous areas on each side. Scutellum reddish brown. Elytra somewhat depressed, shining although distinctly alutaceous and with scattered shallow punctures, deep piceous except the pale lateral (not apical) margin, sometimes slightly paler along sutural edges. Epipleura pale. Body beneath with breast brownish, abdomen even deeper brown, legs pale with a dark streak along upper side; middle tibiae of male notched near apex, first tarsal joint of anterior legs in male short; middle and posterior tibiae with fine spine at apex. Claws appendiculate. Length 4.3–5.2 mm.; width 1.8–2 mm.

TYPE: Not examined by the writer, but H. J. Grant of the Philadelphia Academy of Sciences writes as follows: "Type No. 3792. Labeled holotype. Sex not indicated. Locality: 'Tex.' In the Horn collection there are two additional specimens—one with no data; one labeled simply 'Tex.' "

OTHER LOCALITIES: *Texas:* Round Mountain (Fall collection); Douglass, H. S. Barber; College Station, W. D. Pierce. *Oklahoma:* Ardmore, C. R. Jones. *Kansas:* West Kansas, Popenoe; Onaga,

F. F. Crevecoeur, Wickham; Topeka, Popenoe; Riley County, Popenoe.

REMARKS: The characters described by Jacoby (1891) for the genus *Luperosoma* so well fit the species described from North America by Horn (1893, 1896) as *Phyllecthrus parallelus, P. schwarzi,* and *P. subsulcatus* that I am transferring Horn's species, leaving to *Phyllecthrus* the original ones described by LeConte (1865, 1868, 1884), who took as type of that genus *Phyllecthrus dorsalis* (Olivier).

Luperosoma subsulcatum (Horn)

FIGURE 4,*f*

Phyllecthrus subsulcatus Horn, Trans. Amer. Ent. Soc., vol. 20, p. 126, 1893.

About 3.5 mm. in length, elongate oblong oval, shining although somewhat alutaceous, elytra with numerous longitudinal ridges between which are semistriate, moderately coarse punctures; head, antennae, prothorax, abdomen, tibiae, and tarsi reddish brown, elytra piceous; antennae in male flatly widened towards apex, middle tibiae notched near apex.

Head shining reddish brown, smoothly rounded over occiput with some punctures in the depression over the frontal tubercles, tubercles swollen, a faint median line; antennal sockets depressed but the area between not prominently produced into a carina; eyes widely separated and from above not showing their comparatively large size. Antennae stout in male, the 2d and 3d joints short and robust, 4th longest, 5th and 6th shorter and equal, 7th cylindrical and a little shorter, 8th and 9th short and broad, 10th and 11th very broad and long; in the female, 3d and 4th joints longer than 2d and subequal, 4th longer than succeeding joints which are not enlarged. Prothorax almost as long as wide, with only slightly curved sides, a small tooth at apex, shining reddish brown sometimes with a median round brownish or piceous area; without much sign of semicircular depression on most specimens, a few inconspicuous punctures along base. Scutellum dark. Elytra usually entirely piceous (in one specimen the base and side from humerus down reddish brown, the rest of elytra piceous); shining although faintly alutaceous, a little wider than prothorax and narrowly elongate; humeri moderately prominent, numerous irregular longitudinal ridges between rows of punctures, the punctures moderately coarse and irregularly striate, both punctures and ridges becoming obsolete near apex. Epipleura disappearing at apical curve; body beneath with breast dark, prosternum and abdomen pale, femora more or less dark, tibiae and tarsi paler brown. Middle and posterior tibiae with a fine spine, and in male, the anterior 1st tarsal joint cylindrical and twice as broad as the next; middle tibiae notched, claws appendiculate. Length 3–4.3 mm.; width 1.3–1.7 mm.

TYPE: Not examined by writer but H. J. Grant of the Philadelphia Academy of Sciences writes as follows: "Type No. 3794. Lectotype. Male. Locality: Yuma. There are no other specimens of this species in the Horn collection." Horn wrote: "It occurs in New Mexico, Texas, and Arizona, in the latter region near Yuma and Santa Rita Mts."

OTHER LOCALITIES: *Arizona:* Bear Valley, Atascosa Mts., F. G. Werner; 9 miles west of Benson, F. G. Werner; Brown's Canyon, Baboquivari Mts., F. G. Werner and G. D. Butler; Huachuca Mts.; Marana, Butler and Werner; Nogales, Santa Cruz County, Nunenmacher; 6 miles north of Nogales, 3500 ft., Werner and Nutting; Oracle Junction, Werner and Nutting; 6 miles east of Peace, F. G. Werner; Pima, 3000 ft.; 2 miles east of Ruby, F. G. Werner; Sabino Canyon, Santa Catalina Mts., Werner and Nutting; 8 miles east of San Vicente, F. G. Werner, A. A. Nichol, Tucson Mts., G. D. Butler. *Texas:* El Paso. *New Mexico:* Mesilla Park.

REMARKS: The semicostate elytra readily distinguish this species.

Luperosoma schwarzi (Horn)

FIGURE 4,*a*

Phyllecthrus schwarzi Horn, Proc. California Acad. Sci., ser. 2, vol. 6, p. 377, 1896.

About 5 mm. in length, elongate oblong oval, moderately shiny, although somewhat alutaceous, antennae heavy in male with the last three joints wider, middle tibiae notched near apex in male; prothorax with a depressed spot on each side; head and prothorax reddish brown, the latter with piceous lateral darkening; elytra, legs, and undersurface dark; elytra with faint irregular costae; the punctures with a suggestion of irregular striation in basal half.

Head smooth and shiny above the swollen frontal tubercles, a slightly produced short carina between antennal sockets, deep orange-brown with darker labrum. Antennae of male with the three basal joints shining piceous, remainder densely pubescent with grayish brown hairs, 2d and 3d joints short, 4th longest, last three joints heavier and wider; in female, the joints longer and more slender, 2d and 3d joints together equalling 4th. Prothorax approximately one-third wider than long, nearly rectangular, with only slightly rounded sides, deep yellow-brown with the sides piceous, on each side and in middle of base a shallow depression; alutaceous and finely and inconspicuously punctate near base. Scutellum dark. Elytra long and narrow with slight humeral prominences and faint irregular costae near base, punctation with a tendency to becoming striate near base, not very dense or coarse and becoming much finer near apex; surface alutaceous but shiny, deep piceous. Epipleura vanishing at apical curve. Body beneath entirely dark, legs dark except a little paler at knees; middle tibiae of male notched near apex, tibiae with fine spine, claws appendiculate. Length 4.5–5.0 mm.; width 2 mm.

Type: Not examined by writer, but H. J. Grant of the Philadelphia Academy of Sciences writes as follows: "Type No. 3793. Holotype. Male. Locality: Tex. In the Horn collection there are seven paratypes, these being from Texas, Arizona and New Mexico, and four other specimens from Arizona, Kansas and California."

Other localities: Houston, Tex., on *Helianthus*; Shreveport, La., F. V. Mally.

Remarks: Horn originally mistook this for *Phyllecthrus dorsalis* (Olivier), and three years later corrected this error, which E. A. Schwartz had pointed out to him, and described it again as new.

Genus *Ectmesopus* Blake

Figure 6,*a–k*

Ectmesopus Blake, Proc. Ent. Soc. Washington, vol. 42, p. 95, 1940.

Small, slender beetles 2–4 mm. long, with long slender legs, usually pale yellow or reddish with lustrous green, blue or violet elytra. Head smoothly rounded, without depressions or protuberances, frontal tubercles not pronounced. Antennae usually not much over half the length of the beetles, in one species nearly the length. Usually some abnormality in the apical antennal joints, 7, 8, 9, 10 or 11 of the male. In one species, the one with the long antennae, this abnormality in the 3d joint. Prothorax from one-fourth to one-third wider than long, with the sides only slightly curved, often nearly straight, narrowly margined and with a small seta-bearing pore at the corners, hind margin nearly straight; the disk not at all depressed or deeply punctate, but usually smoothly rounded and polished. Elytra wider than the prothorax with a small humeral prominence, and usually a little wider in the apical half. Beneath, the epipleura gradually disappear towards the apex. Anterior coxal cavities open. In the male, the front tibiae frequently stout and the middle tibiae with a deep notch on the inside near the apex. Tibiae with a tiny spur, extremely hard to detect in some specimens. First joint of the hind tarsi equal to or longer than the following. Claws with a small basal tooth.

Type of genus: *Ectmesopus darlingtoni* Blake.

Key to species of *Ectmesopus*

1. Prothorax entirely dark without any pale areas, joints 8–10 of male antennae deformed. Jamaica . . . . **tristis** Blake
   Prothorax entirely pale or pale with dark markings 2
2. Prothorax pale with dark markings 3
   Prothorax entirely pale 7

3. Elytra shining green with a broad irregular pale band. Puerto Rico. **zonatus** Blake

Elytra entirely dark 4

4. Antennae extending much below the middle of the elytra, in male the 3d joint very tiny, in both sexes the 4th joint very long. Haiti. **longicornis** Blake

Antennae not reaching beyond the middle of the elytra, mostly not so far as the middle 5

5. Prothorax with a broad, often T-shaped median marking extending nearly the whole length; 10th joint of male antennae slightly enlarged. Cuba. **occipitalis** Blake

Prothorax with lateral dark marks. 6

6. Prothorax with a vitta on each side, this sometimes very short, sometimes well marked and extending down the whole side; 10th joint of male antennae much enlarged. Puerto Rico . . . . **vitticollis** Blake

Prothorax with sides near margin sometimes deep brown; antennal joints in male not deformed or enlarged. Dominican Republic. **angusticollis** Blake

Prothorax with lateral margin piceous black. Tortue Island, Haiti. **leonardorum** Blake

7. Notch in middle tibiae not deep, little more than an emargination; male antennae not deformed or enlarged or unlike those of the female. Dominican Republic . . . . **angusticollis** Blake

Notch in middle tibiae of male deep, forming a sharp tooth on upper inside margin; last joints of male antennae either deformed or enlarged 8

8. Antennae of both sexes very similar up to the last joint and in male the last joint enlarged. Cuba . . . . **malachiodes** (Suffrian)

The 10th antennal joint and sometimes others of the male deformed . . . 9

9. Antennae dark with the last 2 or 3 joints pale, joints 6–9 in male triangular, 10th much enlarged. Haiti . . . . **darlingtoni** Blake

Antennae not bicolored, joints 6 to 9 in male not at all triangular . . . 10

10. Head, thorax, legs and antennae pale yellowish; 10th antennal joint in male much enlarged. Dominican Republic . . . . **pallidus** Blake

Head, thorax, and legs reddish, antennae with dark outer joints; 10th joint in male constricted and not any longer than 9th. Dominican Republic. **crassicornis** Blake

Since all but one of the species given in the above key have been described by the writer (Blake, 1940), it does not seem necessary to repeat the descriptions in detail, as the key and illustrations are sufficient for purposes of identification.

Ectmesopus leonardorum, new species

FIGURE 6*e*

Approximately 2.7 mm. in length, elongate oblong oval, shining, inpunctate, yellow-brown with piceous lateral margin to the pronotum and metallic green elytra; middle tibiae of male widely and shallowly emarginate; antennae with distal joints missing.

Head with interocular space more than half width of head, entirely pale, smoothly rounded over occiput, a slight depression over the bulging frontal tubercles, a short carina between antennal sockets running down the lower front. Antennae with the four distal joints missing, pale yellow-brown, 3d joint longer than 2d and shorter than 4th. Prothorax subquadrate, nearly as long as wide, with only slightly curved sides, pale yellow-brown, the lateral margins piceous black, shining, impunctate; a dent in middle of disk (probably from immature softness of specimen), the surface in life probably without depression of any sort. Scutellum yellowish brown. Elytra shining metallic green, impunctate. Undersurface and legs entirely pale yellow-brown; anterior tibiae thickened in male, middle tibiae widely and shallowly emarginate near apex. Length 2.7 mm.; width 1 mm.

Type: Male, USNM 63364, from Bassin Bleu, Tortue Island, Haiti, collected by E. C. and G. M. Leonard.

Remarks: Although the specimen is immature and badly shrivelled, and the distal joints of the antennae are missing, this can readily be seen as a distinctive little beetle with its heavy dark markings on the lateral margin of the prothorax. In addition, the middle tibiae of the male are widely emarginate, in this respect resembling *E. angusticollis* Blake from the Dominican Republic. It differs from that species in the coloration of the margin of the prothorax as well as in having metallic green instead of blue elytra, and also in being even narrower. It is unfortunate that the end joints of the antennae, usually so abnormal in the male, are lacking.

Genus *Platymorpha* Jacoby

Platymorpha Jacoby, Biologia Centrali-Americana, Coleopt., vol. 6, pt. 1, p. 602, 1888.

The original generic description is as follows:

> Body elongate; antennae longer than the body, the second and third joints extremely short, the other joints elongate-triangular; thorax subquadrate, the disc depressed; elytral epipleurae continued below the middle; the posterior tibiae mucronate, the first joint of the posterior tarsi as long as the following three joints together; claws appendiculate; the anterior coxal cavities open. Anterior tibiae and the first joint of the anterior tarsi strongly dilated in the typical species in the male.
>
> Type *Platymorpha variegata.*
>
> In general appearance *Platymorpha* agrees with *Chthoneis;* the third joint of the antennae, however, is extremely small, the posterior tibiae are armed with a spine. The last named character proves the affinity of *Platymorpha* with *Luperus* and its allies. I probably have only male specimens of *P. variegata* before me; these are at once distinguished by the curious dilation of the anterior tibiae and the first joint of the anterior tarsi. The two species I refer to this genus inhabit Mexico and Guatemala.

To Jacoby's description may be added that it is possible these two species he has assigned to the genus are not congeneric. He originally described *smaragdipennis* in the genus *Chthoneis.* The anterior tibiae and first tarsal joint in the male in *Platymorpha variegata* are much swollen and resemble that of *Cerotoma dilatipes* Jacoby, while the beetle itself bears a striking resemblance to *Phyllecthrus dorsalis* (Olivier). Although J. A. Wilcox has written me that *Platymorpha variegata* has excised middle tibiae in the male, I have been unable to detect it in the mounted specimens in the Bowditch collection. *P. smaragdipennis,* on the other hand, has no such dilation in the front legs, the middle tibiae are clearly excised, and the shape of the beetle is different. In one point both agree: in the short, truncate 3d antennal joint.

I am including in this genus, purely because of the similarity of its excised middle tibiae and the short third antennal joint with its truncate apex, a third species from Peru. It is not closely related to either *P. variegata* or *P. smaragdipennis* and someday will doubtless be referred elsewhere.

***Platymorpha smaragdipennis* Jacoby**

FIGURE 5,*c*

Platymorpha smaragdipennis Jacoby, Proc. Zool. Soc. London, p. 786, 1879.

About 6 mm. in length, elongate oblong, shining, the elytra densely and coarsely punctate; head, prothorax, femora, and undersurface yellow, elytra shining metallic green, tibiae and tarsi deep brown.

Head with a few minute punctures, carina and encarpae ill-defined. Antennae long, black, the 2d and 3d joints very small, truncate at apex; remainder long, densely covered with short hairs. Prothorax subquadrate, wider at middle, contracted near the base; impunctate, very shiny, yellow, disk in basal half with transverse depression. Scutellum pale. Elytra bright metallic green, closely and coarsely rugose punctate. Body beneath and femora pale, tibiae and tarsi dark; middle tibiae of male deeply excised; tibiae with spine, claws appendiculate.

TYPE: Male in Bowditch collection from Capetillo, Guatemala, and two paratypes (one male, one female).

***Platymorpha albiventris,* new species**

FIGURE 4,*d*

About 4 mm. in length, oval, parts of the prothorax and the entire elytra densely punctate, shining black with pale abdomen and the 8th and 9th antennal joints (possibly also the terminal ones which are missing in the single male specimen examined) pale, prothorax with a transverse scooped-out depression; middle tibiae of male excised.

Head with interocular space half width of head, occiput polished, frontal tubercles distinctly marked, a small carina between antennal sockets, lower front somewhat bulging. Antennae in male with 3d joint very short, about half length of 2d, remainder long and slender;

only nine joints of one antenna and the basal joint of the other left; joints 1–7 black, 8 and 9 pale. Prothorax not quite twice as wide as long with nearly straight sides and scooped-out transverse depression in basal half; except in this depression the surface punctate; shining black. Scutellum black. Elytra widened toward apex with wide explanate margin, very shiny black with moderately dense punctation; no suggestion of costae. Body beneath shining black with pale abdomen; anterior coxal cavities open, anterior tibiae in male thickened, middle tibiae in male excised near apex; first tarsal joint of hind legs longer than succeeding joints together; claws appendiculate. No terminal spurs discernible on tibiae. Length 4 mm.; width 2.2 mm.

TYPE: Male in Cornell University collection, from LaChorerra, Putumayo District, Peru, collection Aug. 17–20, 1926.

REMARKS: This is another galerucid that has characters similar to the group with excised tibiae but differs in the male sex characters, being unusual in the shortness of the 3d antennal joint. In this case the 3d joint is unlike the short 3d joint found often in *Diabrotica*, *Luperosoma*, or *Iceloceras* in that it is not so long as the second, truncate at the apex, and cup-shaped. It most closely resembles the antennae of the two species of *Platymorpha*, and I am tentatively placing the species in that genus although it is not very closely related.

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A REDEFINITION OF THE BUTTERFLY GENERA TATOCHILA, PHULIA, PIERCOLIAS, AND BALTIA, WITH DESCRIPTIONS OF RELATED GENERA AND SUBGENERA

By William D. Field

The genera of butterflies treated in this paper are those labeled by Klots (Ent. Americana, vol. 12, new ser., pl. 13, fig. 100, 1933) as the "Tatocheilae-Phulia" branch of the family tree. These genera probably will be considered as constituting a subtribe of the Pierini when that tribe is subdivided.

The history of revisionary work in the Rhopalocera shows that the systematics of the group has progressed by three main stages. The earliest workers studied the habitus (shape, color, and pattern) of the wings almost exclusively. Before the middle of the 19th century the veins of the wings were discovered to be of great value and were thereafter used extensively in revisionary work. A few years later the male genitalia were found to be of great systematic value and slowly were used by more and more workers throughout a large part of the Rhopalocera.

Surprisingly, studies of the female genitalia were almost never attempted, partly because the females were frequently harder to dissect and because of an erroneous contention of early workers that the female genitalia were of little taxonomic value. We know today that this is not true, and it has been demonstrated numerous times that the female genitalia are often as useful as the male genitalia in ascertaining the relationship of butterfly groups.

Concerning the genera now under scrutiny, the soundest early works were those of Butler (Cist. Ent., vol. 1, pp. 33–58, 1870) and Grote (Proc. Amer. Philos. Soc., vol. 39, pp. 4–67, 1900) and were based, according to the practice of that time, mainly upon venational characters. To these studies Klots (loc. cit., pp. 217–220) added a study of the male genitalia, arriving at a fairly satisfactory generic treatment which was superior to all similar generic studies in the Rhopalocera and was certainly an outstanding landmark.

In preparing the present paper, the male genitalia, venation, and habitus were thoroughly studied and evaluated. Also, the legs, including the claws (which proved to be of great value), and the female genitalia were studied.

The complexities of relationship among the genera studied were found to be much greater than heretofore believed. The use of any one character (or kind of character) alone was found to produce a different alignment than when some other character was employed. Thus, a consideration of the uncus alone shows *Theochila*, new genus; *Tatochila; Phulia* (*Infraphulia*, new subgenus); *Piercolias;* and *Baltia* to be quite distinct from one another, while *Hypsochila* and *Phulia* (*Phulia*) would be considered very close to each other and quite like *Tatochila.* Considering the aedeagus only, one group of the genus *Tatochila* and the genera *Hypsochila*, *Phulia*, *Piercolias*, and *Baltia* would certainly seem to be nearly identical, while *Theochila* and four of the species groups of *Tatochila* would appear to be quite different from each other and from those mentioned above. On the other hand, *Hypsochila*, *Phulia*, *Piercolias*, and *Baltia* differ greatly from *Theochila* and *Tatochila* in lacking the tibial spurs of the mid and hind legs. Again, if we placed too much emphasis upon the claws, paronychia, and pulvilli, we would place *Hypsochila* and *Theochila* an unreasonable distance from the other genera and from each other. A consideration of the number and fusion of the radial veins taken by itself would give us the unnatural alignment of having *Theochila*, *Tatochila*, *Hypsochila*, and the nominotypical subgenus of *Piercolias* at one end (with four radial veins), one species of *Phulia* (*Infraphulia*) at the other end (with two radial veins), and *Phulia* (*Phulia*), a second species of *Phulia* (*Infraphulia*), and *Piercolias* (*Pierphulia*, new subgenus), in the middle (with three radial veins).

It became quite obvious, if we were going to attain a nearly natural classification, that all of these characters had to be considered and used. The result was that sometimes special importance was given to a single structure in one genus (or in several genera) and that much less importance had to be given that same structure in another genus (or in several other genera).

Two of the genera treated below are each divided into two subgenera upon characters that certainly would be considered of generic instead of subgeneric value if it were not for the fact that they could not be separated upon habitus. It did not seem logical, for example, to treat the subgenera *Phulia* and *Infraphulia* as separate genera—in spite of the several really important differences in male and female genitalia and venation— simply because they look so very much alike. Thus, habitus was regarded as being of great importance and genera were not divided unless differences in habitus supported the other reasons for such division. On the other hand, habitus differences alone were not regarded as sufficient to divide genera. Thus, the two species of *Baltia,* although differing greatly in habitus (one species resembling *Piercolias* and the other somewhat resembling *Phulia*) were retained together in the genus *Baltia* because other characters did not support a division based upon habitus differences either on the generic or the subgeneric level.

The species here transferred to *Piercolias* (*Pierphulia*) were taken from *Phulia,* where they have hitherto been placed, because of the differences in the uncus of the male, in the inner genital plates of the female, and in other characters which were supported by habitus differences. On the other hand they could not be regarded as typical *Piercolias* (except on habitus characters) because of some differences in these same structures and in venation.

All of the genera treated here are Neotropical in distribution except *Baltia,* which occurs only in the Himalayas of central Asia. Klots (loc. cit., p. 219) says "whether there is a real relationship between *Baltia* and *Phulia* or whether the resemblances are merely to be regarded as similar developments in the same type of environment is a matter of doubt." Klots had the false notion that *Phulia* and *Baltia* both lacked pulvilli and paronychia. These structures are present in all of the genera here treated but are sometimes so greatly reduced in *Phulia, Peircolias,* and *Baltia* that they cannot be seen without dissection and great magnification. *Baltia,* however, in the majority of its characters, certainly seems more closely related to these Neotropical genera with which Klots has placed it than to any of the Old World genera.

Of the Neotropical genera, *Theochila* is found in the southern nontropical parts of Brazil and eastern Argentina; *Tatochila* in Colombia, Ecuador, Peru, Bolivia, Argentina, and south to Tierra del Fuego; *Hypsochila* in the Andes of Bolivia and Peru, south to the high elevations in central Chile and west-central Argentina, and south from there to Tierra del Fuego; *Phulia* in the high Andes of Bolivia and Peru, south to the high elevations in central Chile and west-central Argentina, and *Piercolias* in the Andes of Bolivia and Peru, south into northern Chile.

In the treatment below, the species belonging to each of the genera are neither described nor discussed, but are merely assigned to their proper place. Subspecies are not listed at all in this paper. Complete specific accounts will be offered at a later date by both the present writer and by Prof. José Herrera-G. of the University of Chile.

Key to the genera and subgenera treated in this paper

1. Tibial spurs present on mid and hind legs 2
   Tibial spurs absent on mid and hind legs 3
2. Male with uncus distinctly shorter than its greatest width (dorsal or ventral view) (fig. 9); female with inner genital plate having a finger-like process that is nearly parallel to the anterior lobe (fig. 34); claw short and thick, only slightly more than twice as long as its width at base (fig. 25). **Theochila** (p. 106)
   Male with uncus at least as long as its greatest width (dorsal or ventral view) (fig. 10); female with inner genital plate having a finger-like process that is not parallel to anterior lobe (fig. 35); claw nearly three times as long as its width at base (fig. 26) . . . . **Tatochila (p. 108)**
3. Forewing with four radial veins 4
   Forewing with two or three radial veins 5
4. Forewing with vein M_2 from apex of cell or from very near apex of cell (connate or nearly connate with base of $R_3+R_{4+5}+M_1$) (fig. 19). **Hypsochila** (p. 110)
   Forewing with M_2 from distinctly below apex of cell (fig. 23) (see third choice) . . . . **Piercolias (Piercolias)** (p. 118)
   Forewing with M_2 stalked with base of $R_3+R_{4+5}+M_1$ (fig. 24). **Baltia** (p. 118)
5. Hindwing with Cu_2 arising from near middle of cell and about opposite origin of R_s (figs. 20, 21); with distance between bases of Cu_1 and Cu_2 on the hindwing equal to the distance between bases of R_s and M_1 (figs. 20, 21) 6
   Hindwing with Cu_2 arising from distinctly beyond middle of cell and not at all opposite origin of R_s (fig. 22); with distance between bases of Cu_1 and Cu_2 on the hindwing less than the distance between the bases of R_s and M_1 (fig. 22) . . . . **Piercolias (Pierphulia)** (p. 117)
6. Forewing with R_1 from less than two-thirds to about one-half the length of R_2 (fig. 20); hind leg with femur shorter than tibia; harpe acuminate (fig. 4) . . . . **Phulia (Phulia)** (p. 114)
   Forewing with R_1 nearly the same length as R_2 or only slightly shorter (fig. 21); hind leg with femur about same length as tibia; harpe blunt (fig. 5). **Phulia (Infraphulia)** (p. 114)

Theochila, new genus

TYPE: *Pieris maenacte* Boisduval=*Theochila maenacte* (Boisduval), new combination.

Theochila differs from the other genera chiefly in the aedeagus, anellus, and uncus of the male genitalia and in the inner genital plate of the female. In addition it differs from most species of *Tatochila* in the position of vein Cu_2 of the hindwing and from all of the related genera in the form of the claws, paronychia, and pulvilli as well as in habitus.

VENATION: Figure 17. Forewing with four radial veins, R_5 having anastomosed with R_4; R_1 long, only slightly shorter than R_2; R_2 from apex of cell or very close to the apex; M_2 from well below apex of cell. Hindwing with Cu_2 from distinctly beyond middle of cell and not opposite to origin of R_s and with distance between bases of $Sc+R_1$ and R_s about equal to distance between Cu_2 and M_3; distance between bases of Cu_1 and Cu_2 greater than distance between bases of R_s and M_1.

LEGS: As in *Tatochila* with a pair of apical spurs present on mid and hind tibiae. Paronychium (fig. 25) about as long as claw and broad, about one-half as wide as its length and broadly rounded distally. Claw (fig. 25) directed somewhat outward and with its dorsal margin greatly arched, its long axis nearly parallel to basal margin; extremely short and thick, only about twice as long as its width at base. Tooth somewhat divergent from distal portion of claw and originating from distinctly beyond middle; about equal in size to distal portion of claw, with dorsal margin of tooth about equal to width of claw at base. Pulvillus (fig. 25) broad, much broader than base of claw.

GENITALIA: Male (figs. 1, 9) with uncus short, distinctly shorter than greatest width (ventral or dorsal view) and equal to about one-third the length of tegumen; distal half of uncus finger-like, gradually tapering, not distinctly swollen behind tip and lacking the lateroventral internal ridges or infoldings of the lateral walls found in *Tatochila*, *Hypsochila*, and *Phulia* (*Phulia*); harpe acuminate; subscaphium absent; anellus with a dorsal plate which together with the ventral plate completely surrounds the aedeagus; aedeagus in lateral view very broad and flat distally, at least twice as wide as in the middle.

Female (fig. 34) with ductus bursae as long as bursa copulatrix (excluding the accessory pouch), not sclerotized except posteriorly where there is a large bulbous structure containing the ostium and to which the ductus seminalis attaches dorsally; eighth tergite entire and semiannulate; eighth sternite with outer genital plate large and smooth; inner genital plates entirely setulose on outer surfaces and each divided into a posterior finger-like lobe and an anterior lobe that has its posterior margin nearly parallel to the finger-like lobe.

HABITUS: Wings white above with apex of forewing fuscous and without a distinct silvery white sheen except at base of wings. Male with both wings mainly white to pale yellowish white below. In the female this yellow is somewhat stronger. Black discocellular spot missing on both surfaces of forewing in both sexes. With a faint orange spot at base of hindwing below and with black outlining veins on hindwings below very faint in the male, somewhat stronger in the female.

SPECIES:

1. *Theochila maenacte* (Boisduval), Histoire naturelle des insectes. Species général des lépidoptères, vol. 1, p. 517, 1836 (*Pieris*).

Tatochila Butler

Tatochila Butler, Cist. Ent., vol. 1, pp. 38, 51–52, 56, pl. 3, fig. 7, 1870.

TYPE: *Synchlöe autodice* Hübner=*Tatochila autodice* (Hübner). Type by original designation (misspelled as *T. autodyce*).

Remarks: In *Tatochila* the female genitalia are rather similar to *Hypsochila* and *Phulia* (*Phulia*). It differs from those genera in possessing a pair of tibial spurs on the mid and hind legs and from all related genera in the form of the claws.

VENATION: Figure 18. Forewing with four radial veins, R_5 having anastomosed with R_4; R_1 usually from one-half to two-thirds length of R_2; R_2 from distinctly before apex of cell; M_2 from well below apex of cell. Hindwing with Cu_2 either from near middle of cell and about opposite origin of R_s or with Cu_2 distinctly beyond middle of cell and not opposite origin of R_s; distance between bases of veins $Sc+R_1$ and R_s about equal or greater than distance between bases of veins Cu_2 and M_3; distance between veins Cu_1 and Cu_2 greater or about equal to the distance between bases of R_s and M_1.

LEGS: As in *Theochila* with a pair of spurs present on mid and hind tibiae. Paronychium (fig. 26) narrower than in *Theochila* and more pointed distally and about as in *Hypsochila*, being at least two-thirds as long as claw, constricted near the middle and tapering and with its width at base from one-fourth to one-third of its length. Claw (fig. 26) directed outward with its dorsal margin gradually curved and its long axis divergent from basal margin; relatively long, at least three times as long as its width at base. Tooth usually divergent from distal portion of claw and originating from beyond the middle or sometimes from near the middle (*T. microdice*), only slightly shorter than distal portion of claw beyond tooth and with its dorsal margin nearly equal or slightly less than width of claw at base, not distinctly longer than this width. Pulvillus (fig. 26) not distinctly broader than width of claw at base, usually more narrow.

GENITALIA: Male (figs. 2, 10) with uncus relatively long and slender, at least as long as its width (in ventral view), usually longer and at least one-half as long as length of tegumen; distal one-third to one-half of uncus finger-like and distinctly swollen immediately in front of tip; behind this finger-like tip there is a long, lateroventral platelike internal ridge on either side, these ridges sometimes appearing to be infoldings of the lateral walls; harpe acuminate; subscaphium usually absent, sometimes faintly indicated; anellus without a dorsal plate; aedeagus in lateral view not distinctly broader distally than through middle or much less than twice as wide as in middle.

Female (fig. 35) with ductus bursae as long as bursa copulatrix (excluding the accessory pouch); usually with a ribbon-like plate immediately anterior to ostium and usually with a separate subtriangular or crescentic shaped plate on ventral surface anterior to this. Sometimes this plate completely rings the ductus bursae and sometimes it is fused to the ribbon-like plate. Ductus seminalis attached dorsally to nonsclerotized area opposite the area between these two plates; remainder of ductus bursae nonsclerotized. An exception to the above types of bursae is that found in *T. xanthodice* which has that structure entirely nonsclerotized. Eighth tergite entire and semiannulate; eighth sternite with outer genital plate large and reticulate; inner genital plate entirely setulose on outer surface, divided into a posterior finger-like lobe and an anterior subtriangular lobe, these lobes not parallel but distinctly farther apart near their base than at apex.

HABITUS: Discocellular spot present on forewing and very distinct at least on upper surfaces. Wings below with veins outlined with fuscous or black, at least in the female, or around outer margin of hindwing and on apex of forewing in the male, usually extending along entire length of veins in hindwing. Ground color of hindwing and apex of forewing below in both sexes usually yellow or at least with some yellow either in base of hindwing or around outer margin of hindwing and apex of forewing. Usually with at least one orange spot in base of hindwing and with an orange streak along costal margin of this wing. Ground color of wings above white, cream or yellow with the silvery sheen restricted to the base.

SPECIES:

1. *Tatochila theodice* (Boisduval), Voyage de découvertes de *l'Astrolabe*, pt. 1, Lépidoptères, p. 51, 1832 (*Pieris*).
2. *Tatochila autodice* (Hübner), Zuträge zur Sammlung exotischer Schmetterlinge . . . vol. 1, p. 26, 1818; pl. 27, figs. 151, 152, [1814–1818] (*Synchlöe*).
3. *Tatochila blanchardii* Butler, Trans. Ent. Soc. London, pp. 472–473, 1881.
4. *Tatochila microdice* (Blanchard), *in* Gay, Historia física y Política de Chile, Zoologia, vol. 7, p. 14, 1852 (*Pieris*).
5. *Tatochila vanvolxemii* (Capronnier), Ann. Soc. Ent. Belgique, vol. 17, p. 11, pl. 1, fig. 1, 1874 (*Pieris*).
6. *Tatochila mercedis* (Eschscholtz), *in* Kotzebue, Entdeckungs-Reise in die Süd-See und nach der Berings-Strasse . . . vol. 3, p. 215, pl. 9, fig. 22a, 1821 (*Pontia*).
7. *Tatochila inversa* Hayward, Acta Zool. Lilloana, Inst. "Miguel Lillo," vol. 7, pp. 136–137, 1949.
8. *Tatochila orthodice* (Weymer), *in* Weymer & Maassen, *in* Stübel and Reiss, Reisen in Süd-Amerika . . . Lepidopteren . . . , pp. 99, 124, pl. 3, fig. 20, 1890 (*Pieris*).

9. *Tatochila homoeodice* Paravicini, Mitt. Schweizerischen Ent. Ges., vol. 12, pt. 1, p. 23, 1910.
10. *Tatochila sagittata* Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde . . . , vol. 5, p. 57, pl. 18, fig. 1, 1908.
11. *Tatochila stigmadice* (Staudinger), Deutsche Ent. Zeitschr., "Iris," Dresden, vol. 7, pp. 62–63, 1894 (*Picris*).
12. *Tatochila xanthodice* (Lucas), Rev. Mag. Zool., ser. 2, vol. 4, pp. 337–338, 1852 (*Pieris*).
13. *Tatochila distincta* Jörgensen, Anales Mus. Nac. Hist. Nat. Buenos Aires, vol. 38, pp. 465–467, figs. 6, 7, 1916 (*Pieris*).

Hypsochila Ureta

Hypsochila Ureta, Bol. Mus. Nac. Hist. Nat., vol. 26, p. 58, 1955.

TYPE: *Tatochila microdice f. wagenknechti* Ureta=*Hypsochila wagenknechti* (Ureta). Type by original designation.

This genus differs from *Tatochila*, its nearest relative, and from the other genera in the shape of the claws. From *Tatochila* and *Theochila* it differs in lacking tibial spurs on mid and hind tibiae and in the position of vein M_2 on forewing as well as in habitus. From *Phulia* and *Piercolias* (*Pierphulia*) it differs also in having proportionately broader wings and in having four radial veins present on the forewing. It differs from all of the other genera in having the silvery sheen on forewing extending over a much larger area.

VENATION: Figure 19. Similar to that of *Tatochila* and *Theochila*, differing in having M_2 of forewing from apex of cell or from very near apex of cell. Forewing with four radial veins, R_5 having anastomosed with R_4; R_1 more than one-half but not more than two-thirds the length of R_2; R_2 from distinctly before apex of cell. Hindwing with Cu_2 from near middle of cell and about opposite to origin of R_s; distance between bases of veins $Sc+R_1$ and R_s about equal to the distance between Cu_2 and M_3; distance between Cu_1 and Cu_2 about equal to the distance between the bases of R_s and M_1.

LEGS: Spurs lacking on all three tibiae. Paronychium (fig. 27) at least two-thirds as long as claw, rather narrow, tapering and slightly constricted near middle and with its width at base about one-fifth its length. Claw (fig. 27) directed outward with its dorsal margin gradually curved and its long axis divergent from basal margin; relatively long, at least three times as long as width at base. Tooth divergent from distal portion of claw, originating from near the middle and very small, having its dorsal margin less than width of claw at base. Pulvillus (fig. 27) narrow, about one-half as broad as base of claw.

GENITALIA: Male (figs. 3, 11) with uncus, harpe, and anellus not different from that of *Tatochila;* subscaphium absent or only very faintly indicated; aedeagus in lateral view about as broad distally as through the middle, and deeply incised both dorsally and ventrally from one-half to one-third its entire length. The aedeagus is thus similar to that of *T. xanthodice* and *T. distincta* of group E of *Tatochila.* [The five groups of Tatochila are defined in a second paper, in press.]

Female (fig. 36) with ductus bursae very similar to *Tatochila,* differing chiefly in the reduced sclerotization, having a very narrow and faint ribbon-like plate immediately anterior to ostium and either lacking other sclerotization or having a very small ventral plate anterior to this ribbon-like one. Eight tergite and sternite as in *Tatochila.*

HABITUS: Wings above in both sexes with ground color white and with the silvery sheen at base extending throughout most of the cell of the forewing, otherwise similar to *Tatochila,* having the discal spot present on forewing on both surfaces and having the black sagittate markings in apex of forewing with a submarginal series of spots or a solid band inward from these markings. Undersurfaces with ground color of hindwing and apex of forewing yellow with veins in these areas overlaid with fuscous. Costa of hindwing orange and with a white spot at end of cell on this wing.

Ureta (Bol. Mus. Nac. Hist. Nat., vol. 26, pp. 66, 67, 1955) established a new subgenus, *Chionanema,* thereby dividing the genus *Hypsochila.* However he did not describe the typical subgenus except by inference. He included in *Hypsochila* (*Chionanema*) a single species, known from a single specimen. The characters he selected for this subgenus do not seem to me to be of more than specific value. However, I am retaining this subgenus until I am able to examine the species upon which it was established and ascertain if it displays characters of subgeneric value.

Hypsochila (*Hypsochila*) Ureta

Reference and type species as given above under the genus.

For reasons given above, this nominotypical subgenus is not here assigned characters.

SPECIES:

1. *Hypsochila* (*Hypsochila*) *argyrodice* (Staudinger), Hamburger magalhaensische Sammelreise, vol. 2, No. 6, pp. 14–17, fig. 11, 1899 (*Tatochila*).
2. *Hypsochila* (*Hypsochila*) *wagenknechti* Ureta, Rev. Chilena Hist. Nat., vol. 41 (1937), pp. 278–283, pl. 12, fig. 3♂, 4♀, text fig. 39, 1938 (*Tatochila*). (Note: Although this name was originally treated by Ureta as a "form" he later elevated it to full specific rank; it is clear from his original description that his term "form" comes within the meaning of the term subspecies, so that his name is here treated as being available as of the original date.)
3. *Hypsochila* (*Hypsochila*) *galactodice* Ureta, Bol. Mus. Nac. Hist. Nat., vol. 26, pp. 65–66, pl. 2, fig. 3, 1955.

Hypsochila (*Chionanema*) Ureta

Hypsochila (*Chionanema*) Ureta, Bol. Mus. Nac. Hist. Nat., vol. 26, pp. 66, 67 pl. 1, fig. 3, pl. 2, fig. 4, 1955.

TYPE: *Hypsochila* (*Chionanema*) *peñai* Ureta. Type by original designation.

This subgenus is supposed to differ from the typical one in having a straighter costal margin on forewing with a narrower discal cell as well as in certain venational characters and in having proportionally larger eyes. As mentioned above none of the described characters seem to be of more than specific value to the present writer.

VENATION: Forewing with R_3+R_{4+5} (stated in original description as $R_{3+4}+R_5$) longer than in *Hypsochila* (*Hypsochila*), with M_2 and M_3 nearly parallel and with Cu_1 and Cu_2 subparallel with greater divergence distally than in *Hypsochila* (*Hypsochila*). Hindwing with veins less divergent outward.

LEGS: Not mentioned in original description.

GENITALIA: According to the original figure (loc. cit., pl. 2, fig. 4) not differing except specifically from the typical subgenus.

HABITUS: Wings above with marginal sagittate markings greatly enlarged and entirely confluent with submarginal series of spots causing the entire apex of wing down to vein Cu_1 to be largely black except for small yellowish white dashes between the veins. Undersurfaces with ground color white and with all dark markings heavier than in *Hypsochila.*

SPECIES:

1. *Hypsochila* (*Chionanema*) *peñai* Ureta, Bol. Mus. Nac. Hist. Nat., vol, 26, No. 4, pp. 67, 69, pl. 2, fig. 4, 1955.

Phulia Herrich-Schaeffer

Phulia Herrich-Schaeffer, Correspondenz-blatt Naturw. verein, Regensburg, vol. 21, No. 9. pp. 105, 144, 1867.

TYPE: *Pieris nymphula* Blanchard=*Phulia nymphula* (Blanchard). Type by reason of being the sole included species.

Phulia differs from all the other genera in habitus and from all except *Piercolias* (*Pierphulia*) in the claws. From *Hypsochila, Theochila, Tatochila,* and *Piercolias* (*Piercolias*) it differs in having three or only two radial veins on the forewing. From *Theochila* and *Tatochila* it differs also in lacking tibial spurs. From *Piercolias* it differs in addition in the form of the uncus, in the female genitalia, and in the position of vein Cu_2 of hindwing.

VENATION: Figures 20, 21. Forewing with three radial veins, R_4 and R_5 having anastomosed with R_3 or with two radial veins, R_{3+4+5} having anastomosed with M_1. Vein R_1 about one-half or less than two-thirds length of R_2 in the typical subgenus and in the other subgenus with R_1 about the same length as R_2; M_2 stalked with base of $R_{3+4+5}+M_1$; R_2 from well before or near apex of cell. Hindwing with Cu_2 from near middle of cell and about opposite origin of R_s and with distance between bases of vein $Sc+R_1$ and vein R_s about equal or slightly less than distance between bases of Cu_2 and M_3; distance between veins Cu_1 and Cu_2 slightly less, about equal or greater than distance between bases of R_s and M_1.

Legs: Spurs lacking on all three tibiae. Paronychium (figs. 28, 29) (not absent as reported by Klots, loc. cit., pp. 146, 219) as described for the two included subgenera. Claw (figs. 28, 29) directed distinctly downward, with its dorsal margin very gradually curved and its long axis nearly parallel to the basal margin; relatively long, at least three times as long as its width at base. Tooth closely approximate to distal portion of claw and originating from before the middle or from near the middle; only slightly shorter than distal portion of claw and usually having its dorsal margin much longer than width of claw at base. Pulvillus (figs. 28, 29) narrow and greatly reduced, being from less than one-half to one-half the width of base of claw.

Genitalia: Male (figs. 4, 5, 12, 13) similar to *Tatochila*, with uncus relatively long and slender as compared with *Theochila* and *Baltia*. Distal one-third to one-half of uncus finger-like and distinctly swollen behind tip; base of uncus lacking the lateroventral internal ridges in the atypical subgenus and possessing them in the typical one. Harpe may be acuminate or rounded distally; subscaphium sometimes present; anellus hardly different from *Tatochila* and *Hypsochila;* aedaegus not distinctly broader distally and quite similar to *Hypsochila* and group E of *Tatochila*, being deeply incised both dorsally and ventrally. [The groups of *Tatochila* are defined in a second paper, in press.]

Female (figs. 37, 38) with ductus bursae at least as long as bursa copulatrix (without the accessory pouch) and colorless and nonsclerotized. Other characters as described under the two separate subgenera.

Habitus: Hindwing and apex of forewing below with ground color yellow and with veins broadly bordered with stripes of brown or gray and with these stripes outlined with black on the margin. Hindwing on this surface with a black stripe through the middle of cell and in interspace Cu_2 and with a series of submesial black spots between the veins.

The genus *Phulia* is here divided into two subgenera, *Phulia* and *Infraphulia*, the latter being erected for two speices (one as yet undescribed) that differ greatly from *Phulia* in characters of male and female genitalia that would ordinarily be considered of generic value. Indeed the lack of the accessory pouch of the bursa copulatrix and the reduced and modified signa in the females are so unique that they are not known to occur elsewhere in the subfamily. To separate *Infraphulia* from *Phulia* as a distinct genus would mean overlooking the very great similarities in habitus, in claws, and in venation. For these reasons, *Infraphulia* is treated here as a subgenus in the genus *Phulia*.

Phulia (*Phulia*) Herrich-Schaeffer

Reference and type species as given above under the genus.

Distinguished from *Phulia* (*Infraphulia*) chiefly in the uncus and harpe of the male and in the female genitalia.

VENATION: Figure 20. Forewing with three radial veins, R_{4+5} having anastomosed with R_3; R_1 short, being from less than two-thirds to about one-half the length of R_2. Hindwing with distance between base of Cu_1 and Cu_2 not distinctly greater than distance between R_s and M_1.

LEGS: Paronychium (fig. 28) greatly reduced, being slightly less than one-third the length of claw, triangular in shape and with its width at base about one-half its length.

GENITALIA. Male (figs. 4, 12) with lateroventral wall at base of uncus well folded inward and closely appressed upon its inner side; subscaphium absent; with a large weakly sclerotized clasper flap on inner face of harpe near middle and with harpe acuminate.

Female (fig. 37) with eighth tergite entire and semiannulate; eighth sternite with inner genital plate not reduced, divided into a broad subtriangular shaped anterior lobe and a smaller finger-like projection posterior to this and with both of these parts entirely and thickly setulose; signum of the common pierid type, being a single long bilobed and heavily dentate bar on dorsal surface of bursa near opening of ductus bursae.

Species:

1. *Phulia* (*Phulia*) *nymphula* (Blanchard), *in* Gay, Historia física y política de Chile, Zoologia, vol. 7, p. 14; Atlas, vol. 2, Lepidópteros, pl. 1, figs. 3a, 3b, 1852 (*Pieris*).
2. *Phulia* (*Phulia*) *paranympha* Staudinger, Deutsche Ent. Zeitschr., "Iris," Dresden, vol. 7, pp. 44–46, pl. 1, figs. 5, 10, 12, 1894.
3. *Phulia* (*Phulia*) *nymphagoga* Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde . . . vol. 5, p. 97, pl. 28, figs. d4, d5, 1909.
4. *Phulia* (*Phulia*) *nannophyes* Dyar, Proc. U. S. Nat. Mus., vol. 45, p. 629, 1913.

Phulia (*Infraphulia*), new subgenus

TYPE: *Phulia nymphula* var. *illimani* Weymer=*Phulia* (*Infraphulia*) *illimani* Weymer.

This subgenus is unique in the Pierinae in lacking the accessory pouch of the bursa copulatrix. It differs also from *Phulia* (*Phulia*) in the uncus and harpe.

VENATION: Figure 21. Forewing either with three radial veins (R_{4+5} having anastomosed with R_3) or with two radial veins (R_{3+4+5} having anastomosed with M_1); R_1 long, nearly the same length as R_2 or only slightly shorter. Hindwing with the distance between bases of Cu_1 and Cu_2 greater than distance between R_s and M_1.

LEGS: Paronychium (fig. 29) slightly over one-half length of claw, rather narrow, tapering and constricted near middle with its width at base about one-half its length.

GENITALIA: Male (figs. 5, 13) with lateroventral wall at base of uncus not at all folded inward; subscaphium present, only slightly sclerotized, harpe broadly produced apically and not acuminate and with a small clasper flap above middle on inner face.

Female (fig. 38) with eighth tergite not developed in dorsal region, forming two subtriangular shaped lateral plates; these plates are much broader than the lateral arms of the eighth tergite in *Phulia* (*Phulia*) and are more distad of the eighth sternite than in that subgenus; inner pair of genital plates greatly reduced, being a narrow sclerotized smooth band and lacking the finger-like process; signum reduced in size and with a very few dentations or entirely smooth and semicircular in shape; bursa lacking the accessory pouch found in most pierids.

SPECIES:

1. *Phulia* (*Infraphulia*) *illimani* Weymer, *in* Weymer and Maassen, *in* Stübel and Reise, Reissen in Süd-Amerika . . . Lepidopteren . . . pp. 98, 125, pl. 4, fig. 12, 1890.

Piercolias Staudinger

Trifurcula Staudinger, Deutsche Ent. Zeitschr., "Iris," Dresden, vol. 7, pt. 1, pp. 56–59, July 14, 1894. TYPE: *Trifurcula huanaco* Staudinger=*Piercolias huanaco* (Staudinger), by reason of being single included species. Preoccupied by *Trifurcula* Zeller, 1848 (Lepidoptera: Nepticulidae).

Piercolias Staudinger, Deutsche Ent. Zeitschr., "Iris," Dresden, vol. 7, pt. 1, p. 56, 1894; Grote, Canadian Ent., vol. 35, p. 139, 1903. This is a Staudinger manuscript name, mentioned in the original description of *Trifurcula* as a name that author formerly used for the genus. Grote applied it to the genus after discovering that *Trifurcula* Staudinger was preoccupied. Some authors have attributed the name *Piercolias* to Grote; however, following section 115, paragraph 2, page 63 of the Copenhagen Decisions on Zoological Nomenclature, 1953, the name *Piercolias* of Staudinger is here accepted, even though it was originally a manuscript name.

Andina Staudinger, Deutsche Ent. Zeitschr., "Iris," Dresden, vol. 7, p. ii (of the Inhalts-Uebersicht), 1895. Röber, *in* Seitz, Gross-Schmetterlinge der Erde . . . , vol. 5, p. 97, 1909. TYPE: *Trifurcula huanaco* Staudinger=*Piercolias huanaco* (Staudinger), by reason of being sole included species in *Trifurcula*, for which *Andina* is a substitute name.

TYPE: *Trifurcula huanaco* Staudinger=*Piercolias huanaco* (Staudinger).

Piercolias differs from all the other genera in the uncus, in the female genitalia, and in habitus. From *Phulia* it differs also in the position of Cu_2 in hindwing. From *Tatochila* and *Theochila* it differs in lacking tibial spurs on mid and hind legs and in the form of the claw.

Venation: Figures 22, 23. Forewing with three radial veins, R_{4+5} having anastomosed with R_3, or with four radial veins, R_5 having anastomosed with R_4; R_1 long, nearly same length as R_2 or only slightly shorter; M_2 from below apex of cell or stalked with base of $R_{3+4+5}+M_1$; R_2 from apex or from very near apex of cell. Hindwing with Cu_2 from distinctly beyond middle of cell and not at all opposite origin of R_s and with distance between bases of veins $Sc+R_1$ and R_s distinctly greater than distance between Cu_2 and M_3; distance between veins Cu_1 and Cu_2 distinctly less than distance between bases of R_s and M_1.

Legs: Spurs lacking on mid and hind tibiae. Paronychium (figs. 30, 31) as described for the two included subgenera. Claw (figs. 30, 31) relatively long, at least three times as long as width at base and with its dorsal margin gradually curved. Tooth from near middle of claw and with its dorsal margin about equal to or longer than width of claw at base. Pulvillus (figs. 30, 31) narrow and greatly reduced, being from less than one-half to one-half width of claw at base.

Genitalia: Male (figs. 6, 7, 14, 15) with uncus very slender, much more so than in *Tatochila* and *Phulia*, and gradually produced into a finger-like process that is neither constricted near the middle (in lateral view) nor swollen behind tip; lateroventral walls at base of uncus neither infolded nor possessing internal ridges; subscaphium present, although sometimes poorly developed; harpe either acuminate or broadly produced apically; anellus as in *Phulia, Hypsochila,* and *Tatochila*, lacking dorsal plate; aedeagus not different from *Phulia, Hypsochila,* and group E of *Tatochila*. [The five groups of *Tatochila* are defined in another paper, in press.]

Female (figs. 39, 40) with ductus bursae shorter than bursa copulatrix (without the accessory pouch), colorless and nonsclerotized and with other characters as described for the two included subgenera.

Habitus: Hindwing and apex of forewing below with a white to cream or pink ground color, entirely and heavily irrorated with black scales giving a gray or pinkish gray appearance. Hindwing without long brown, gray, or black bars and stripes but usually with a submesial series of dark spots.

Piercolias is here divided into two subgenera. First, the subgenus *Piercolias* for the species traditionally placed in the genus by that name, and second, for two species usually placed in *Phulia*. The latter are included with *Piercolias* because they have essentially the same type of uncus, vein Cu_2 on the hindwing has the same point of origin, the female genitalia are similar, and there is a great similarity in habitus. These facts were taken as better reasons for associating these two species with *Piercolias* than with *Phulia*, in spite of their similarity to the latter in such structures as claws and the number of radial veins. The number of radial veins, while usually regarded as of generic importance, sometimes certainly amounts to less than that. This is shown by the existence of two species in the subgenus *Infraphulia* of *Phulia*, one having three radial veins, and a second, very closely related species, having only two radial veins (the greatest reduction of radials known for the family).

Piercolias (*Pierphulia*), new subgenus

TYPE: *Phulia nysiella* Röber=*Piercolias* (*Pierphulia*) *nysiella* (Röber).

Differing from *Piercolias* (*Piercolias*) in the number of radial veins of forewing, in length of tibia of foreleg, in uncus, subscaphium and harpe, and in female genitalia as well as in the paronychium and claw.

VENATION: Figure 22. Forewing with three radial veins, R_4 and R_5 having anastomosed with R_3; M_1 and M_2 both stalked with base of R_{3+4+5}. Hindwing with M_1 distinctly shorter than Cu_1.

LEGS: Foreleg with tibia shorter than first tarsal subsegment. Paronychium (fig. 30) greatly reduced, being about one-third to less than one-half length of claw, tapering to a point, slightly constricted beyond middle and with its width at base one-half its length. Claw (fig. 30) similar to *Phulia*, abruptly directed downward with its long axis nearly parallel to basal margin. Tooth approximate to distal portion of claw.

GENITALIA: Male (figs. 6, 14) with uncus short and slender, shorter than length of tegumen; ventral opening for anal tube about two-thirds length of entire uncus; subscaphium small and weak; harpe broadly produced apically, not acuminate and without a clasper flap or lobe on inner face.

Female (fig. 39) with eighth tergite not developed in dorsal region, forming two triangular lateral plates; eighth sternite with outer genital plates large and reticulated; inner genital plate greatly reduced and subtriangular in shape and slightly setulose, lacking a posterior finger-like process.

SPECIES:

1. *Piercolias* (*Pierphulia*) *nysiella* (Röber), *in* Seitz, Die Gross-Schmetterlinge der Erde . . . , vol. 5, p. 98, pl. 28, fig. d6, 1909 (*Phulia*).
2. *Piercolias* (*Pierphulia*) *nysias* (Weymer), *in* Weymer and Maassen, *in* Stübel and Reiss, Reisen in Sud-Amerika . . . Lepidopteren . . . pp. 98, 125, pl. 4, fig. 11, 1890 (*Phulia*).

Piercolias (*Piercolias*) Staudinger

Reference and type species as given under the genus.

Distinguished from *Piercolias* (*Pierphulia*) in the number of radial veins of forewing, in length of tibia of foreleg, in uncus, subscaphium and harpe, and in female genitalia as well as in paronychium and claw.

VENATION: Figure 23. Forewing with four radial veins, R_5 having anastomosed with R_4; M_1 stalked for more than one-third its length with base of R_3 and R_4; M_2 from slightly below apex of cell; hindwing with M_1 longer than Cu_1.

LEGS: Foreleg with tibia longer than first tarsal subsegment. Paronychium (fig. 31) relatively large, at least two-thirds length of claw, tapering to a blunt point, constricted near the base or near middle and with its width at base from slightly more than one-fifth to about one-fourth its length. Claw (fig. 31) not as abruptly directed downward as in *Pierphulia* and with its long axis divergent from basal margin. Tooth divergent from distal portion of claw.

GENITALIA: Male (figs. 7, 15) with uncus long and slender, as long as length of tegumen; ventral opening for anal tube about one-fourth length of entire uncus; subscaphium large and heavily sclerotized; harpe acuminate and with a large clasper lobe near middle on inner face.

Female (fig. 40) with eighth tergite entire and semiannulate; eighth sternite with outer genital plates large and smooth, inner plates not at all reduced, setulose and each divided into a broad outwardly dentate anterior section and a large club-shaped posterior process.

SPECIES:

1. *Piercolias* (*Piercolias*) *huanaco* (Staudinger), Deutsche Ent. Zeitschr., "Iris," Dresden, vol. 7, pt. 1, pp. 56–59, pl. 1, figs. 7, 16, 18, 1894 (*Trifurcula*).
2. *Piercolias* (*Piercolias*) *coropunae* (Dyar), Proc. U. S. Nat. Mus., vol. 45, p. 629, 1913 (*Andina*).

Baltia Moore

Baltia Moore, Ann. Mag. Nat. Hist., ser. 5, vol. 1, p. 228, 1878.

TYPE: *Mesapia shawi* Bates=*Baltia shawi* (Bates). Type by reason of being sole included species.

Baltia differs from all the other genera in the form of the harpe and in the venation of forewing. From *Piercolias* (*Pierphulia*) and *Phulia* it differs in the number of radial veins of forewing and from *Piercolias* (*Piercolias*), *Hypsochila*, *Tatochila*, and *Theochila* in the stalking of vein M_2 on forewing and in claw, pulvillus and paronychium. From the last two genera it differs also in lacking tibial spurs on the mid and hind legs.

VENATION: Figure 24. Forewing with four radial veins, R_5 having anastomosed with R_4; R_1 long, only slightly shorter than R_2; R_2 from distinctly before apex of cell; M_2 stalked for some distance with base of $R_{3+4+5}+M_1$. Hindwing with Cu_2 from distinctly beyond middle of cell and not opposite to origin of R_s and with distance between bases of veins $Sc+R_1$ and R_s about equal to the distance between Cu_2 and M_3; distance between veins Cu_1 and Cu_2 equal to or less than distance between bases of R_s and M_1.

LEGS: Tibial spurs lacking on mid and hind tibiae. Paronychium (fig. 32) (not absent as reported by Klots, loc. cit., pp. 146, 219) from nearly one-third to slightly more than one-half length of claw. Claw (fig. 32) directed downward, but not as much so as in *Phulia;* dorsal margin gradually curved; its long axis divergent from basal margin; relatively long, at least three times as long as width at base. Tooth divergent, originating from near middle, only slightly smaller than distal part of claw and with its dorsal margin about equal to width of claw at base. Pulvillus (fig. 32) narrow and greatly reduced, being less than one-half to one-half width of claw at base.

GENITALIA: Male (figs. 8, 16) with uncus relatively broad at the base, not longer than the tegumen, being about one-half the length of tegumen in the type species (*B. shawi*) and nearly as long as the tegumen in the second species (*B. butleri*); slightly constricted near middle and very gradually produced to a blunt tip; very slightly swollen just behind tip; with very weakly developed lateroventral internal ridges; harpe not produced apically, more rounded than in *Phulia* (*Infraphulia*) and *Piercolias* (*Pierphulia*); subscaphium well developed, but not as much so as in *Piercolias* (*Piercolias*); anellus without a dorsal plate; aedeagus in lateral view not distinctly broader distally than through middle, dorsal incision deeper than in *Phulia* and about as in *Piercolias.*

Female (fig. 33) hardly distinct from *Piercolias* (*Pierphulia*) except that the ductus bursae is longer than the bursa copulatrix with the accessory pouch. Ductus bursae colorless and nonsclerotized; eighth tergite nonsclerotized dorsally or only very poorly sclerotized dorsally; eighth sternite with outer genital plate large and reticulate; inner genital plate weakly setulose with posterior process very greatly reduced and anterior lobe broadly rounded and sometimes reduced but not as much so as in *Phulia* (*Infraphulia*).

HABITUS: The two species included in this genus present two rather different types of color pattern. In both there is a large discocellular spot on both surfaces of the forewing. The hindwing underneath in one type (*Baltia shawi*) somewhat resembles *Piercolias* (*Pierphulia*) in having a white ground color that is heavily irrorated with black scales and with a submesial series of dark spots. However, it has in addition a black spot at the end of the cell on this wing. In the second type (*Baltia butleri*) there is some superficial resemblance to the color pattern of *Phulia;* however, it is distinctly different in having two black spots at end of cell on hindwing on both surfaces, in having a pinkish instead of yellowish ground color on hindwing and apex of forewing below, in lacking the black stripes found in the middle of cell and in interspace Cu_2, and in lacking the submesial series of black spots between the veins that are found in *Phulia.*

SPECIES:

1. *Baltia shawi* (Bates), *in* Henderson and Hume, Lahore to Yarkand, pp. 305, 306, 1873 (*Mesapia*).
2. *Baltia butleri* (Moore), Proc. Zool. Soc. London (1882), p. 256, pl. 2, figs. 6, 6a, 1882 (*Synchloë*).

Explanation of the symbols used on the figures

Male genitalia: *Ae*, aedeagus; *An*, anellus or juxta; *ap*, articulatory process of tegumen; *AT*, anal tube; *clpl*, clasper lobe; *Hp*, harpe; *ip*, inner plate of uncus; *Sac*, saccus; *Subs*, subscaphium; *Teg*, tegumen; *U*, uncus; *Vm*, vinculum.

Female genitalia: *acp*, accessory pouch of bursa copulatrix; *al*, anterior lobe of inner genital plate; *ap*, anterior apophysis; *Bc*, bursa copulatrix; *Db*, ductus bursae; *ds*, ductus seminalis; *fp*, finger-like process of inner genital plate; *igp*, inner genital plate; *Ob*, ostium bursae; *ogp*, outer genital plate; *Ov*, ovipositor; *S*, signum; *tg*, tergite.

Other symbols: *Cl*, claw; *Pr*, paronychium; *Pv*, pulvillus; *h*, humeral vein.

Explanation of Figures 1–5

The figures are of the male genitalia in lateral view. The aedeagi have been removed and the lower drawings of same in figures 1–3 are in a ventral view. The anelli shown in these three figures have also been removed and show both a lateral and a flat view.

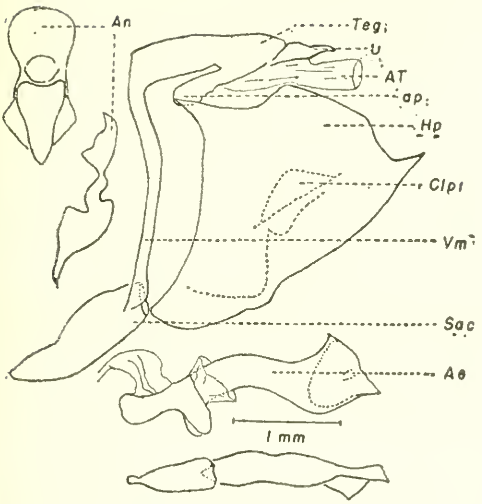
Figure 1.—*Theochila maenacte* (Boisduval). Type species of *Theochila,* new genus. Drawn from Preparation 107.

Figure 2.—*Tatochila autodice* (Hübner). Type species of *Tatochila* Butler. Drawn from Preparation 71.

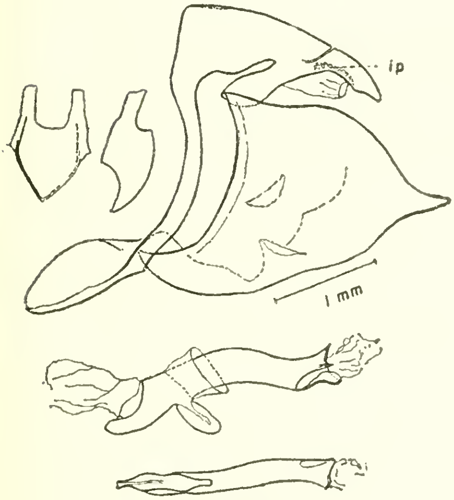
Figure 3.—*Hypsochila wagenknechti* (Ureta). Type species of *Hypsochila* Ureta. Drawn from Preparation 31.

Figure 4.—*Phulia (Phulia) nymphula* (Blanchard). Type species of *Phulia* Herrich-Schaeffer. Drawn from Preparation 230.

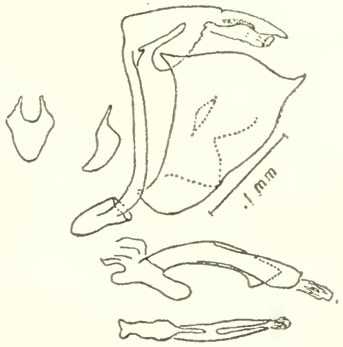
Figure 5.—*Phulia (Infraphulia) illimani* Weymer. Type species of *Infraphulia,* new subgenus. Drawn from Preparation 169.



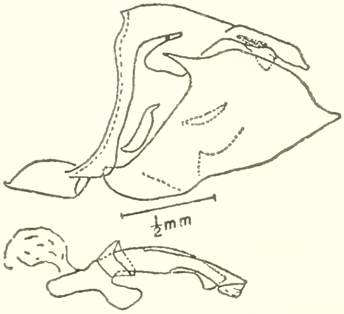
1. THEOCHILA



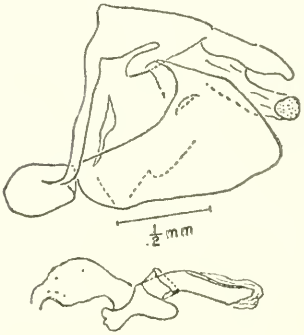
2. TATOCHILA



3. HYPSOCHILA



4. PHULIA (PHULIA)



5. PHULIA (INFRAPHULIA)

Figures 1–5.—Explanation on facing page.

Explanation of Figures 6–16

Figures 6–8 are of male genitalia in lateral view with aedeagi removed. In figure 7 the subscaphium is shown both fastened to anal tube in lateral view and detached and flat. Figures 9–16 are ventral views of the uncus and tegumen.

Figure 6.—*Piercolias* (*Pierphulia*) *nysiella* (Röber). Type species of *Pierphulia*, new subgenus. Drawn from Preparation 5343.

Figure 7.—*Piercolias* (*Piercolias*) *huanaco* (Staudinger). Type species of *Piercolias* Staudinger. Drawn from Preparation 155.

Figure 8.—*Baltia shawi* (Bates). Type species of *Baltia* Moore. Drawn from Preparation 5411.

Figure 9.—*Theochila maenacte* (Boisduval). Drawn from Preparation 107.

Figure 10.—*Tatochila autodice* (Hübner). Drawn from Preparation 22.

Figure 11.—*Hypsochila wagenknechti* (Ureta). Drawn from Preparation 31.

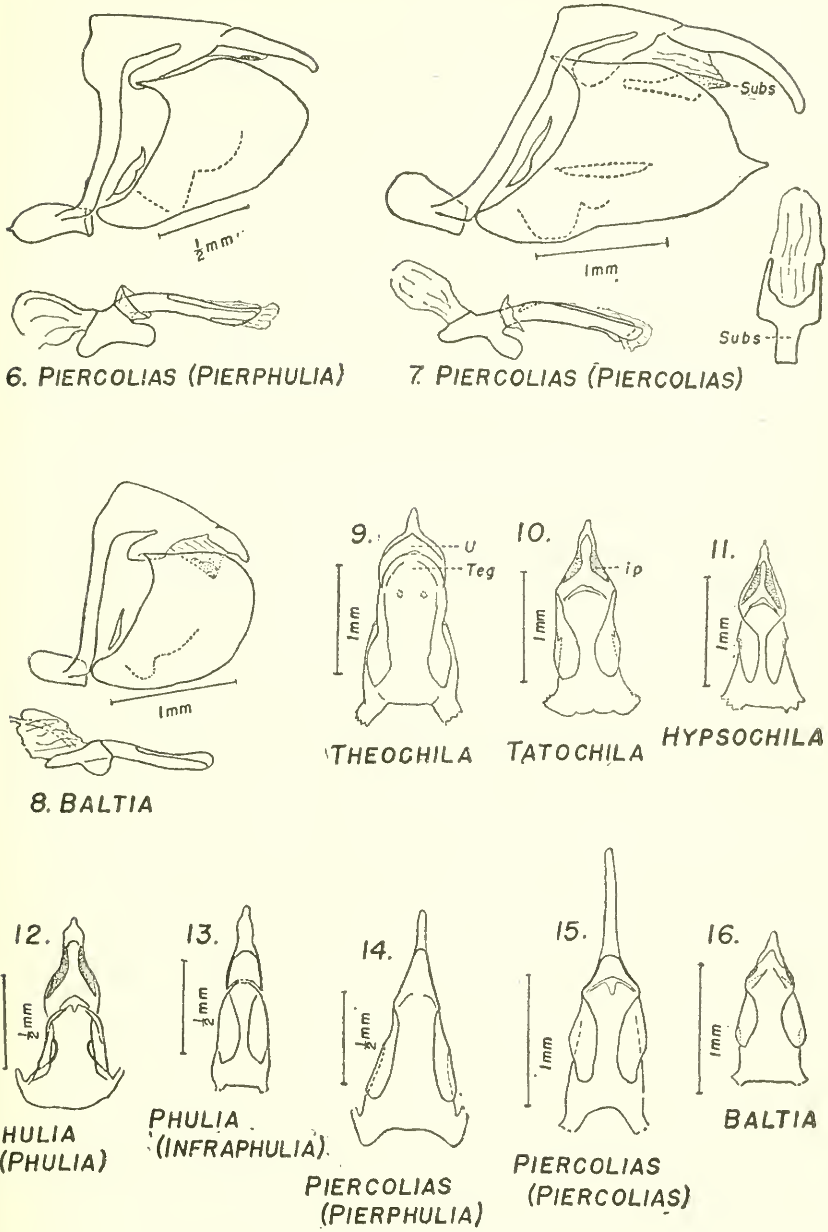
Figure 12.—*Phulia* (*Phulia*) *nymphula* (Blanchard). Drawn from Preparation 299.

Figure 13.—*Phulia* (*Infraphulia*) *illimani* Weymer. Drawn from Preparation 169.

Figure 14.—*Piercolias* (*Pierphulia*) *nysiella* (Röber). Drawn from Preparation 5343.

Figure 15.—*Piercolias* (*Piercolias*) *huanaco* (Staudinger). Drawn from Preparation 5411.

Figure 16.—*Baltia shawi* (Bates). Drawn from Preparation 5411.



Figures 6–16.—Explanation on facing page.

EXPLANATION OF FIGURES 17–24

The figures are of wing venation and are slightly larger than natural size.

FIGURE 17.—*Theochila maenacte* (Boisduval). Drawn from Slide 1148.

FIGURE 18.—*Tatochila autodice* (Hübner). Drawn from Slide 1151.

FIGURE 19.—*Hypsochila wagenknechti* (Ureta). Drawn from Slide 1159.

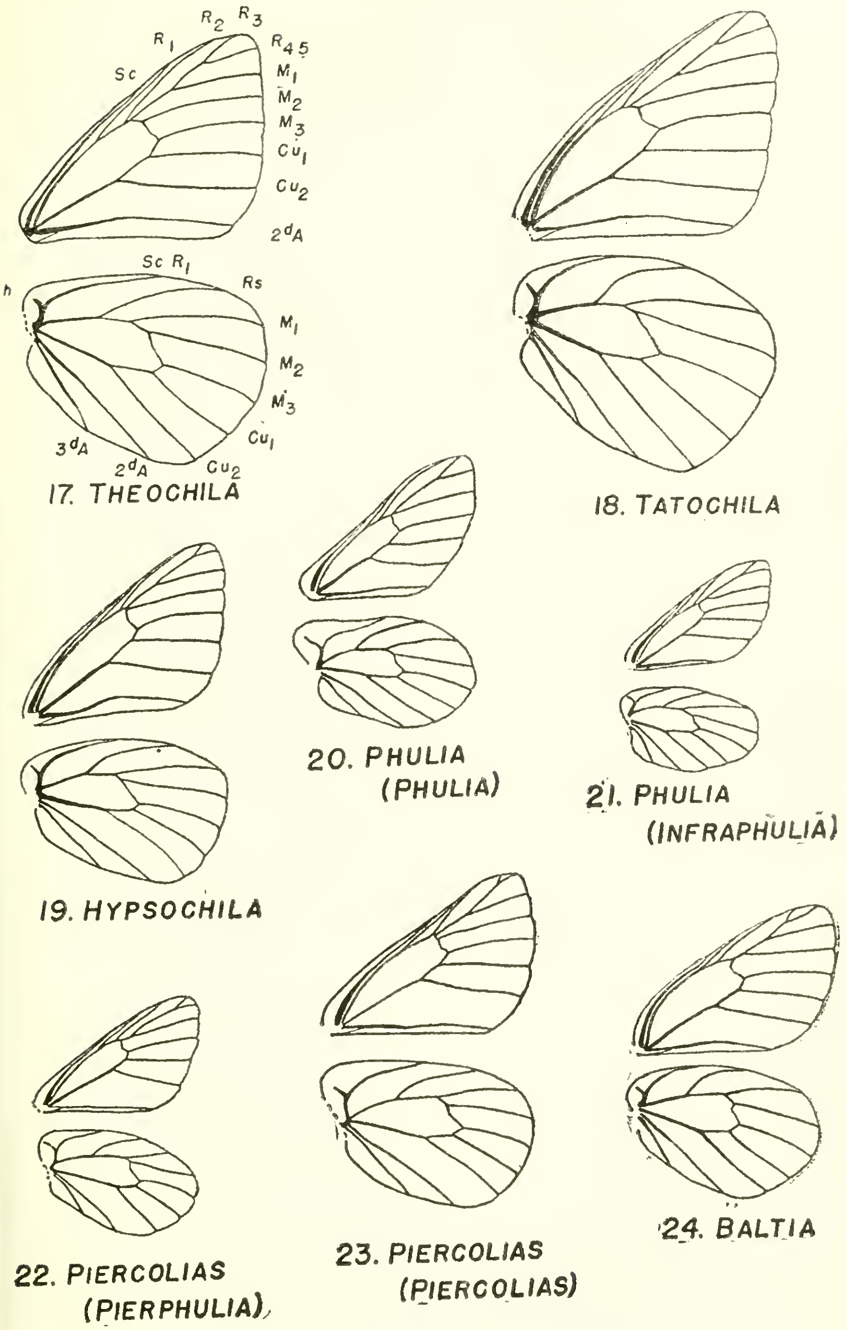
FIGURE 20.—*Phulia* (*Phulia*) *nymphula* (Blanchard). Drawn from Slide 114.

FIGURE 21.—*Phulia* (*Infraphulia*) *illimani* Weymer. Drawn from Slide 169.

FIGURE 22.—*Piercolias* (*Pierphulia*) *nysias* (Weymer). Drawn from Slide 180.

FIGURE 23.—*Piercolias* (*Piercolias*) *huanaco* (Staudinger). Drawn from Slide 155.

FIGURE 24.—*Baltia shawi* (Bates). Drawn from Slide 3810.



Figures 17–24.—Explanation on facing page.

EXPLANATION OF FIGURES 25–33

Figures 25 through 32 are greatly enlarged outline drawings of the claws, paronychia, and pulvilli. Setae and other armature are omitted, except on the paronychium in figure 27. All drawings are to the scale shown in figure 28.

Figure 33 is of the female genitalia showing lateral view, except for the bursa copulatrix, which is turned to show the signum in ventral view. The 7th tergite and the outer genital plate are shown only in dotted outlines to allow other structures to show up more clearly.

FIGURE 25.—*Theochila maenacte* (Boisduval.) Drawn from Preparation 1148.

FIGURE 26.—*Tatochila autodice* (Hübner). Drawn from Preparation 1151.

FIGURE 27.—*Hypsochila wagenknechti* (Ureta). Drawn from Preparation 1160.

FIGURE 28.—*Phulia* (*Phulia*) *nymphula nymphaea* (Staudinger). Drawn from Preparation 1172.

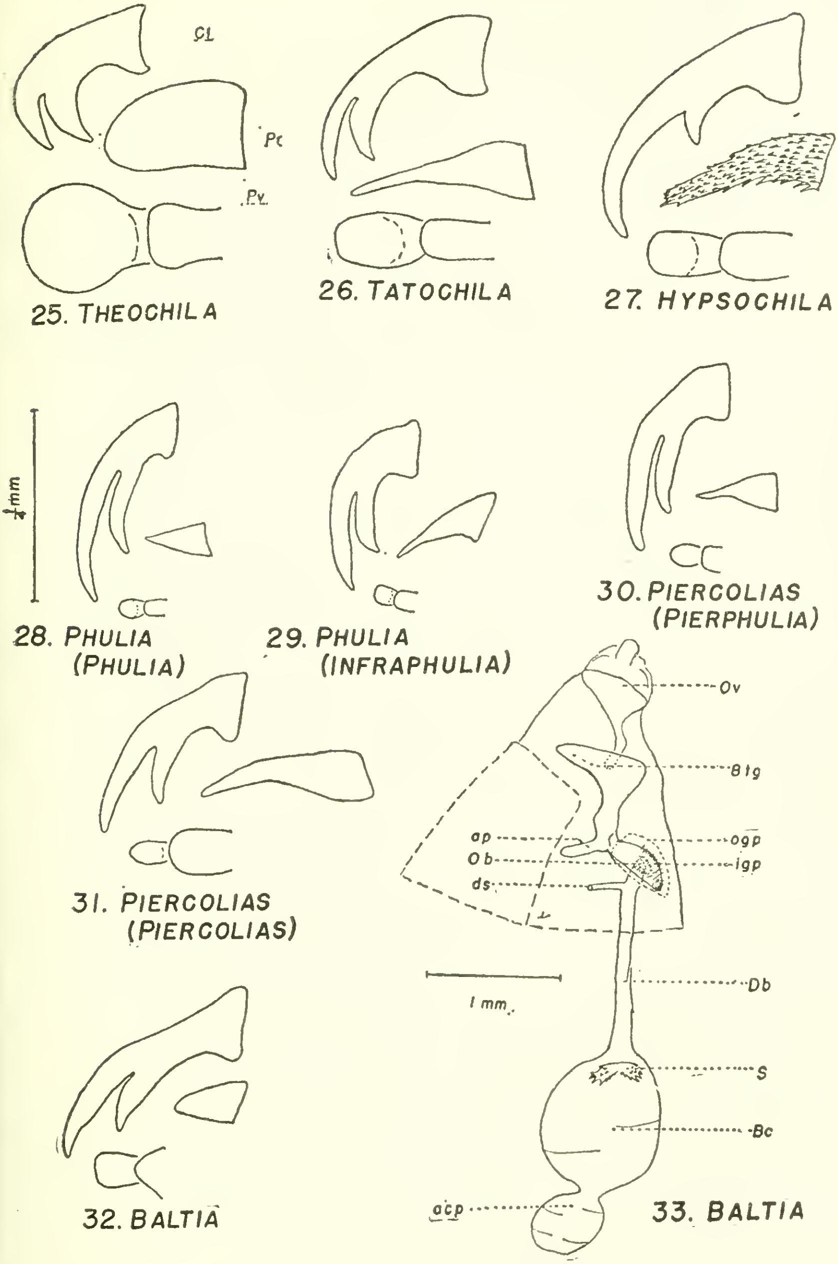
FIGURE 29.—*Phulia* (*Infraphulia*) *illimani* Weymer. Drawn from Preparation 1169.

FIGURE 30.—*Piercolias* (*Pierphulia*) *nysiella* (Röber). Drawn from Preparation 1165.

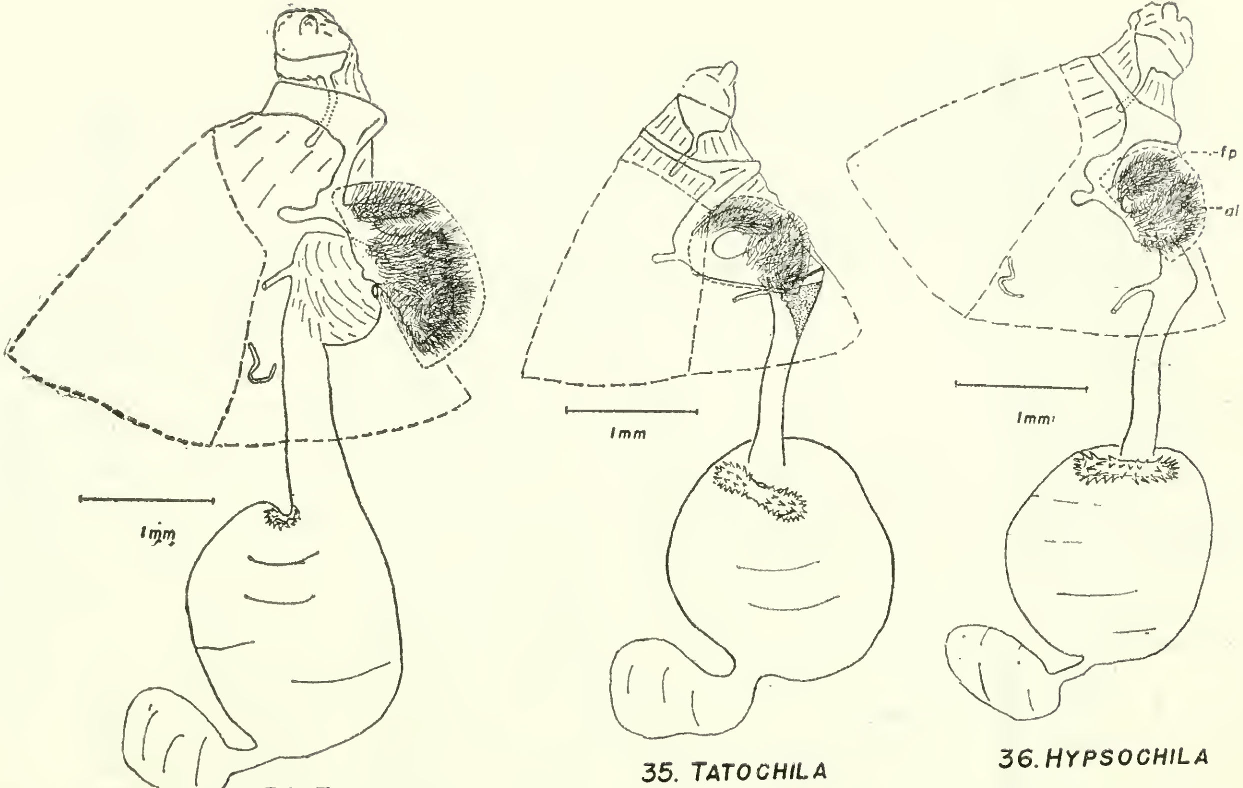
FIGURE 31.—*Piercolias* (*Piercolias*) *huanaco* (Staudinger). Drawn from Preparation 1167.

FIGURE 32.—*Baltia shawi* (Bates.) Drawn from Preparation 1168.

FIGURE 33.—*Baltia shawi* (Bates). Drawn from Preparation 5412.



FIGURES 25–33.—Explanation on facing page.

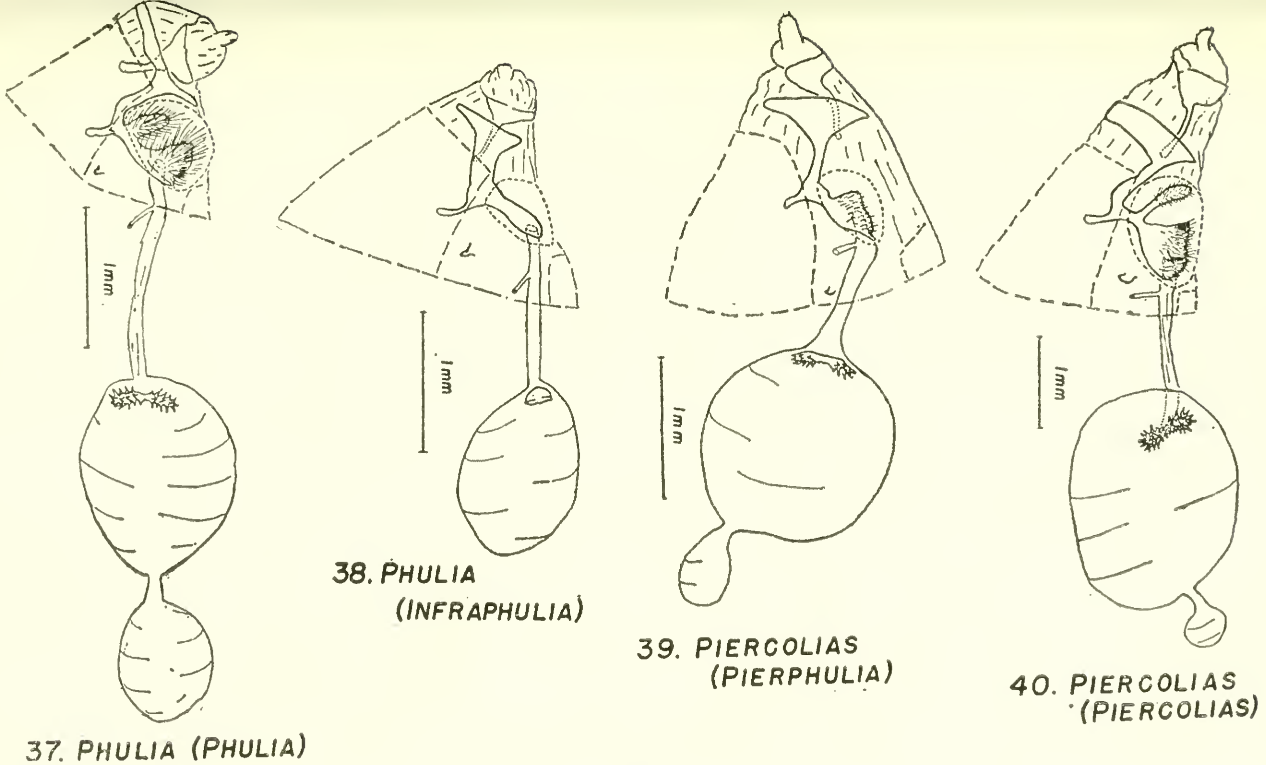


34. THEOCHILA

35. TATOCHILA

36. HYPSOCHILA

Figures 34–36.—Lateral views of female genitalia of: 34, *Theochila maenacte* (Boisduval), drawn from Preparation 5354; 35, *Tatochila autodice* (Hübner), drawn from Preparation 91; 36, *Hypsochila wagenknechti* (Ureta), drawn from Preparation 105. In all figures the accessory pouch is turned slightly upward because of lack of space, and the 7th tergite and the outer genital plate are shown only in dotted outline. In figures 35 and 36 the bursa copulatrix is turned to show a ventral view of the signae.



37. PHULIA (PHULIA)

38. PHULIA (INFRAPHULIA)

39. PIERCOLIAS (PIERPHULIA)

40. PIERCOLIAS (PIERCOLIAS)

Figures 37–40.—Lateral views of female genitalia of: 37, *Phulia* (*Phulia*) *nymphula* (Blanchard), drawn from Preparation 272; 38, *Phulia* (*Infraphulia*) *illimani* Weymer, drawn from Preparation 170; 39, *Piercolias* (*Pierphulia*) *nysiella* (Röber), drawn from Preparation 5344; 40, *Piercolias* (*Piercolias*) *huanaco* (Staudinger), drawn from Preparation 5346. The bursa copulatrix is turned to show a ventral view of the signae; the 7th tergite and the outer genital plate are shown only in dotted outline.

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THE SYSTEMATIC POSITION OF THE BIRD GENUS APALOPTERON

By H. G. Deignan

The Ornithological Society of Japan's (1942) list of Japanese birds indicates that, by 1942, 100 species of birds had been reported from the Bonin Islands, an oceanic group of volcanic origin lying about 500–600 nautical miles southeast of Yokohama. Of these, only 19 species (four of them by then extinct on the islands) were known to have bred. Of the 19, eight pelagic forms (two albatrosses, four shearwaters, one gannet, and a tern) may be disregarded at this time. Of the land birds, seven are mere races of species common in the Japanese Archipelago (one hawk, one pigeon, one bulbul, one crow, one thrush, one warbler, and one greenfinch), while two (a pigeon and a hawfinch), extinct and not examined by me, may be presumed to have had similar origin. An anomalous element in the avifauna is found in the former presence of a night heron characteristic of the coasts and islands of the southwestern Pacific and otherwise not occurring north of the Palaus and the Philippines. Finally, there is the genus *Apalopteron* Bonaparte, the subject of these remarks.

First named *Ixos familiaris* by its discoverer, F. H. von Kittlitz,[1] and considered a bulbul, it was removed to the "Timaliidae" by

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[1] Mem. Acad. Imp. Sci. St. Petersbourg, vol. 1, pt. 3, p. 235, pl. 13, 1830.

Bonaparte[2] in 1854 as a monotypic genus, *Apalopteron.* Sharpe (1882, p. 120, footnote) restored it to the bulbuls as a member of the type genus *Pycnonotus*, and the most recent Japanese writers, using the name *Apalopteron*, have retained it in that family. Delacour (1946, pp. 21, 29), on the other hand, has considered it to be a timaliine closely related to the genera *Actinodura* and *Minla.* It is my contention, however, that *Apalopteron* is in fact a fairly typical genus of the Australasian Meliphagidae or honey-eaters.

The true meliphagid tongue, fringed and quadrifid at its distal end, has been most recently discussed and portrayed by Scharnke (1931, pp. 454–466) in the genera *Myzomela, Myza, Melidectes, Orodytes, Philemon, Xanthotis, Ptiloprora,* and *Toxorhamphus;* by the same author (Scharnke, 1932, pp. 117–119) in *Promerops;* and by Dorst (1952, pp. 185–214) in *Meliphaga, Gliciphila, Melithreptus, Zanthomiza, Meliornis,* and *Melipotes.* Comparison of the flattened tongue of *Apalopteron* (pl. 1) with the drawings of the tongues of *Myzomela* and *Philemon* (Scharnke, 1931, pp. 456, 457) and the schematized drawing of the tongue of *Meliphaga* (Dorst, 1952, p. 187) will show that all are modeled upon a common pattern.

The Meliphagidae are unusual, if not unique, among oscinine birds by their pervious nostrils. I have noted this character in freshly collected specimens representing the Australian genera *Melithreptus, Entomyzon, Ramsayornis, Conopophila, Myzomela, Meliphaga, Lichmera, Myzantha,* and *Philemon.* Specimens of *Apalopteron* in the U. S. National Museum that quite certainly have never had the nostrils pierced by a needle are similarly devoid of the narial septum.

Such unspecialized genera of the Meliphagidae as *Myzomela, Lichmera, Ramsayornis, Conopophila, Meliphaga,* et al. have the tarsus in the adult so obscurely scutellate as to appear booted (bilaminate behind), although scutellation is usually apparent in the young. The tarsus of adult *Apalopteron* shows the same quasi-booted aspect, and it is interesting to note that, according to a recent communication from Dr. Yamashina, scutellation cannot be seen even in the newly hatched chick.

In its gross external features, *Apalopteron* certainly more nearly resembles the unspecialized honey-eaters than it does any member of either the Pycnonotidae or the Timaliinae. Its but slightly decurved bill, with strongly operculate nostrils, is not strikingly different from that of *Lichmera,* while its general coloration and pattern about the head are reminiscent of those found especially in certain species of *Meliphaga* (e. g., *M. chrysops* and *M. melanops*). The short, somewhat recurved, bristle-like feathers that appear on the front and

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[2] Comptes Rendus, Acad. Sci. Paris, vol. 38, pp. 54, 59, 1854.

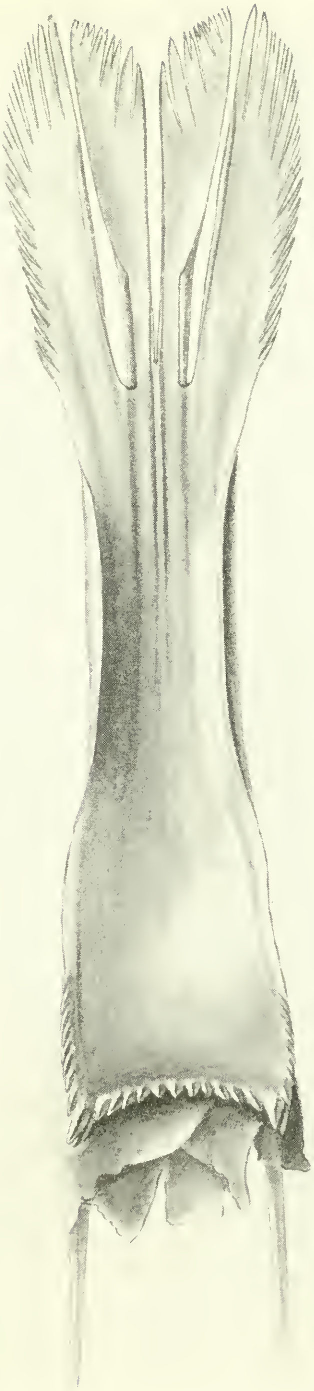

PLATE 1.—Dorsal view of tongue of subadult *Apalopteron familiares.* Magnification, × 15.

throat of *Apalopteron* seem to be identical with those seen in the two above-named species and many others.

Yamashina (1930, pp. 332–334) has reported upon six nests of *Apalopteron*, each of which contained either two brown-spotted, greenish blue eggs or two naked nestlings. Five of the nests were constructed principally of fibers of *Pandanus* and *Livistona*, one (in a *Livistona* flower) wholly of *Livistona* fibers. The cup-shaped nest, the materials used, the number of eggs, and the nakedness of the chicks all would, if the bird were native to Australia, be used to confirm the view that it is a typical honey-eater. (It should be mentioned, however, that the eggs of the Australian species of the unspecialized genera seem always to have a pinkish or buffy rather than a greenish blue ground color.)

The food habits of *Apalopteron*, and its probable role as a pollinator of one or more species of ornithophilous plants, are of prime importance. Dr. Yamashina has written to me that his visits to the Bonins, in winter and spring, did not coincide with the true season of flowers, and that he found the birds then feeding on insects and fruits: ". . . when we broke a large fruit of *Pandanus*, *Apalopteron* gathered to eat its seeds." He adds that *Apalopteron* (in captivity) likes sweet food and delights in sugar-water or honey added to its diet. Parenthetically, it may be noted that insects and fruit seem to be the primary foods of many of the Meliphagidae, with pollen and nectar only secondary ones.

At discovery the Bonins were described as wholly overgrown with a dripping forest of tall trees. The endemic flora was of mixed provenience, some of the genera having originated in temperate eastern Asia, while others, perhaps a majority, were unquestionably of Oceanic origin and here reached their northernmost outpost from the Papuasian matrix. Hosokawa (1934, pp. 201–209, 657–670) has discussed the phytogeography of the Bonins and has pointed out that, among the botanical curiosities of the islands, are a palm, *Cyphokentia* (a genus otherwise restricted to New Caledonia and the Samoan Islands), and an arborescent lobelioid (whose nearest relatives are restricted to the Hawaiian Islands). Endemic plants of Oceanic origin that may have had a special relationship with *Apalopteron* are *Myoporum boninense* (northernmost representative of a Papuasian family highly attractive to the Meliphagidae) and the *Lobelia* (whose allies are favored feeding flowers for the Hawaiian Drepaniidae). While settlement of the islands has brought about immense alteration of the flora, it may be supposed that *Apalopteron* has benefitted by the introduction of such fruits as the banana, orange, mango, papaya, guava, longan, persimmon, and passionfruit, to say nothing of the ornamental, often nectariferous, plants common to subtropical gardens.

ACKNOWLEDGMENTS: For comment and advice, I am indebted to Dr. Ernst Mayr of the Museum of Comparative Zoölogy and Dr. Austin L. Rand of the Chicago Natural History Museum, both of whom have had broad experience with the Meliphagidae in the field and in the laboratory. To the Marquess Yoshimaro Yamashina I owe thanks for information on specimens in his collection and unpublished observations on the living bird, and to Dr. F. Raymond Fosberg of the National Research Council and Dr. Egbert H. Walker of the U. S. National Museum for guidance in the botanical literature. Finally, I am indebted to Mrs. Patricia Isham of the U. S. National Museum for the drawing of the tongue of *Apalopteron*.

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A REVIEW OF THE COPEPOD GENUS RIDGEWAYIA (CALANOIDA) WITH DESCRIPTIONS OF NEW SPECIES FROM THE DRY TORTUGAS, FLORIDA

By Mildred Stratton Wilson [1]

The calanoid copepods discussed herein represent a small number of incompletely known, closely allied species for which three generic names have been proposed. To this list are added two new species from collections made among the keys of the Dry Tortugas, Florida, by Mr. Clarence Shoemaker of the United States National Museum in the course of an amphipod survey of that region (Shoemaker, 1933, 1956). The debris washed from rocks and corraline algae taken at very shallow depths of a few inches to a few feet has yielded not only amphipods but other Crustacea among which were many small copepods. These included mostly Harpacticoida and Cyclopoida characteristic of such a habitat, but some Calanoida were also present. Among these were adults of the two new species and a few subadult males of an unknown species that are herein assigned to the genus *Ridgewayia*.

This rather unusual genus has been known since 1903 when Thompson and Scott described the female of *R. typica* from Ceylon. Since then, closely allied species have been described as the types of new genera without comment on their obvious relationship to *Ridgewayia*.

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[1] Collaborator, Smithsonian Institution.

Through a study of literature and comparison of descriptions with the Tortugas material, it is apparent that *Lampoidopus marki* Esterly from Bermuda and *Suezia canalis* Gurney from the Suez Canal are very closely allied to *Ridgewayia typica*. Of these species, only *marki* is known from both sexes, and has been listed in literature beyond the original record. Only the female of *typica* has been described; *canalis* is known only from the male. A single male specimen, representing either an unknown species or the male of *typica*, has been briefly described from Madras as *Suezia* sp. by Krishnaswamy (1953). Both this Madras male and that of *canalis* are relatable to the female of *Ridgewayia typica* through knowledge of both sexes of *marki* and the new Tortugas species. On the basis of present knowledge, there seems little justification for maintaining three generic names for this small group of species, and they are all herein referred to *Ridgewayia* (*R. typica*, *R. marki*, and *R. canalis*).

Specimens of only the new species have been available for study. The specific diagnoses included here are all based upon the original descriptions (text and figures); note is made of characters omitted in these descriptions.

Generic synonymy

The results of study of the literature and of the available specimens do not permit an absolute, unqualified synonymy of the generic names that have been proposed. Therefore this study is presented with the recognition and suggestion that *Lampoidopus* and *Suezia* may with increased knowledge be fully and satisfactorily separable generically from *Ridgewayia*. That this is not now possible is due largely to the fact that in *Ridgewayia* and *Suezia* only the one sex is known. If I were presenting a paper dealing only with literature, or with specimens of the same sexes as were originally available for the described species, it would seem sufficient to point out the hitherto unsuspected relationship of *Ridgewayia typica*, *Lampoidopus marki* and *Suezia canalis*. Since, however, there exists the primary problem of placing two new species as accurately as possible, it has been necessary to consider critically the question of whether there is any valid objective reason for not placing them in the genus of prior date.

The generic diagnosis given for *Ridgewayia* by Thompson and Scott (1903) confused the exopod and endopod of the antenna, and gave no information for the third leg of *typica*. It is also possible that the presence of an inner seta on the first basipod segments of legs 1 and 2 may have been overlooked. It is doubtful if the setation shown in the figure of the antennule is entirely exact. Otherwise the description is complete and accompanied by excellent figures. It affords therefore an adequate basis of support for inclusion in the genus *Ridgewayia* of the females of the new Tortugas species and of Esterly's

(1911) Bermuda species *marki*. Among calanoids, the modification of the female fifth leg is distinctive for these species. That of *R. typica* differs from that of the three American species only in having a shorter inner apical spine on the third exopod segment. This and other differentiating characters are either interpretable as specific, or concern structural features that have been sketchily presented, or could have been overlooked. These characters and features are pointed out in the specific diagnoses and discussion.

When the similarity of the basic characters is considered, it does not seem possible to me that there is any choice other than to refer the Tortugas material to *Ridgewayia*. It seems inconceivable that Esterly would have erected a new genus for his Bermuda specimens had he been aware of and considered the description of *R. typica*. Since the male of *typica* is still unknown, there exists no more justification for the genus *Lampoidopus* today than there did in 1911. Gurney (1927) appears to have been unaware of Esterly's paper, since he failed to point out not only the similarity of his Suez Canal specimens with the males described by Esterly, but in the same paper he named a new species of *Pseudocyclops* without noting its striking similarity to *P. magnus* described in Esterly's Bermuda paper. It also seems inconceivable that if Gurney had referred in his study to both Esterly's and Thompson and Scott's papers that he would have failed to note the relationship of his specimens to *Ridgewayia*, as shown through Esterly's description of both sexes. Krishnaswamy also makes no mention of *Ridgewayia* or of *Lampoidopus*. Thus, all the authors who have reported species of this group since the original description of *Ridgewayia typica* have failed to relate their material to it. Sewell (1929, 1932, 1948), in summaries of copepods of Indian waters, has not included *R. typica*, although *Suezia* is mentioned. The genus *Ridgewayia* has therefore in effect become buried in the literature.

The generic diagnosis given herein for *Ridgewayia* is a composite of the characters of both sexes of all the known species. It is detailed, contains exceptions and alternatives, and points out wherein knowledge is not complete for some species. Such a diagnosis is intended to form a working basis for the present report and also to be useful in future studies. In searching for the characters that indicate relationship of a group of calanoid species to one another, either on the generic or familial level, it is necessary to consider every appendage. In the species dealt with here, the evidence for their very close relationship is found in all appendages. Particularly noteworthy is the correlation of all oral appendages, the maxilliped and the first and fifth legs. The characteristics of these appendages in large groups may define a family, but they are also highly pertinent at the generic level in the Calanoida. It remains for future studies and accurate, detailed knowledge of both sexes of all the species to determine whether we are dealing here with more than one genus. Most of the differences that have been found to exist on the basis of literature, need, in my opinion, to be verified by further examination of specimens.

The determination of the proper generic status of all these species is primarily dependent upon knowledge of the male of *typica.* Its discovery should serve to differentiate *Ridgewayia* and *Lampoidopus* if they are truly generically distinct. It may or may not solve the status of *Suezia canalis,* which may be further dependent upon knowledge of the female and reexamination of the male. The two new Tortugas species would be referable to *Lampoidopus* if it is established as a separate genus.

Subclass COPEPODA

Order CALANOIDA

Genus *Ridgewayia* Thompson and A. Scott

Ridgewayia Thompson and A. Scott, 1903, p. 245.
Lampoidopus Esterly, 1911, p. 219, new synonym.
Suezia Gurney, 1927, p. 457, new synonym.

Diagnosis (emended): Species small, approximate range of length between 0.6 and 1.0 mm.

Metasome stout, 5–6-segmented, the somite of leg 1 distinctly or indistinctly separated, or fused with cephalic segment.

Urosome less than half the length of metasome, 3–4-segmented in female; if present, the fourth segment reduced to width of caudal rami; 4–5-segmented in male, fifth segment, if present, reduced as in female. Paired genital openings of female closely set (known only for the new species). Caudal rami longer than wide, with four terminal setae longer than rami, of these the second from the inner the longest (an outer spine also present in *marki* and in the new species).

Rostrum downturned, broad at base, rounded or pointed distally; filaments lacking.

Cephalic appendages all of primitive calanoid type, without reduction, excessive modification, or sexual differentiation.

Antennule reaching from near end of metasome to caudal rami; 25–26-segmented in female (21–22-segmented in *canalis*?); the three apical segments elongate. Left antennule male like that of female (where known); the right of 21–24 segments, with a moderately developed geniculation, segmentation beyond this specialized joint varying from three to four segments (geniculation reportedly not present in *canalis* and *Ridgewayia* sp. (Madras)).

Antenna: Outer ramus a little longer than inner, 7–8-segmented, only the apical segment elongate. Inner ramus 2-segmented, the first segment longer than the second, bearing 1–2 lateral setae; the second with terminal portion expanded into two setiferous lobes, the outer produced beyond the inner.

Mandible: Masticatory blade not conspicuously expanded, produced or grooved, with about 7–10 shallowly incised teeth not separated by any large gaps. Palp with broad, unsegmented basipod bearing 3–4 lateral setae. Exopod 4-segmented, the two distal segments more or less defined. Endopod 2-segmented, with numerous apical setae.

Maxillule (unknown for *canalis*): Basal portion well developed, with indistinct segmentation or none; its greater proximal part consisting of an expanded inner lobe (gnathobase) bearing short, spiniform setae; outer portion an unexpanded setiferous plate with 9–10 mostly elongate setae. Distad to this outer plate a reduced lobe (epipodite) bearing (in the new species) a single seta (no seta shown in illustrations for *typica, marki*). Inner side beyond gnathobase with two narrow laciniae, each bearing 4–5 setae. Beyond these laciniae, the basis elongated and produced on inner proximal side into setiferous lobe. Endopod attached just outside this lobe, 2-segmented (apical segment not shown as separated in *marki*); proximal segment greatly enlarged with several (6–8) lateral setae; apical segment reduced, with 5–6 setae. Exopod rather well developed, arising from the basis nearly opposite the inner laciniae (clearly separated in the new species, but not shown as demarcated in *marki, typica*), with lateral and apical groups of setae (exopod entirely unsegmented in *typica* and in the new species, but apex shown as demarcated in *marki*).

Maxilla: The whole equal to or a little longer than the basal segment of the maxilliped, with three broad primary divisions expanded into small setiferous lobes, and a reduced terminal portion which may or may not be distinctly separated or segmented. Lobes 5–7 in number, of which 1–3 are on the proximal division; the other two divisions each with two lobes. Setae of lobes long and slender, none conspicuously more developed than the others.

Maxilliped: Not conspicuously enlarged, but its length 3–4 times greater than that of the maxilla and longer than the first leg. The basipod of 2–3 segments (a proximal, nonsetiferous segment not shown in figures of other species, but present in the new species); second segment with four lobes or groups of setae. Endopod shorter than total basipod, of five well-defined segments; intercalated between it and basipod an incompletely separated segment bearing two setae.

Legs 1–4 slender, with narrow connecting pieces; biramous, both rami 3-segmented. Inner seta on basipod segment 2 of leg 1. (Information on setae of basipods otherwise incomplete in literature; the new species and *marki* have inner setae on both basipod segments of leg 1, and on basipod 1 of legs 2–4; legs 3 and 4 entirely unknown for *canalis;* leg 3 unknown for *typica.*) Exopod segments 1 and 2 with one outer spine and inner seta. Exopod segment 3, total number of outer and terminal spines (so far as known): three on legs 1 and 2, four on legs 3 and 4; these spines mostly without serrations or membranes; total number of inner setae: four on leg 1; five on legs 2–4. Endopod segment 1 with one inner seta on all legs; endopod segment 2 with two setae on legs 1 and 2, and on leg 3 where known; one or two setae on leg 4. Endopod segment 3, total of six setae on leg 1; eight on leg 2; five to eight on leg 3; six or seven on leg 4. Most of the setae divided into two joints, consisting of a stiff basal cylinder and a longer, flexible distal part, densely plumose.

Leg 5 of female showing only slight specific differences, slender, symmetrical, with well-developed 3-segmented exopod and reduced 2-segmented endopod. Exopod modified; segment 3 constricted basally and set into narrowed, well-defined socket of segment 2; the outer, distal spine-bearing portion of segment 2 enlarged and considerably produced beyond this insertion. Exopod segment 3 with four spines and four inner marginal setae. Endopod segment 1 reduced, without inner seta. Endopod segment 2 at least twice the length of first segment and usually longer; with seven setae (two outer, two apical, three inner). All setae with jointed bases.

Leg 5 of male: Right and left basipod segment 1 fused or with definable connecting plate. Both rami modified and strongly asymmetrical. Right exopod 2-segmented, sometimes with imperfectly separated apex; second segment tending to elongation, with two outer marginal spines, or with one proximal spine and more distally placed spinous points; the segmental portion beyond proximal spine narrowed and more or less incurved. Left exopod 3-segmented, or third segment not entirely separated from second (as in Gurney's figure for *canalis*); the whole third segment or apical portion considerably modified, with a short but stout basal portion from which may extend spines, complex ornamented processes and fragmented membranes of irregular length. Endopods unsegmented; the right elongate, nearly as long as or longer than exopod; the left much shorter than the right (tending to be about half as long or less); either endopod entirely unarmed, or with setae, spines or processes.

Type species: *Ridgewayia typica.*

Ridgewayia typica Thompson and A. Scott

Ridgewayia typica Thompson and A. Scott, 1903, p. 245, pl. 1, figs. 1–13.

Diagnosis (after Thompson and Scott): *Female:* Length about 0.85 mm. Metasome of six well-defined segments, the somite of leg 1 clearly separated; ventral margin of last segment deeply incised and showing in lateral view a hooklike process. Rostrum broad and pointed. Urosome 4-segmented; genital segment with distal hooklike process on right side. Caudal ramus twice as long as broad, with four long apical setae (details unknown). Antennule reaching to near end of metasome, 25-segmented. Antenna, exopod 8-segmented. Maxilla with seven well-developed setiferous lobes, of which three belong to basal division.

Leg 1 (from figure): Exopod 2, outer distal part with inner, narrow, serrate process about half length of outer spine. Inner apical spine of exopod 3 nearly as long as total exopod (about 17:20). For armature of legs 1–4, see under "Discussion" (p. 168).

Leg 5: Exopod 3 with all four spines shorter than segment, the innermost apical spine of about same length as outer apical spine. Endopod 2, first inner seta placed above middle of segment, at point about 23 percent of total length of segment; first outer seta at point about 54 percent of length of segment.

Male: Unknown.

Distribution: Ceylon, from the Muttuvaratu pearl oyster washings.

***Ridgewayia* sp. (Madras)**

Suezia sp., Krishnaswamy, 1953, p. 127, figs. 7–9.

This reference is to a brief description of a single, damaged male specimen found in plankton collected on the Madras coast of India. The record is particularly interesting because it is from the same geographic region as *R. typica,* and raises the question of whether it may represent the unknown male of that species. Unfortunately, the description given is too incomplete to allow for any decision other than the relationship traceable through the species in which both sexes are known.

The textual description is brief and so may be repeated here exactly as given (with correction of obvious printing errors). "*Size:* Male 0.679 mm. *Colour:* Formalin fixed specimens appear yellow. *Salient features:* General body shape cyclopiform. The last thoracic segment with a small projection. The basal 2 of the endopod of first leg with a curved spine. Antennule not prehensile. Fifth leg highly modified and biramous."

Under "Remarks" there is a short comparison with Gurney's figures of the fifth leg of *Suezia canalis:* ". . . the left leg resembles Gurney's figures exactly while the right exopod differs from it in the second joint being shorter."

One of the figures given is of the last thoracic segment, and shows a spinous point somewhat similar to that of *typica,* but smaller. The other figures are of the first and fifth legs. Both call for comments on detail of structure.

In the figure of the first leg, both spines and processes are solidly inked, so that they cannot be distinguished from one another. The exopod would have the same number of spines as in the other species, if distinction had been made between the processes and spines. The long inner apical spine of exopod 3 is shorter than that shown for *typica*, being equal to the length of the third segment plus about half of segment 2, and may thus indicate that the two are not conspecific. In both the text and the figure there is some confusion as regards the distinction between the produced inner portion of the second basipod segment and the endopod. The text refers to the spine of the "basal 2 of the endopod." Obviously the spine referred to belongs to the second basipod segment and not to the endopod; it appears to be similar to the stout, curved seta of the other species. No inner setae are shown on endopod segments 1 and 2; this is probably due to incomplete delineation rather than actual lack of setae. Endopod segment 3 differs from all the other species in that there is a stout apical spine in the position of the spinous process, though because all processes and spines are solidly inked, the actual nature is not determinable from the illustration. There seem to be five inner setae, but these are somewhat indefinitely portrayed.

The structure of the fifth leg is for the most part clear from the figure. As further pointed out in the discussion (p. 171), the left exopod is relatable to the American species and is not identical to that of *canalis*. The important characteristics of the leg are: Right and left basipods about equal in length; the first segments not fused; left segment 2 with inner seta. Right second exopod segment only little longer than first, with one prominent, proximally placed outer marginal spine; beyond this spine the margin with a pair of closely set points beyond which the segment is abruptly shortened, narrowed, and inwardly directed. Right endopod reaching beyond exopod, with three inner marginal setae. Left exopod shortened but 3-segmented, not reaching to end of right exopod; segments 1 and 2 with prominent outer spines about as long as total exopod and closely set to one another; exopod segment 3 reduced (detail not shown in figure). Left endopod reaching to end of exopod, unarmed.

There is little doubt that this Madras specimen represents a different species from *canalis* or from any other in which males are known. Its occurrence near the type locality of *typica* makes it imperative that consideration be given to the possibility that it may be the male of that species. This point may or may not be establishable from a complete comparison of appendages.

Ridgewayia canalis (Gurney), new combination

Suezia canalis Gurney, 1927, p. 457, fig. 109.

Diagnosis (after Gurney): *Female:* Unknown. *Male:* Length (2 specimens), 0.72, 0.74 mm. Body form "cyclopoid," metasome 6-segmented, lateral wing of last segment with small, backwardly directed tooth. Rostrum pointed. Urosome 4-segmented, fifth segment said to be "scarcely distinct."

Antennule reaching to about end of metasome; segmentation said to be "indistinct," of 21 or 22 segments; the right not prehensile. (No direct reference made to left antennule.) Exopod of antenna 7-segmented. Mandible palp as for genus. Maxillule undescribed. Maxilla shorter than segment 1 of maxilliped; with five inner setiferous lobes, of which one belongs to basal division; apical portion of two segments. Maxilliped as for genus (setae of basal segment appear to be incompletely shown in illustration).

Leg 1 (from fig. 109F): No inner seta shown on basipod 1; present on basipod 2. Exopods 1 and 2, outer margin with distal, serrate process, that of second segment about half length of outer spine. Exopod 3, inner apical spine shorter than segments 2+3, about 14:18. Endopod 1, outer margin with stout, partially separated lobe (as in new Tortugas species). Spines and setae as given for the genus.

Leg 2 with inner seta on basipod segment 1; setation of exopods and endopod as given for the genus (see also p. 169).

Legs 3 and 4 unknown, except that the rami are 3-segmented and the exopod spines lack hyaline membranes.

Leg 5 (from fig. 109H,I): No spines or setae shown on basipods; first basipod segments at least partially separated by connecting plate; right and left basipods of nearly equal length. Right exopod 2, outer margin with one spine set near proximal fourth of segment, the inner margin incised at this point and the segment narrowed and tapered, forming an incurved prolongation; outer margin with two minute spinous points at middle and near tip of segment. Left leg shorter than right. Outer spine of exopod 1 reaching to near end of leg, evenly tapered, with wide, serrated fringe. Exopod 2 produced into stout lateral spinous point inside of which is a modified spine ornamented with outer hyaline flange and inner basal process (comparable to outer spine of other species?). Inside this modified spine, a shorter produced portion of the segment shown as partially separated on the anterior side, divided into an outer, seemingly flattened structure with bifid tip, and an unmodified segmental inner portion (this appears to represent a reduced third segment, less complex in structure and armature than that of the other species). Endopods modified as in other species of the genus. The right elongate, reaching to near end of exopod, inner margin with four short, thick setae disposed along its length, the distal the largest and armed marginally with a hyaline flange. Left endopod much shorter than right, but nearly as long as the shortened left exopod, its outer distal margin with two short lobed processes.

DISTRIBUTION: Suez Canal. Original record from two specimens, taken in separate plankton collections at night, from Kabret and Ismailia.

REMARKS: Since only the female of *Ridgewayia typica* and the male of *R. canalis* are known, the question of their possible conspecificity has been considered in this study. It has been concluded from the following differences in the first leg and the cephalic appendages, exclusive of the antennule, that *R. canalis* is a distinct species and does not represent the male of *R. typica*:

ANTENNA: Endopod 8-segmented in *typica*, 7-segmented in *canalis;* last segment with 3 apical setae in *typica*, with 4 in *canalis*.

MAXILLA: Seven lobes in *typica*, of which three belong to the basal division; five lobes in *canalis*, of which one belongs to the basal division.

LEG 1: Exopod segment 1 without distal process on outer margin in *typica*, with process in *canalis*. Apical inner spine of exopod segment 3 longer than last two segments in *typica*, shorter in *canalis*.

These characters have been taken from illustrations given in the descriptions of the two species. The characters are easily determined for the antenna and maxilla, and it is probable, unless immature specimens were originally studied, that examination of the species when again collected will show them to be as given. With the exception of the spine length, the characters of the first leg need most careful study from an advantageous view. Mere comparison of the figures may not necessarily give exact detail of the armature of the exopods. All of these differences should also help in identifying the female of *canalis*.

Ridgewayia marki **(Esterly), new combination**

Lampoidopus marki Esterly, 1911, p. 219, pl. 1, fig. 4; pl. 2, figs. 13, 14, 20, 21; pl. 3, figs. 25, 26, 28–31, 34; pl. 4, figs. 35, 38, 42.—Pinney, 1933, p. 142.

DIAGNOSIS (after Esterly): Length of both sexes about 1.0 mm. Metasome 5-segmented, somite of leg 1 fused with cephalic segment. Rostrum broad and rounded at apex. Urosome female 3-segmented; male 4-segmented; caudal rami about 3.5 times as long as broad in both sexes. (See also p. 162.)

Antennules reaching to end of caudal rami; female and left male 25-segmented. Right antennule male geniculate, 23-segmented, "terminal portion 4-jointed." Antenna, exopod 8-segmented. Maxilla with six well-developed lobes and unsegmented apical portion; basal division with two lobes.

Leg 1 (from fig. 42): Exopod 2, outer distal part with flattened, serrate process, a slender spine (or process?) between it and outer spine, both shorter than outer spine. Inner apical spine of exopod 3 a little longer than exopod 2+3, equal to about 75 percent of total exopod length. (See p. 168 for detail of setal armature of legs 1–4.)

Leg 5, female: Exopod 3 with the three outer spines shorter than segment; inner apical spine subequal to segment and about twice the length of outer apical spine; basal joints of all inner setae reaching beyond point of insertion of succeeding seta. Endopod segment 2, first inner seta placed a little above middle, at point about 44 percent of total length of segment; first outer seta placed below middle of segment, at point about 69 percent of total length of segment.

Leg 5, male (rami separated in Esterly's illustrations, and the basal segments of left leg incompletely shown; not possible to judge relative length of left and right sides): Right exopod, outer spine of segment 1 reaching to about middle of segment 2; tip of exopod 2 truncated, without lappet or partial division, with two outer spines, relative length of segment and first and second spines about 38:20:15. Left exopod 3-segmented; segment 1 with long, narrow, setiform outer spine that reaches a little beyond the second segment. Second segment about twice the length of and much broader than first segment, its outer distal spine stout basally, tapered apically, its length only little more than half that of segment. Segment 3, membranes and processes elongated, length from base to tip exceeding that of segment 2 and reaching far beyond end of its outer spine. Endopods unarmed; the right elongate, club-shaped, reaching to beyond middle of last segment; the left shorter, length about twice its own width, reaching to near end of exopod 2.

Distribution: Bermuda Islands. In cave on small ledge-like island across from Agar's Island, at high tide (Esterly); in night plankton haul in Grasmere Cove, near shores of Bermuda (Pinney).

Ridgewayia gracilis, new species

Figures 1–27

Specimens examined: 31 females, 40 males. Vicinity of Loggerhead and Bush Keys, Dry Tortugas, off the southwestern coast of Florida, July 23–Aug. 12, 1926, Clarence R. Shoemaker.

Types: Holotype female (alcoholic) USNM 99511; allotype male (alcoholic) USNM 99512. Paratype specimens (slides and alcoholic) in U. S. National Museum collections.

Diagnostic characters: Urosome female 4-segmented, male 5-segmented; the two middle caudal setae jointed basally. Antennules, female and left male, 26-segmented; segments 13–22 with partial rows of spinules. Right antennule male 23-segmented, with three segments beyond geniculation; segment preceding geniculation with distal longitudinal comblike row of spinules. Maxilla with six lobes, two on basal division. Total number setae, endopod 3, legs 1–4: 6, 8, 8, 7. Leg 1, inner apical spine of exopod 3 subequal to segments 2+3. Leg 5 female, inner apical spine of exopod 3 longer than outer spine, about as long as segment. Leg 5 male, right exopod 2, first outer spine about twice the length of second spine; left exopod 3-segmented, outer spine of segment 2 reaching beyond segment 3; left endopod with movable basal process as long as the endopod.

Female

Length, dorsal midline, 0.83–0.90 mm.; the greater number of specimens 0.86–0.87 mm.

Body slender and of distinct calanoid shape. (In a few specimens, the fore part is curved downwards so that the body does not have the usual erect appearance shown in fig. 2. Although the normal flexibility of the body segments or effect of the preservative might account for some of this, there is a real though small difference in the amount of the curvature of the fore part of the body in individual specimens.) Metasome 2.7–3 times the length of the urosome, with its greatest width at beginning of second segment; 6-segmented, the division between the cephalic segment and that of leg 1 not so distinct as those of the other segments. Cephalic segment, in dorsal view, rounded anteriorly and tapered sharply outwards so that beyond the middle the segment is nearly as wide as the second segment; its length, in midline, a little greater than that of the other segments combined. Length of segment 2 a little less than that of segments 3 and 4 together (relative lengths, segments 2–4: 35:20:20). Segments 2–5 with lateral, apically acute, hyaline flanges. Last segment not expanded laterally, in dorsal view the "wings" narrowed and slightly pointed; in lateral view, the wings show on the inner edge, three notches bearing minute hairs, the notch nearest the outer edge the largest and easily visible, the others seen only at high magnification (fig. 3).

Urosome (fig. 1) 4-segmented, the genital segment the longest; the fourth segment very short, reduced to the width of the caudal rami, with which it is more or less fused medially, but clearly distinct outwardly. Relative lengths of the segments and rami (dorsal):

1	*2*	*3*	*4*	*CR*
28	13	10	4	16

Surface of all segments and of caudal rami, both dorsally and ventrally, covered by irregular groups of minute spinulose scales (not illustrated). Segments with nonserrate, inconspicuous fringe; second and third segments with a prominent proximal sclerotization on each side (fig. 1).

In lateral view, the genital segment appearing rounded and only a little produced ventrally. External portion of the genital field simple (fig. 8), more or less defined by a cuticular sclerotization which is heavier in the posterior area; the distal half with a crosswise, asymmetrical opercular flap drawn out on the right side into a pointed process; the slit formed by the flap noticeable in lateral view (fig. 2); when turned semilaterally, the process of the right side prominent. Paired genital openings set close together, rather large, filling most of the area defined by the external sclerotization (outlines visible with oil immersion objectives, but structurally indistinct).

Caudal ramus with its inner portion somewhat expanded proximally; the distal inner margin armed with fine hairs. In most specimens the rami a little divergent, but parallel in some specimens and closely set so that the inner expansions of the basal part cross over one another (the rami thus apparently with a somewhat flexible attachment).

Caudal setae consisting of an outer, subterminal spine shorter than the ramus, and four long, plumose, terminal setae, the outer of which is shorter than and the inner subequal to the urosome. The two middle setae with thickened, jointed bases; both longer than the urosome; the innermost of these two setae the longer, jointed secondarily near its distal third and without hairs beyond this joint. A short seta with very long marginal hairs inserted dorsally between the bases of the innermost setae. Ventrally, two flat spinules overlying the bases of the setae (fig. 7).

Rostrum (fig. 4) of the broad form characteristic of the genus, not demarcated at base, tapered to a rounded point. A pair of minute frontal hairs present above the base of the rostrum.

Antennule reaching to about the end of the metasome; comprised of 26 clearly defined segments (fig. 14). The two proximal segments subequal in length to one another (fig. 16), wider and longer than most of the succeeding segments except the four apical segments, which are progressively narrowed and lengthened (fig. 21). Two setae on every segment except segments 1, 21, and 22 which have only one each, segment 2 which has four setae, and segment 26 which has one lateral and five terminal setae. On many segments, particularly in the midportion of the antennule, the proximal seta short and hairlike. Elongate setae (reaching at least beyond the succeeding four segments) on segments 4, 8, 10, 13, and 22; the longest of these on segment 4 (reaching to segment 12) and on segment 22 (reaching to end of antennule; fig. 21). Some of the setae of apical segments modified by division into one or more joints (fig. 21). Aesthetes present on most of the segments, stouter than the setae and of uniform width throughout their length; those of the proximal segments (fig. 16) stouter than those beyond the midportion of the antennule; the longest that on segment 10 (reaching to the middle of segment 15). Segments 13–22 and 24–25 with small groups of surface spinules (figs. 15 and 21). Summary of setation of individual segments as follows (s=seta; a=aesthete):

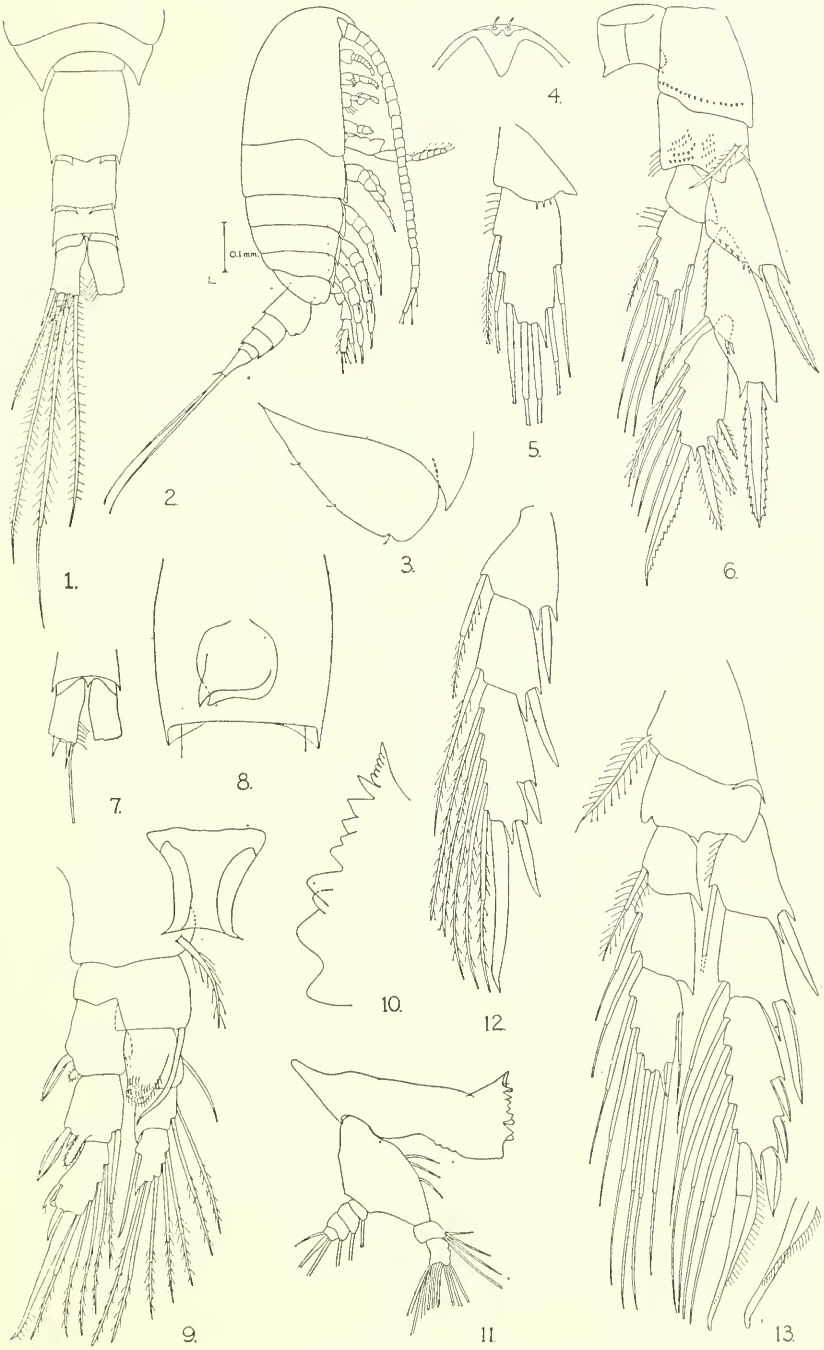
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
s	4s	2s	2s	2s	2s	2s	2s	2s	2s	2s	2s	2s	2s	2s
a	a		a	a	a	a	a	a	a		a	a	a	a

16	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*
2s	2s	2s	2s	2s	s	s	2s	2s	2s	6s
a	a			a				a		a

Antenna (fig. 20) with basipod of two well-defined segments, the proximal with a plumose inner seta, the distal with two unarmed setae. Exopod reaching beyond inner ramus by about half the length of its apical segment; 8-segmented, the first seven segments differing little in length from one another, but progressively narrowed from the basal segment, each with a single inner seta; apical segment about 3 times the length of the other segments and with four terminally placed setae. Endopod of two stoutly developed segments, the apical (measured to end of outer lobe) about three-fourths the length of the first; two setae at distal inner third of first segment; inner lobe of second segment with eight setae graduated in length from outer to inner edge; the outer lobe with four setae.

Apex of mandible blade (fig. 11) only slightly expanded and with shallowly incised teeth (fig. 10). Palp with expanded basipod armed with three inner setae; the four segments of exopod well defined, the proximal three with inner seta, the apical with three setae of which the outer is much shorter than the others; first segment of endopod shorter and broader than the apical, with four inner, distally placed setae; apical segment of endopod with two groups of terminal setae, six in the outer group and three in the inner.

Figures 1–13.—*Ridgewayia gracilis*, new species, female: 1, Distal part of metasome and urosome, dorsal; 2, habitus, lateral; 3, detail of metasomal wing, lateral; 4, outline of rostrum, ventral, with frontal hairs; 5, leg 5, detail of endopod; 6, leg 5; 7, distal part of urosome and caudal rami, ventral; 8, genital segment, ventral, with detail of operculum; 9, leg 1; 10, detail of edge of mandible blade; 11, mandible blade, with palp; 12, leg 2, exopod; 13, leg 4, with detail of marginal armature of inner apical spine.



FIGURES 1–13.—*Ridgewayia gracilis*, new species, female. Explanation on facing page.

Maxillule (fig. 17) with well-developed basipod but without definable lines separating segments from one another. The first inner lobe (gnathobase) comparatively large, prominently produced, oval in outline, bearing eight stout spines and five subapically placed setae. Just distal to this lobe two narrow laciniae, each bearing four apical setae. The proximal outer portion an unexpanded plate bearing nine setae, of which the distal six are greatly lengthened. Between this group of setae and the basal attachment of the exopod, a protrusion (epipodite?) bearing a single setae. Exopod and endopod borne on the distal narrowed portion of the basipod, which has its inner part produced as a small lobe bearing four setae. The endopod 2-segmented; its proximal segment comparatively enlarged, with eight lateral setae; the apical segment reduced, with six setae. Exopod constricted beyond its middle so as to form two setiferous portions, the proximal bearing five lateral setae; the distal somewhat expanded and bearing three lateral and three apical setae.

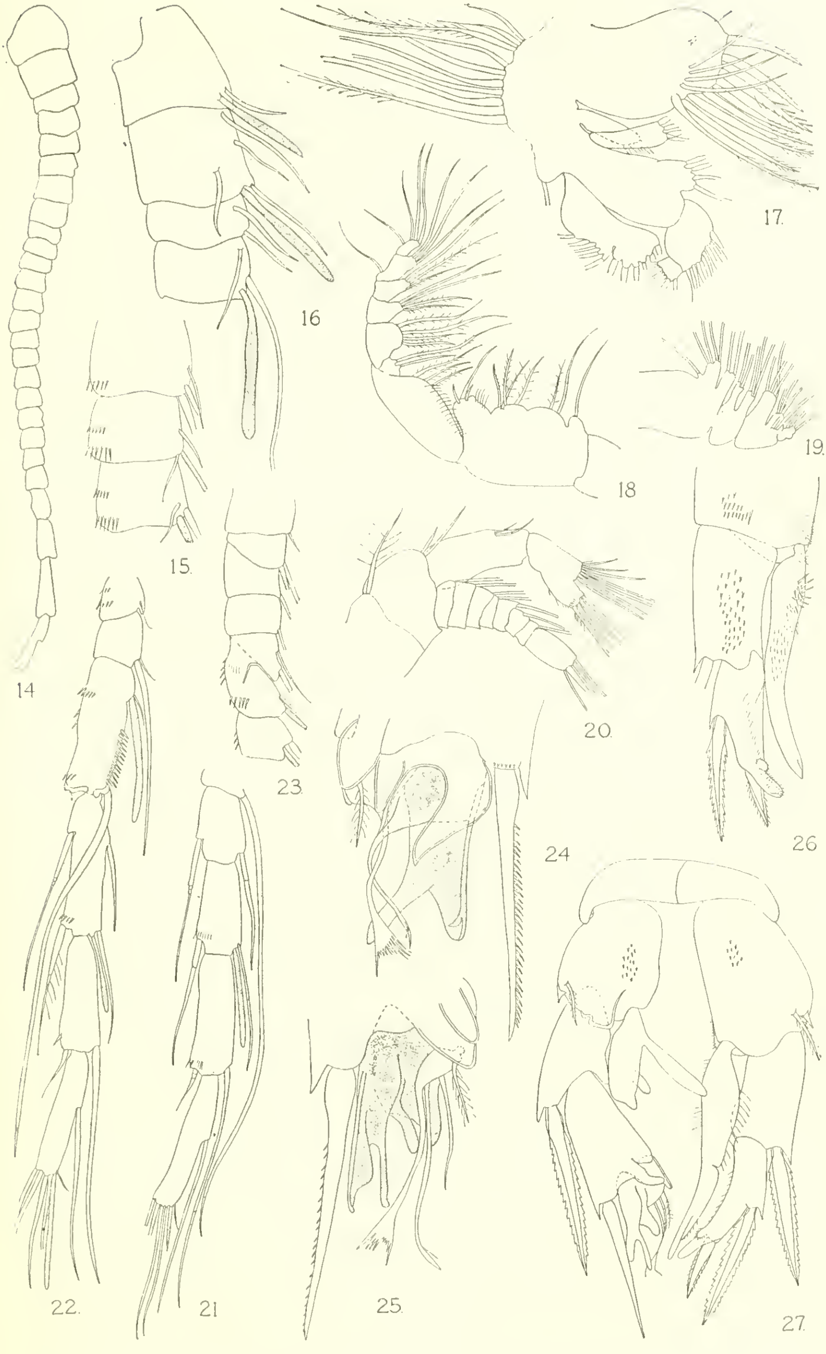
Maxilla (fig. 19) with six distinctly developed lobes of which two belong to the basal division, which is incompletely demarcated from the second. An accessory seta on a short stalk at the proximal base of the first lobe. The fifth lobe (the proximal of the third division) the largest. The number of setae on the lobes as follows (lobes numbered from proximal to distal):

Lobes:	*1*	*2*	*3*	*4*	*5*	*6*
Apical setae:	4	2	2	3	4	3
Basal setae:	1					2

The reduced terminal portion of the maxilla indistinctly separated and segmented, with three setae.

Maxilliped (fig. 18) with short, nonsetiferous basal segment (present in all dissections). Second segment with four lobes, the number of setae from proximal to distal lobe, 1, 2, 4, 3. The longest setae that of the first lobe and the proximal of the second lobe; both of these naked. Two of the setae of the distal lobe extremely reduced. Third segment with three plumose setae, between it and the endopod an incompletely separated segment, distinct neither from the endopod nor from the basipod. Endopod of five distinct segments bearing setae as follows:

FIGURES 14–27.—*Ridgewayia gracilis*, new species. 14–21, Female: 14, outline of antennule, showing segmentation; 15, antennule, segments 13–15; 16, antennule, segments 1–4; 17, maxillule, greatly enlarged; 18, maxilliped; 19, maxilla; 20, antenna; 21, antennule, apical segments 22–26. 22–27, Male: 22, right antennule, apical segments; 23, right antennule, segments 9–15; 24, leg 5, detail apex of left exopod, anteromedial view; 25, same, posterior view; 26, leg 5, detail right exopod and endopod, anterior view; 27, leg 5, posterior view.



FIGURES 14–27.—*Ridgewayia gracilis,* new species. Explanation on facing page.

Segment:	*1*	*2*	*3*	*4*	*5*
Apical setae:	4	4	3	3	3
Basal setae:				1	1

Legs 1–4: Both basal segments of leg 1 with inner seta; only first segment of legs 2–4 with inner seta. First two segments of exopod of legs 1–4 with outer spine and inner seta; segment 1 of endopod with inner seta, segment 2 with two inner setae.

Armature of third segments of both rami as follows (sp=spine; s=seta):

	Leg 1	*Leg 2*	*Leg 3*	*Leg 4*
Exopod:	3sp 4s	3sp 5s	4sp 5s	4sp 5s
Endopod:	6s	8s	8s	7s

Leg 1 (fig. 9) with several distinctive modifications. Outer spines of exopod with marginal flanges and tipped with a hair. Distad to the spine a flattened process; the processes of segments 1 and 2 with serrate edges; that of segment 1 very small; that of segment 2 larger, about half the length of the outer spine, between it and the spine an unarmed spiniform process; the process of segment 3 extremely small, nonserrate and placed at the outer distal corner of the segment. Inner apical spine of third segment of exopod subequal in length to segments 2+3. Seta of basipod segment 2 long and characteristically curved over the first two endopod segments. Distal outer portion of endopod segment 1 with an enlarged, partially separated, lobelike process or extension, densely setose on its anterior side. Segment 3 of endopod reduced in width, its terminal outer margin extended into spinous process.

Excepting the seta of endopod 1 of leg 1, all the setae of legs 1–5 jointed, usually below the middle. The proximal portion of these modified setae appear stiff and rodlike, and are sparsely plumose; the terminal flexible portion densely plumose. Spines of outer margins of exopods of legs 2 and 3 bladelike and unarmed (fig. 12), those of segments 1 and 2 elongate, reaching to near the base of the next spine or beyond, set into deeply defined sockets. The distal outer spine of segment 3 set in nearly terminal position with a prominent segmental process between it and the longer inner apical spine; inner spine about as long as its segment and unarmed. Spines of leg 4 (fig. 13) differing from those of legs 2 and 3 in having marginal flanges; the flange of the long inner apical spine of segment 3 armed with marginal hairs; near its distal fourth, these hairs cross over the surface of the spine to the edge of the inner margin.

Leg 5 (fig. 6): Basipod segments without inner setae; segment 2 with small outer spinous process and submarginally placed seta, usually inwardly directed; surface of these segments with groups of small spinules. Exopod segments 1 and 2 with stout outer spines armed marginally with serrate flanges; segment 2 with an inner, jointed seta, the stiff basal portion of which reaches more than halfway to the base of the first seta of segment 3. Exopod segment 3 with a group of three outer, serrate spines, all shorter than the segment; the two proximal spines placed marginally, the distal apically; the fourth spine (inner apical) with outer hyaline flange, about as long as the segment and nearly twice the length of the distal outer spine (about 60:35). The basal portions of the jointed setae of the inner margin of exopod 3 all reach beyond the base of the succeeding seta. Segment 1 of the endopod without seta; its outer distal margin produced to point. Segment 2 with seven jointed setae, the basal portion of each of the three inner setae reach beyond the base of the succeeding seta. The first outer seta placed just below the middle of the segment (at a point representing about 60 percent of the length of the inner margin of the segment); the first inner seta placed above the middle of the segment (at about 36 percent). Apical outer spinous process and basal portion of apical setae long, the process 20 percent, the setal bases 54 percent of the length of the inner margin of the segment. (See also p. 170.)

MALE

Length, 0.8 mm. Habitus as in female. Urosome 5-segmented, the first four segments subequal to one another in length, the fifth reduced as in the female. Caudal rami and setae exactly like those of female.

Rostrum enlarged as in female, with broader tip and separated from forehead by a distinct surface demarcation across its entire base. All appendages except right antennule and fifth leg like those of female.

Left antennule 26-segmented and with setation as in female. Right antennule with proximal segments as in female; midportion modified in that segments 13 and 14 are fused outwardly and imperfectly divided from one another by a deep cleft beginning at the inner margin and extending irregularly into the middle of the segment (fig. 23). The antennule with 23 apparent free segments (counting 13 and 14 as two segments). The four apical segments elongated and of similar length (fig. 22); the point of geniculation between the proximal two of these segments (segments 20 and 21) so that there are three segments beyond the geniculation. Segment 20 with a longitudinal row of spinules arranged as a comb along the distal inner half. (See p. 163 for interpretation of segmentation.)

Leg 5 (figs. 24–27): First basal segments fused, forming a narrow crosswise bar to which the enlarged second basal segments are attached. Right basipod 2 longer than left, each with outer distally placed spinous process and submarginal seta. Right exopod: Segments subequal in length, the second narrowed. Outer spine of segment 1 with serrate flange, reaching to end of segment 2. First outer spine of segment 2 similar in size and armature to that of segment 1, second outer spine about half length of first; both spines reach beyond end of exopod. Apical part of segment 2 modified, an imperfectly separated, rounded serrate lappet on the inner margin opposite the placement of the second outer spine; beyond this lappet, the segment slightly incised on the anterior side (the possibility that this tip is at least partially movable is suggested by the various positions found in different dissections; the tip may or may not be interpretable as an imperfectly separated third segment).

Left exopod: Segment 2 much stouter than segment 1, broadened and stout at its apex into which is set the highly modified third segment; its outer distal spine narrowed and tapered, reaching beyond the tips of the processes of the third segment, armed only with outer marginal spinules. Third segment consisting of a shortened segmental portion clearly separated on the anterior side from the second segment (fig. 24) but imperfectly separated on the posteromedial side. The segmental portion of the surface of the anterior side deeply incised medially with heavy marginal sclerotizations and forming in part on its posterior side the base for the attachment of a set of thin, apically and irregularly fragmented membranes (or a single folded membrane) and three heavier, exceedingly flexible processes. Of these, the innermost simple in structure (setiform). One process, with an irregularly serrate, flared tip, has a broadened base which is set into a socket of the posteromedial portion of the segment (fig. 25). The other process is deeply widened at its base and attached inside the segment on the anterior side (fig. 24), below its attachment it is abruptly contracted into a long narrow setiform process with a slightly widened tip which is split near its end. These processes appeared in dissections separated as shown in figure 25, or twined around one another as in figure 24.

In interpreting the figures given here, it must be remembered that the membranes, though perhaps representing only one single structure, are irregularly fragmented and folded, and their appearance in any one dissection may be different from any other dissection. In figure 24, the membrane shown is only the expanded outer portion of that shown in figure 25; the edge appeared in all dissections to be strengthened by a heavy band.

Right endopod elongate-narrow, reaching to near end of exopod, the tip partially split; anterior side set basally with groups of surface spinules (fig. 26). Left endopod short, reaching only little beyond exopod segment 1; inner margin with two movable processes; the distal process short; the basal process nearly as long as the endopod (in dissections, this process found expanded as shown in fig. 27, or entirely "pulled in" and lying along the margin of the endopod).

Ridgewayia shoemakeri, new species

FIGURES 28–35

SPECIMENS EXAMINED: 2 females, 13 males. Occurring with *R. gracilis* in the vicinity of Loggerhead and Bush Keys, Dry Tortugas, Fla., July 23–Aug. 12, 1926, Clarence R. Shoemaker.

TYPES: Holotype female (slides) USNM 99517; allotype male (slides) USNM 99518. Paratype specimens (slides and alcoholic) in U. S. National Museum collections.

DIAGNOSTIC CHARACTERS: Urosome female 4-segmented, segments with distal serrate fringe; male 5-segmented; the two middle caudal setae not jointed basally in either sex. Antennules, female and left male, 26-segmented; segments 13–22 with row of spinules extending across distal edge of segment. Right antennule male 24-segmented, with four segments beyond geniculation; segment preceding geniculation without lateral comblike row of spinules. Maxilla with six inner lobes, of which two belong to basal division. Total number setae, endopod 3, legs 1–4: 6, 8, 8, 7. Leg 5 female, inner apical spine exopod 3 longer than outer spines, about as long as segment. Leg 5 male, right exopod 2, first outer spine only little longer than second spine; left exopod 3-segmented, outer spine of segment 2 reaching to end of modified processes of segment 3; right endopod with slender outer seta; left endopod unarmed.

FEMALE

Length, dorsal midline, 0.67–0.68 mm. Body slender, but lacking the erect appearance of *gracilis*, due to the strong curvature of the forepart of the cephalic segment (as shown for male, fig. 32). Proportions and segmentation of metasome very similar to those of *gracilis*. Cephalic segment longer than rest of metasome (about 80:71). Segments 5 and 6 both reduced in midline; wings of last segment like those of *gracilis*, except that the outer notch of the posterior edge is not enlarged.

Urosome segmented as in *gracilis*, the fourth being likewise reduced to the width of the caudal rami. Relative lengths of the segments and rami:

1	*2*	*3*	*4*	*CR*
20	8	6	2	13

Posterior edges of the segments with a complete dorsal fringe, that of segments 1–2 indistinctly serrate, that of segment 3 deeply serrate.

External genital field defined by sclerotization, the distal edge of operculum a flaplike opening, the right side rounded (fig. 31).

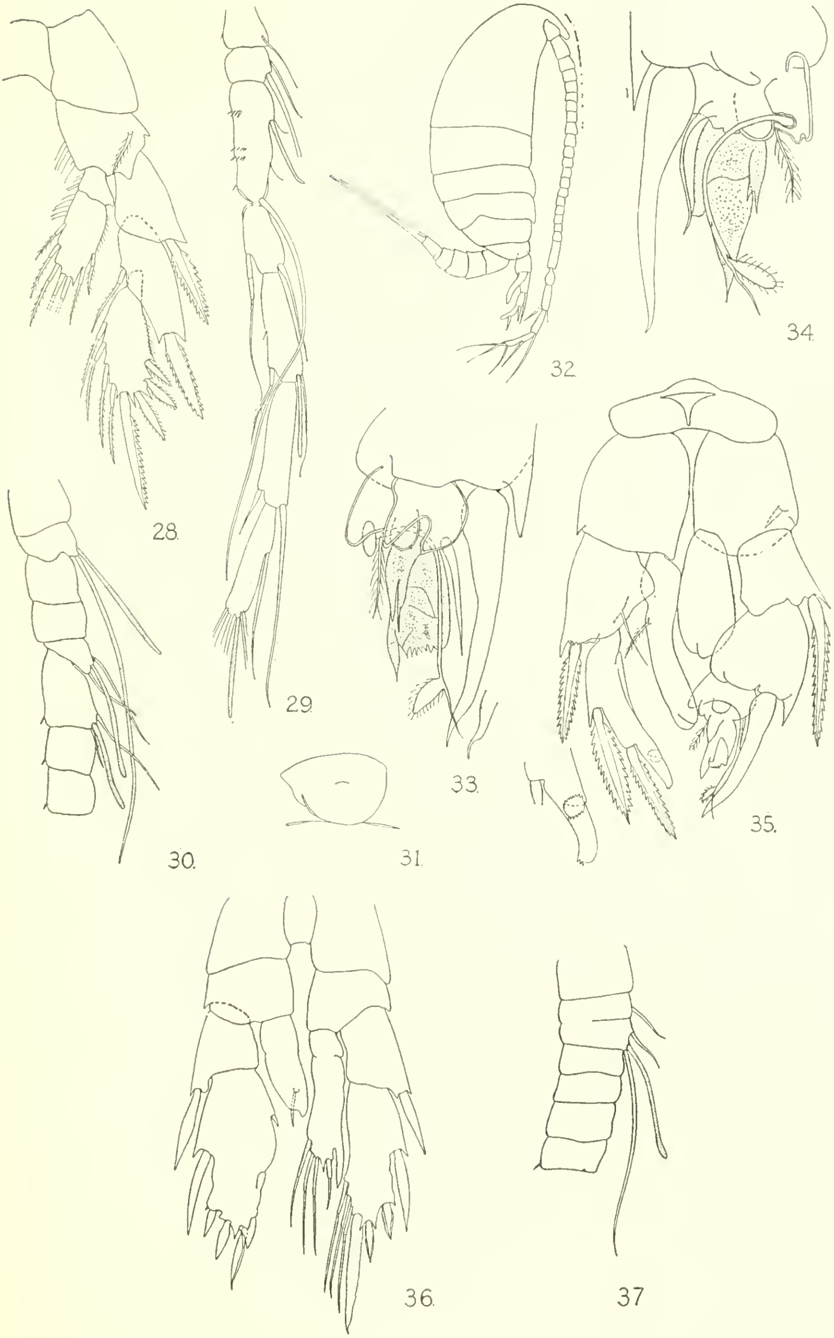
Caudal setae exactly like those of *gracilis*, except that the two long middle setae are not jointed at their bases.

Appendages differing very little from those of *gracilis*. Antennule longer, reaching to the end of the genital segment; clearly 26-segmented, the proportions of the segments and numerical setation exactly like *gracilis* except that the last four segments tend to greater elongation, and segment 24 is nearly subequal to 25 and 26; the long setae of segments 4, 8, 10, 13, and 22 comparatively shorter; the surface spinules of segments 13–22 arranged in single rows extending across the entire distal edge of the segment, size of spinules varying from segment to segment. Segmentation and setation of antenna and mandible palp like *gracilis*. Maxillule like *gracilis* except that the first of the two laciniae just distad to the gnathobase has five instead of four setae. Maxilla also with six large lobes, of which two belong to the basal portion; the apical portion clearly 2-segmented, a difference from *gracilis* that might be an individual variation or due to position in mounting. Maxilliped exactly like that of *gracilis*.

Legs 1–4 identical to *gracilis* in arrangement, structure, and number of setae and spines. Leg 1 differing slightly in that the spinous process between the outer spine and flattened process of exopod segment 2 is as long as the distal process instead of shorter; the inner apical spine of segment 3 about as long as segments 2+3.

Leg 5 (fig. 28) very similar to that of *gracilis*. Basal portions of all jointed setae of exopod and endopod comparatively shorter; that of exopod 2 hardly reaching beyond segment, first two setae of exopod 3 reaching about to point of insertion of succeeding setae. Endopod segment 2, first outer seta set below middle of segment, at point about 64 percent of total length; first inner seta set a little above the middle, at a point about 42 percent of total length; spinous process of outer margin short, only about 10 percent of total length of segment. (See also p. 170.)

FIGURES 28–37.—*Ridgewayia shoemakeri*, new species, and *Ridgewayia* sp. (Tortugas). 28–35: *R. shoemakeri*, new species: 28, female, leg 5; 29, male, right antennule, apical segments; 30, male, right antennule, segments 9–16, with armature of segments 10, 13, 14; 31, female, genital operculum; 32, male, habitus, lateral; 33, male, leg 5, detail apex of left exopod, anterior view; 34, same, posteromedial view; 35, male, leg 5, anterior view, with detail apex of right exopod. 36, 37, *Ridgewayia* sp. (Tortugas), male copepodid stage V: 36, leg 5, posterior view; 37, left antennule, segments 8–13, with armature of segment 9.



Figures 28–37.—*Ridgewayia shoemakeri*, new species, and *Ridgewayia* sp. (Tortugas). Explanation on facing page.

Male

Length, 0.63–0.68 mm. Forepart of body strongly curved (fig. 32). Urosome 5-segmented, the fifth segment reduced. Antennules reaching beyond the metasome; the left like that of the female, the right (fig. 29) with 24 free segments, four beyond the point of geniculation. (See pp. 163–167 for comparison of segmentation with *gracilis*.) Segments 13 and 14 modified as in *gracilis* but completely separated (fig. 30). Segment preceding the geniculation without a comblike group of spinules.

Cephalic appendages and legs 1–4 as in female.

Leg 5 (figs. 33–35): First basal segments reduced in size and completely fused. Second basal segments of nearly equal size. Right exopod: Segment 1 with medial inner expansion and a very fine accessory seta; outer spine reaching just beyond base of first spine of second segment, with a broad, serrate hyaline flange. The two outer spines of segment 2 subequal to one another in length, both reaching beyond the end of the segment, and with serrate flanges. Beyond insertion of second spine, the inner margin of segment with a cleft and a serrate lappet which appears hardly separated from the anterior surface; tip of segment minutely serrate.

Left exopod: Segment 1 reduced in both width and length, with a stout outer spine reaching beyond segment 2 and armed with hyaline flange. Segment 2 broadened and thickened at its apex; its outer spine thick and irregular, without marginal flange or serrations, longer than its segment and reaching to about the same point as the longest of the processes of segment 3. Segment 3 distinctly separated from segment 2 on anterior side and very nearly so on posterior side. Membranes folded and irregular in length and fragmentation as in *gracilis* (figs. 33, 34). In addition to membranes, a plumose seta as in *gracilis*, and two modified processes. Of these, one simple in structure with a relatively small base, set into the segment near the outer edge, not reaching beyond the membranes. The other much longer, set into a well-defined socket on the inner portion of the segment; protruding from near its distal end a large flattened structure with hairy margins (from its position and mode of attachment this process comparable to the one with flared serrate tip in *gracilis*).

Right endopod elongate, reaching to near base of distal spine of exopod 2, without evidence of segmentation, armed only with a slender plumose seta on the outer edge. Left endopod swollen, not reaching quite to end of exopod 2, without ornamentation or processes.

Ridgewayia sp. (Tortugas)

FIGURES 36, 37

SPECIMENS EXAMINED: 6 males, copepodid stage V. Occurring with *R. gracilis* and *R. shoemakeri*, off Loggerhead Key, Dry Tortugas.

Description: Length, 0.665–0.69 mm. Somite of leg 1 separated from cephalic segment. Urosome 4-segmented; caudal rami with more or less distinct division of the outer margin near the base (representing incipient division of a reduced fifth segment ?); fourth segment with distal row of fine spinules ventrally and on the lateral areas of the dorsal side; caudal rami covered with hairs on both sides. Caudal setae of same relative lengths as in *gracilis* and *shoemakeri*, none jointed basally, but the longest jointed near the end as shown for *gracilis* in figure 1.

Antennules alike, reaching just beyond metasome; with 25 free segments; segment 9 somewhat elongate and partially divided by a line running from the inner margin to the middle of the segment, with two setal groups (fig. 37); segments 1 and 2 subequal in length; the three apical segments elongate, the last two subequal to one another.

All cephalic appendages weakly developed, but fully segmented. Exopod of antenna 8-segmented. Maxilla with six lobes, of which two are on the basal division.

Legs 1–4 fully segmented; segmentation and setation exactly as in *gracilis* and *shoemakeri*; all setae jointed. Leg 1 resembles the adult of *gracilis* and *shoemakeri*, but the processes of the outer margin of the exopod segments are not fully developed.

Leg 5 (fig. 36): First basipod segments well developed, connected by medial plate. Both exopods 2-segmented, the distal segments elongate and of similar length, the left broader than the right. Right exopod 2 with an outer medially placed spine that reaches to end of segment; distally with two shorter spines and a long apical spine equal to about three-fourths the segment length; distal inner portion with three closely set, jointed setae. Left exopod segment 2 with medially placed spine on outer margin, spine reaching beyond apex of segment; apex with three membranous spines of graduated length, increasing from outer to inner; the innermost with a stout inner marginal sclerotization; at inner apex of segment, a conspicuous hyaline projection overlying base of inner spine. Right endopod longer than left, its proximal part partially segmented; the apex armed with setae and processes; of these, the outermost a stout spiniform process arising laterally; setae four in number, all jointed basally. Left endopod broad, armed near distal part on anterior side with a slender surface seta; otherwise closely resembling the unarmed endopods of the adult *shoemakeri* and *marki*.

Remarks: It does not seem possible to relate this subadult male to either of the Tortugas species. In many calanoid families the development of the fifth leg is progressive, and, if such were known to be true in *Ridgewayia*, it might be assumed that these copepodids represent a third unknown species in which the right exopod may have inner apical setae, and the right endopod is also armed with setae. However, there are often striking changes in this appendage between the recognized stage V and the adult, such as is known for *Centropages* (Gurney, 1931). It is therefore impossible to say with absolute certainty that this does not represent the subadult stage of one or the other of the two species. The left antennule in the adult could be 25- or 26-segmented, depending upon whether the partially divided ninth segment becomes fused or separated. There is no indication of modification of the right antennule, either in the middle or distal portions.

One interesting point brought out by examination of this copepodid is that the modified processes of the first leg are not fully developed until the adult stage, although the leg is otherwise like that of the adult.

Discussion

The name *Ridgewayia* was proposed in honor of Sir West Ridgeway, governor of Ceylon. Attention is drawn to this in order to emphasize that the spelling of the generic name is correct. A genus of birds, *Ridgwayia* Stejneger 1883, named for the ornithologist Robert Ridgway differs in the spelling by one letter.

For purposes of brevity in the following discussion, the new Tortugas species (*gracilis, shoemakeri*) and the Bermuda species (*marki*) are referred to collectively as the American species.

SPECIFIC DIFFERENTIATION

HABITUS: In general appearance, the species are alike. Only for *marki* is there a recorded lack of separation of the cephalic and first thoracic somites. Since the separation of this segment in the Tortugas material was not always as distinct as that of the other segments, specimens in future collections of *marki* should be carefully examined for indistinct or partial separation. There is also need to determine the possible presence of the reduced last urosomal segments in both *marki* and *canalis*. Esterly's (1911) drawing of the female shows the caudal rami united basally and suggests the presence of this reduced segment. The urosome of *canalis* (male) as illustrated is very like that of the subadult male listed herein as *Ridgewayia* sp. (Tortugas). Gurney (1927) says "Abdomen of four somites" but adds "the 5th somite scarcely distinct." The possibility that Gurney's specimens were in the subadult stage is dismissed on the basis of the apparent complete development of the first leg, and of Gurney's wide experience in study of developmental stages of copepods, precluding the possibility that he would err in this regard, even with an unfamiliar genus.

The specific difference noted in the two Tortugas species in the jointed basal portions of the two middle caudal setae is a valuable character for distinguishing whole specimens, and particularly the females of associated species. It is not mentioned for any of the other species, but should be recorded for all species encountered in future studies.

In all of the species the rostrum appears to be a large, somewhat expanded structure, without filaments.

ANTENNULE: The antennules of the two new species have been studied in detail at high magnification with oil immersion objectives. The material has been critically checked and rechecked, partly because the antennules of the female and that of the left side of the male are 26-segmented, differing thus from the segmentation recorded for *typica* and *marki*, or recognized for any other calanoid species. The greatest number of segments that has been conceded to be present in the antennule of existing calanoids is 25. The few instances in which a 26-segmented antennule has been reported are thought to be due to the fact that the observer included the surface eminence to which the antennule is attached. Whole specimens of both species as well as dissected antennules have been examined with this in mind, so that such an error would not be repeated in the case of these two species of *Ridgewayia.*

Gurney (1931, pp. 40–48; 1933, pp. 46–61) has discussed the interpretation of the armature and development of the antennule in relation to its evolution, and points out (1931, p. 42) that the primitive antennule of calanoids probably consisted of 27–28 segments, or even of 30 or 31 segments. It seems apparent in all species that some of the fusion leading to reduction has taken place in the proximal part of the antennule, particularly in the usual second segment of a 25-segmented appendage. This segment is usually comparatively long, and bears more than the two setae and aesthete considered to represent the archetypical grouping for each segment. The second segment shown in the illustration of the antennule of *typica* (Thompson and A. Scott, 1903, pl. 1, fig. 3) is elongate and appears to have two or even three groups of setae. On the basis of length it is comparable to segments 2 and 3 of *gracilis* and *shoemakeri,* indicating that the difference in segmentation of these congeners may be due to fusion in these proximal segments. Reference to the summary of setation given herein in the description of *gracilis,* and found to be identical in *shoemakeri,* shows that what is considered a primitive armature, as well as segmentation, has been largely retained—most segments have two setae, and aesthetes are abundantly distributed.

Although admittedly an obvious point, it does seem apropos to stress the desirability of including results of detailed critical examinations of the antennules in published records of any specimens of *Ridgewayia* or of allied genera. The discovery of two species of Calanoida with 26-segmented antennules is a matter of considerable systematic interest. Such an unusual segmentation might be an important part of a generic definition. In the present instance, it cannot separate the Tortugas species generically from *Ridgewayia typica* because the otherwise obviously related Bermuda species *marki* is said to have a 25-segmented antennule. If this is actually the case, then the difference in segmentation must be considered specific. However, on the basis of their descriptions, it is not inappropriate to suggest that there is need to verify whether the antennules of *typica* and *marki* are really 25-segmented, and, if so, how their armature compares with that of *gracilis* and *shoemakeri*. Esterly (1911) gave no detail of the female or left male antennules in his account of *marki*. The antennule is figured for *typica;* it shows a very elongate second segment, and three elongate distal segments. It is personally considered doubtful if the setation shown is entirely exact. There are two setae on nearly every segment but there is no distinction between setae and aesthetes, and many of the setae shown are too similar in length to have been based on exact observation.

Considered critically, it cannot be judged from the text of Gurney's description of *Suezia canalis* whether or not the segmentation given applies to both of the antennules or only to the right. No direct reference is made to that of the left side. If the statement "1st antenna of 21 or 22 joints" refers to both antennules, then the segmentation within this group of species varies over the considerable range of from 21 to 26 segments.

In the specimens observed, the geniculation of the male right antennule is only moderately developed. It was noted while working with the Tortugas material that the antennule could be turned or mounted in such a way that the jointing becomes obscured. There exists, however, as illustrated for the two Tortugas species and as shown by Esterly for *marki,* a real constriction between two of the distal elongate segments. In whole specimens (most advantageously observed in alcohol), the distal part of the antennule is frequently bent upwards or outwards at this joint as is characteristic of geniculate antennules. This modification as it occurs in these species of *Ridgewayia,* though weak, is obviously a specialized joint, giving to the distal portion of the antennule a unit flexibility and freedom of movement not present at any other part of the appendage. Such a specialized joint may be presumed to be functionally and structurally comparable to the variously developed geniculations found in many calanoid genera.

Gurney (1927) and Krishnaswamy (1953) have recorded nongeniculate antennules in their specimens. In reviewing their accounts in light of knowledge of these other species, it is difficult to know how to assess their records. Both worked with limited material (one or two specimens) and both presented their observations in a very brief fashion. Gurney's description can only be considered indefinite inasmuch as he referred to the joints as "rather indistinct." In view of the observation made in my study that the geniculation may easily be obscured in mounting, it does not seem unreasonable to consider this character as inadequately known in these two species. Since it may be of generic significance, it is an exceedingly important character to reaffirm by critical observation of both mounted and unmounted material.

The middle region of the male right antennule is not enlarged in *gracilis* and *shoemakeri*, but there are modifications of some segments. Segment 10 is shortened on the outer side. Segment 13 is even more reduced on the outer side, and while remaining distinctly separated in *shoemakeri* (fig. 30), it seems to have become partially fused with segment 14 in the specimens of *gracilis* that were critically examined. In both species, segment 14 is elongate on the outer side. In *gracilis* there is on the inner side a medial incision with sclerotized edges; the sclerotization appears to extend into the internal part of the segment. Beginning at this point in *gracilis*, and at a similar position in *shoemakeri*, there is a longitudinal muscle band that extends through segment 19. There is indication in Gurney's illustration of a modification at the same point of the antennule of *canalis*, involving a reduction of one segment and elongation of another, but no detail is given.

Esterly did not mention such a modification of these segments in the right antennule of *marki*. The antennule is described simply as "23-jointed" with a "4-jointed terminal portion." The modified geniculate portion of the antennule is illustrated, but unfortunately the figure does not include all the succeeding terminal segments. There is a question as to whether the "4-jointed terminal portion" was meant to include only the segments beyond the geniculation, since the two Tortugas species differ in having three or four segments beyond this joint. This difference is apparently due to a fusion in *gracilis* of the two segments immediately distad to the geniculation. This is shown by comparison of the terminal segments of the two species (figs. 22, 29). The two distal segments correspond to one another in elongation and in the number, placement, and length of the setae and aesthetes, and so would appear to be of identical origin. In *gracilis*, the segment preceding these has the appearance of at least two coalesced segments comparable to the two distinct segments of *shoemakeri*. The two groups of setae on the fused segment of *gracilis* correspond to those of the two separated segments of *shoemakeri* not only in placement but also in modification. It therefore appears that the geniculation occurs at exactly the same point, although the number of free segments beyond the joint is different.

In both *gracilis* and *shoemakeri* there are 20 free segments preceding the geniculation. There would appear to be no question that the modified segments of the midportion counted as segments 13 and 14 represent two segments (fig. 30). It therefore seems impossible to fix the position of the hinge at a point comparable to that presumed to be identical for all calanoids. It has long been held, as Gurney (1931, p. 47) emphasizes, that the ". . . position of the hinge may be regarded as a fixed point. In the Calanoida, this point is always between segs. 18 and 19." In these two species of *Ridgewayia* it seems correct to assume that the 26-segmented unmodified antennule of the male and female has resulted from a lack of fusion of two segments of the proximal area and may differ from the closely allied species *typica* in the division of these segments. The modified antennule agrees with the unmodified antennule in relative length and armature of the proximal segments. In comparing this 26-segmented antennule to the basic calanoid 25-segmented appendage from whose study the hinge position has been derived, it would seem necessary only to add one segment to arrive at a comparable position. The hinge in these two species of *Ridgewayia* should therefore fall between segments 19 and 20, but this is not the case. Not only are there 20 countable segments preceding the geniculation but the elongation and armature of the 20th segment suggests that it may have resulted from fusion of at least two or even three of the segments of the preceding stage.

Comparison of the armature of the unmodified antennule with that of the modified, may not indicate what segments are included in the fused distal region of the right appendage. But attention should be drawn to similarities that characterize certain areas of each in these two species. The proximal and the two distal segments are alike in armature and length. The groups of surface spinules occur on identical segments of the left and right side in both species (13–22 and 24–25). Segment 22 has a particularly long seta on the unmodified antennule; such a long seta is present on the segment preceding the geniculation in both species. Jointed setae are present on the unmodified antennule beginning with segment 23; similar setae are present beyond the geniculation point of the right antennule. Thus, on the basis of comparison of armature, the distal part of the segment preceding geniculation (visible segment 20) is comparable to segment 22 of the unmodified antennule. If this is a true correlation, then the elongate segment preceding the geniculation represents a fusion of three segments. Such an interpretation is easily supported in *shoemakeri* (fig. 29), which has three groups of spinules and three setal groups; in *gracilis*, the comb of spinules obscures any middle setal group.

These two Tortugas species are thus not only unusual among Calanoida in the segmentation of the antennule but also in the position of the specialized hinge. It is not too surprising to find calanoid copepods with 26-segmented antennules, but the difference in the hinge position is unexpected. This seeming departure from what has been considered a basic pattern raises the question as to how well the facts are known. In studying the literature it is apparent that knowledge of detail of antennule structure and armature is lacking for many species and genera. Most of the available data of worth come from the observations of early workers (Claus, Schmeil, Giesbrecht); among the most important examples are the incomparable, detailed figures of Giesbrecht (1892). Since then few workers have given more than the rudiments of antennule structure in their descriptions. This is unfortunate since it is apparent that some very exact patterns of segmentation and armature have been established in the evolutionary development of this appendage in the Calanoida, and it therefore has high significance at all taxonomic levels.

Antenna: This appendage is figured for all the species except *marki*, for which Esterly (1911) describes the exopod as 8-segmented. This agrees with the other species except *canalis*, which Gurney (1927) shows as having a 7-segmented exopod. All segments have an inner, lateral seta except the last, which has four apical setae in all except *typica*, for which three are shown (not known for *marki*).

Oral appendages: Where known, the mandible and maxilliped show no significant differences. The maxillule is unknown for *canalis*, but agrees closely in the other species. A single epipodal seta is present in *gracilis* and *shoemakeri* but is not shown for *typica* and *marki*, though the lobe is present in the illustration of the latter. This point should be checked in future studies of these two species as it may be of taxonomic importance. The number of setae shown in the figures of *typica* and *marki* on the various lobes and laciniae, and on the exopod and endopod, show slight differences from one another and from the new species. As some of these may have specific value and should be checked in future studies, they are summarized here (table 1).

The maxilla appears to have the most taxonomic importance of all the oral appendages in species differentiation, inasmuch as the number of lobes varies from five in *canalis* to seven in *typica*. The reduction is in the proximal portion of the appendage. The American species (including the subadult male) agree with one another in having two lobes on the basal division, and also have a seta at the base of the first lobe, not shown in either *typica* or *canalis*.

Table 1.—*Setation of maxillule in* Ridgewayia

(Unknown for *R. canalis*, and *Ridgewayia* sp. from Madras)

Species	Basal portion						Exopod	Endopod	
	Inner				Outer			Segment 1	Segment 2
	Gnathobase	Lacinia 1	Lacinia 2	Lobe of Basis	Coxa	Epipod			
typica	10	5	4	5	9	0	12	4(5?)	7(6?)
marki	13	5	4	5	10	0	11	8	6
gracilis	13	4	4	4	9	1	11	8	6
shoemakeri	13	5	4	4	9	1	11	8	6

Legs 1–4: Complete information on the armature of legs 1–4 is available for only the American species. It is alike in the Tortugas species, including the subadult male of unknown identity (*Ridgewayia* sp., Tortugas). Since the specific pattern is probably established by this stage, it is included in the summaries of armature. Esterly (1911) illustrated only leg 1 of *marki*, but he gave a table of setation which, if correct, shows that the number of setae on the endopods of legs 3 and 4 differ from the Tortugas species. Information is incomplete for the other species, being known for only some of the legs of a single sex of each species. No summary of setation is given in the text, and only some of the legs are illustrated. These are:

typica ♀	legs 1, 2, 4
canalis ♂	legs 1, 2
sp. (Madras) ♂	leg 1

An inner seta is known to be present on basipod segment 2 of leg 1 in all the species; so far as known, it is absent on all the other legs, but the information available in the literature is complete only for the American species. The same incompleteness of information applies to the inner seta of the first basipod segment. The presence or absence of this seta may be a basic character on all taxonomic levels in calanoid copepods, and it is important that it be accurately determined for every leg of each species. As now recorded in the literature the inner seta of basipod 1 is as follows (+ present; — absent; ? unknown):

		Leg 1	*Leg 2*	*Leg 3*	*Leg 4*
typica	♀	—	—	?	+
sp. (Madras)	♂	—	?	?	?
canalis	♂	—	+	?	?
marki	♀ ♂	+	+	+	+
gracilis	♀ ♂	+	+	+	+
shoemakeri	♀ ♂	+	+	+	+
sp. (Tortugas)	♂	+	+	+	+

It is noteworthy that the figures given in the literature for the first three forms do not show this seta on leg 1, but that it is uniformly present in the American forms. This may be a character of significance on the generic level if it is correlated with other differences, and its presence or absence should be carefully determined in reexamination of the first three species. The presence or absence of this seta in the other legs is inconsistent in *typica* and *canalis*, so that it is difficult to accept the evidence as incontrovertible. Here again, future examination of specimens should be critical in this regard.

Where known, the armature of the first two segments of the exopod of each leg of the incompletely known species agrees with that of the American species; that is, a single outer spine and single inner seta. With the exception of the first leg of the Madras specimen, the endopods likewise agree for legs 1–3; that is, one inner seta on segment 1 and two on segment 2. The complete absence of setae as shown for the Madras specimen would be very unusual, and, as suggested above, is probably due to incomplete delineation. Leg 4 is unknown for the Madras specimen and for *canalis; typica* agrees with the Tortugas species, but *marki* differs from the others in having only one seta on endopod segment 2.

TABLE 2.—*Total number of spines and setae on segment 3 of exopod and endopod, legs 1–4 of* Ridgewayia

Species and known sex		Leg 1		Leg 2		Leg 3		Leg 4	
		Exo.	Endo.	Exo.	Endo.	Exo.	Endo.	Exo.	Endo.
typica	♀	7	6	8	8	?	?	9	7
sp. (Madras)	♂	7	7(6?)	?	?	?	?	?	?
canalis	♂	7	6	8	8	?	?	?	?
gracilis	♀ ♂	7	6	8	8	9	8	9	7
shoemakeri	♀ ♂	7	6	8	8	9	8	9	7
marki	♀ ♂	7	6	8	8	9	5	9	6
sp. (Tortugas)	♂	7	6	8	8	9	8	9	7

Where known, the total number of spines and setae on the third exopod segment are like those of the new species, but there is some difference in the total number of setae on the third endopod segment of legs 3 and 4, as shown in table 2.

Leg 5, Female: This appendage is so similar in the four species in which the female is known that only very precise examination reveals the small differences that do exist. The leg of *typica* differs noticeably from the American species only in the shortness of the innermost apical spine of the third exopod segment (see key, p. 173). Differences in the three American species are found only in the comparative lengths of the basal joints of the setae of the exopod and endopod and in the placement of the proximal inner and outer setae of the second endopod segment. These latter differences have been expressed in the text of the descriptions of the new species as the percentage of the inner margin of the segment. The length of the outer apical spinous process and of the basal portion of the outer apical seta of the endopod are expressed as a similar percentage. There is a striking difference between some of these points in the two Tortugas species (figs. 5, 28 and table 3). From the figure given for *marki*, the placement of the setae is very similar to *shoemakeri*. Esterly's (1911) figure of *marki* does not show the outer spinous process. *R. typica* seemingly differs from the others in the much closer placement of the proximal inner seta to the base of the segment.

Table 3.—*Female leg 5,* Ridgewayia. *Ratio of certain characters of endopod segment 2, expressed as percentage of total length of inner margin of segment*

(KEY: A, distance between base of inner margin and placement of first inner seta; B, distance between base of inner margin and placement of first outer seta; C, length of outer spinous process; D, length of basal joint of outer apical seta)

Species	A	B	C	D
typica	23	54	23	60
gracilis	36	60	20	54
marki	44	69	?	50
shoemakeri	42	64	10	33

Since these characters of the endopod may be useful in differentiating species, a comparison has been made in table 3 between the two new species and the other species. Measurements were made with a millimeter rule on the illustrations given for *typica* and *marki*. These, of course, do not represent exact measurements, but in the absence of specimens they serve very well for comparative purposes.

They are included in table 3 as percentage figures determined in the same way as those for *gracilis* and *shoemakeri*.

Leg 5, Male: An important part of the generic definition as now constituted is found in the modification and asymmetrical development of the endopods of the male fifth leg. This is expressed in the elongation of that of the right side in contrast to the shorter, broadened endopod of the left side and in the varied armature of the different species. The armature seemingly is specific in nature, although with increased knowledge it may be found, in part, to define groups of species or even genera. In the known species, segmentation is suppressed in the adult, but since the subadult male (*Ridgewayia* sp., Tortugas) shows partial segmentation of the right endopod, it may be that some species may be found in which at least the right endopod is distinctly segmented.

The right exopod is 2-segmented in all the five known adult males (including *Ridgewayia* sp., Madras). The first segment is very similar in all the species, but the second segment shows definable differences. The three American species are noticeably most similar to one another not only in the shape and length of the segment but in the presence of two similarly placed outer spines. In *canalis* and the Madras male there is only one well-developed spine, the second or even a third spine being suppressed or broken off in the available specimen. Gurney's (1927) figure shows two spinous points along the extended outer margin of *canalis*, and the exceedingly shortened segment of the Madras male has a projection of closely set points very suggestive at least of the remnants of the cuticular points defining the placement of a spine. With this exception, this segment of the leg of the Madras male, though shortened, is more similar to the American species than it is to that of *canalis*.

The left exopod is separable into three distinct segments in the American species. The third segment is highly modified and is set into a centrally recessed area of the expanded, strongly built apex of the second segment. There is a higher degree of segmental development in *shoemakeri* than in *gracilis*. In *marki*, the apical processes and membranes are much more elongate than in either of the Tortugas species, but in other respects the whole left leg shows more similarity between *shoemakeri* and *marki* than exists between *shoemakeri* and the associated Tortugas species.

Although shortened, the left exopod of the Madras male is easily correlated with that of the American species. The figure given by Krishnaswamy (1953) is reduced in size and allows for little detail; however, its outline is entirely credible and its structure interpretable in light of knowledge of the American species. The outer spines of the first and second segments are present and strongly developed, being nearly as long as the exopod itself. These spines are placed close together, the second segment being much reduced on the outer side. The apical portion appears to be structurally comparable to the modified third segment of the American species. Its simplicity may be due to reduction or lack of some of the processes and fragmented membranes that complicate the structure in the other species, but it is certainly to be correlated with them. Indeed, it appears much like this portion of the exopod in the Tortugas specimens whenever they were viewed under relatively low power (fig. 35). Examination at high magnification with oil immersion objectives might well reveal complex detail in the Madras species such as has been found to exist in the American species. Krishnaswamy's (1953) unnamed specimen is therefore seemingly relatable to these species through the fifth leg. In the presence of setae on the right endopod, in the lack of the second outer spine of the right exopod 2, and in the seeming reduction of the left exopod it represents a possible link between the American species and *canalis*. In the case of this latter species, however, the structure of the apical portion of the left exopod may be somewhat different. As drawn by Gurney (1927) it has a flattened appearance and is difficult to reconcile exactly with the observed species. Such a difference may be entirely graphic in nature. Here again there is need for further examination, and probably also comparison with actual specimens of some of the other species.

Both of the Tortugas species have the first basipod segments fused and comparatively reduced. Unfortunately, Esterly (1911) has not shown or described the basipods completely for *marki*. In his illustrations the legs are entirely separated. A reduced but separated segment is shown for the right leg, but only a portion of the left second basipod segment is included. It would be instructive to know the exact condition, since *marki* and the Tortugas species are obviously congeneric. Gurney shows well-developed segments joined by a center connecting plate very similar to that of the subadult Tortugas male (fig. 36). Apparently the first basipod segments are well developed and separated in the Madras specimen. Correlated with other differences, the lack of fusion may have generic or other taxonomic significance, and it is a character that should be carefully noted.

It is difficult to interpret the fifth leg of the subadult male (*Ridgewayia* sp., Tortugas) in relation to the appendage in the adult. If it does represent a copepodid stage of one of the two known Tortugas species, then considerable change must take place between stage V and the molt to the adult. This would involve fusion of the basal segments, loss of one spine of the apex of the right exopod, and loss of the inner setae of the exopod and of the endopod. However, since two species are known in which the setae are present on the right endopod, it might be predicted that an unknown species with this character is present in Tortugas waters. The apical membranous spines and hyaline processes of the left exopod may or may not be the beginnings of development of the complex armature of the third segment of the adult. Again, they may represent armature belonging to a species that has a simpler development of this part of the exopod, such as shown for *canalis*.

The significant characters of the fifth leg have been summarized in table 4. The segmentation and spinal armature of the left exopod of *canalis* is listed as uncertain (see diagnosis of *canalis*, p. 145).

TABLE 4.—*Comparative characters of male leg 5,* Ridgewayia

(KEY: (+) character present; (−) character absent; (?) unknown)

SPECIES	BASIPOD	RIGHT EXOPOD	LEFT EXOPOD		RIGHT ENDOPOD	LEFT ENDOPOD
	First segments fused	No. spines on segment 2	No. segments	No. spines	Inner setae	Armed with lobes or processes
marki	?	2	3	2	−	−
shoemakeri	+	2	3	2	−	−
gracilis	+	2	3	2	−	+
sp. (Madras)	−	1	3	2	+	−
canalis	−	1	2(3?)	1(2?)	+	+

Key to known species of *Ridgewayia*

The following key has been devised to include both sexes and to summarize and emphasize, in part, similarity of known basic characters that may point up generic or species-group distinctions. Unfortunately, the Madras male cannot be included in the key because of insufficient information. It differs strikingly from all other known males in that the right endopod of the fifth leg reaches beyond the apex of the relatively shortened right exopod. Characters of the caudal setae and antennules used in couplets 3 and 4 need verification in *marki*.

1. Antenna, exopod 7-segmented; maxilla with total of 5 lobes, of which one belongs to basal segment. (Female unknown.) . . . . ***R. canalis***
   Antenna, exopod 8-segmented; maxilla with total of 6–7 lobes, of which more than one belongs to basal segment 2
2. Maxilla, basal segment with 3 lobes; leg 5 female, exopod 3, innermost spine not longer than other spines. (Male unknown.) . . . . ***R. typica***
   Maxilla, basal segment with 2 lobes; leg 5 female, exopod 3, innermost spine longer than other spines, about equal to length of segment 3

3. Middle caudal setae jointed at bases; leg 5 female, endopod 2, first inner seta placed near the proximal third (equaling about 36 percent of total length of inner margin); leg 5 male, left endopod with a proximal, inner, movable process about as long as endopod . . . . ***R. gracilis,*** new species
   Middle caudal setae not jointed at bases; leg 5 female, this seta placed below the proximal third (at about 42–44 percent of margin); leg 5 male, left endopod unarmed 4
4. Antennules, female and left male, 26-segmented; leg 4, endopod segment 2 with 2 inner setae, segment 3 with 7 setae; leg 5 male, left exopod 2, outer spine longer than its segment, reaching about to same point as longest apical process . . . . ***R. shoemakeri,*** new species
   Antennules, female and left male, 25-segmented; leg 4, endopod 2 with 1 inner seta, segment 3 with 6 setae; leg 5 male, left exopod 2, outer spine shorter than its segment, reaching only to about middle of extended apical membranes and processes . . . . ***R. marki***

Systematic position

Ridgewayia (as represented by the female of *R. typica*) was referred to the Calanidae by Thompson and Scott (1903) on the basis of the resemblances of the cephalic appendages and legs 1–4. The lack of agreement in the fifth legs was noted. As now known, the highly modified fifth legs of both sexes and the geniculate antennule exclude the genus from the Calanidae, but Thompson and Scott are correct in their implication that the unreduced, simply modified oral appendages and the first four pairs of legs are essentially primitive in structure.

In his comments on *Lampoidopus marki*, Esterly (1911) did not place the genus systematically.

Gurney (1927) doubtfully referred *Suezia canalis* to the Pseudocyclopidae because of its "general resemblance" to *Pseudocyclops*. He pointed out, however, that *canalis* differs "very materially from *Pseudocyclops*" but that he felt that "it must either be included in the Pseudocyclopidae or have a new family instituted for its reception," a course "hardly justified without more complete knowledge of the two sexes." Sewell (1932) and Krishnaswamy (1953) have listed *Suezia* in the Pseudocyclopidae without comment.

The demonstrated relationship of the species considered herein makes it possible to evaluate more critically their possible relationship to the Pseudocyclopidae. There is some merit in Gurney's suggestion, though the strongest resemblances between *Ridgewayia* and *Pseudocyclops*, the only known genus of the family, are the superficial ones of body form and habitat. Both have the stout body that is seemingly characteristic of extremely littoral and bottom-living calanoids. The segmentation of the body (including the reduced anal segment), the caudal setae, and the large, unfilamented rostrum are similar. The segmentation and armature of legs 1–4 are alike. There is also some similarity in the fifth legs of the females, though the distinctive modification of the exopod of *Ridgewayia* is not found in *Pseudocyclops*, and the endopod of *Pseudocyclops* varies considerably in segmentation and armature from species to species. If other characters showed strong correlation, the differences in the female fifth leg are such that they could well be considered generic rather than familial. It is more difficult, however, to correlate the highly complex male fifth leg of *Pseudocyclops* with that of *Ridgewayia*, though relationship of the two genera might be assumed through the modified endopods and the apical armature of the left exopod.

In what are more easily comparable and, in part, more fundamental characters, the two genera differ more widely. Important among these is the contrast in the location of the paired genital openings of the female. Those of *Pseudocyclops* are widely separated; those of *Ridgewayia*, as exemplified by the two Tortugas species, are closely set as in most other Calanoida. The antennule of *Ridgewayia* is longer than that of *Pseudocyclops*, which has the segments reduced both in number and length so that the antennule is usually shorter than the cephalic segment. In *Pseudocyclops* the right antennule of the male is also more strongly geniculate and otherwise modified. The rami of the antennae differ in their segmentation pattern. There are strong resemblances in the mandible—the blades being very much alike in the two genera and the palps differing principally in the elongation of the basipod in *Pseudocyclops*. The maxillule has the same number of elements, but in *Pseudocyclops* the distal portions tend to elongation, and some parts have much more reduced armature than found in *Ridgewayia*. There are very striking differences in the structure of the maxillae and maxillipeds of the two genera; in *Pseudocyclops*, the maxilliped is much reduced. In general, the several differences of the cephalic appendages do not indicate an extremely close relationship between the two genera. This, combined with the difference in the location of the genital openings, seems to exclude placement in the same family. On the other hand, the likeness of habitus and habitat and the similarities of the legs may indicate some degree of phylogenetic relationship.

The group of species referred herein to the single genus *Ridgewayia* have been shown to be in part inadequately known. The lack of knowledge, however, is specific or generic. The species are quite obviously referable to the same family. In the complete absence of any other family in which they can be placed, and in light of more complete knowledge than was available to former authors, it is appropriate to propose for these species a new family, as follows:

RIDGEWAYIIDAE, new family

Copepoda, Calanoida. Detailed diagnostic characters as given above for the unique genus *Ridgewayia.* Characterized principally by the combination of unreduced and little-specialized cephalic appendages, weakly geniculate right male antennule, fully segmented legs 1–4, and distinctively modified but biramose fifth legs in both sexes.

TYPE AND ONLY KNOWN GENUS (as herein defined): *Ridgewayia* Thompson and A. Scott (1903).

Gurney (1931, p. 84) has outlined a grouping of the calanoid families that is taxonomically very useful. For the most part, the new family Ridgewayiidae is taxonomically referable to the definition of the first group, the Centropagina. Gurney considered this group to represent the most primitive of the Calanoida and to be closely allied to another group which included only the Calanidae. Within the Centropagina there are some genera with highly modified fifth legs and reduced endopods (such as *Isias*), so there would appear little reason to exclude *Ridgewayia* because of the complexity of the left exopod and modification of the endopods of the male fifth legs. The more primitive segmentation of the antennule found in the new Tortugas species emphasizes rather than negates relationship with this group. However, when the phylogenetic position of this family is considered it is probable that important significance must be given to the segmentation of the geniculate antennule in relation to the seemingly unusual position of the hinge. Too little is known to evaluate this at present, and *Ridgewayia* appears as a highly singular genus exhibiting a combination of primitive characters with others of unique or specialized modification. For taxonomic purposes, however, the Ridgewayiidae may be currently placed with Gurney's Centropagina or considered allied to that group.

Similar taxonomic considerations may apply, with some qualifications, to the Pseudocyclopidae, placed by Gurney in an undefined group of "uncertain position." Gurney's concept of the Pseudocylopidae may have been somewhat in error inasmuch as he appears to have considered it as including the very anomalous genus *Platycopia,* which he spoke of as being "related to *Pseudocyclops*" (1931, p. 82). As has been pointed out (M. S. Wilson, 1946), *Platycopia* is unique among known calanoids and cannot be closely related to any known genus. Nor is there any known allied family as implied by Lang (1948, pp. 24, 26) in his reference to "Platycopiidae and closely allied families." Lang has placed the Platycopiidae in a suborder separate from the Calanoida. Nomenclaturally, Lang's system has the regrettable and inconvenient effect of eliminating entirely the much-used term Calanoida, which, though equivalent to Giesbrecht's term Gymnoplea, has long been preferred and extensively used. Lang's comments on the systematics of the Copepoda are brief and in part inconclusive, but the concepts presented are worthy of consideration by systematists. Attention is drawn here to Lang's paper because it is one that may easily be overlooked by specialists in the Calanoida.

Habitat and distribution

The existing records of *Ridgewayia* are all from tropical or subtropical coastal areas. Although they suggest that the species may be somewhat localized, they are too few to verify such a suggestion. They more strongly support the indication that the genus is not a pelagic form. This indication is not refuted by the instances in which it occurred in plankton hauls because the records of occurrence are so few and only one or two specimens were captured. Hauls reported by Gurney and Pinney were made at night when bottom copepods may ascend to higher water levels. Gurney interpreted *Suezia canalis* as "a species living on the bottom during the day" and included the record in the report on the littoral rather than the pelagic Copepoda of the Suez Canal.

The four species represented in collections by several specimens were all found in comparable situations. Specimens of *R. typica* were found in sediment from oyster shells taken on a reef; *marki* occurred in an island cave dominated by the coral *Agaricia gracilis;* and the two new species from the Dry Tortugas were associated with corraline algae. The warm, shallow waters of tropical and subtropical reefs and rocky shores, particularly among islands, is therefore suggested as a common habitat of the genus. This is unusual for Calanoida, but it is such a little-investigated habitat of Copepoda that our information concerning the calanoids that may occur in such situations is very meager.

That the genus may also be a bottom-living form of deeper coastal waters is suggested by the records in which the species occurred in plankton hauls. Aside from the investigations made by Thomas Scott and G. O. Sars on the north European coast, the bottom-living calanoids are practically unknown. Since Scott and Sars found several genera and species not closely related to one another or to known pelagic genera and families, it would appear safe to hazard the guess that there may exist other species, genera, or even families of Calanoida that are as yet undiscovered. There are published records of only five genera of this habitat group from American waters. *Pseudocyclops* has been recorded from northern Canadian waters by C. B. Wilson (1936) and from Bermuda by Esterly (1911). A new species of *Stephos* was found in collections from James Bay by Willey (1923). Two new species of *Platycopia* were described from the Maine coast by M. S. Wilson (1946). *Ridgewayia* was found in Bermuda by Esterly (1911) and to this is now added the Dry Tortugas records. In addition, Fleminger (1957) has described new species of *Stephos* and *Bradyidius* from the Gulf of Mexico.

The distribution of the species of *Ridgewayia* emphasizes the known faunistic affinity between the Indo-West-Pacific region and the American tropical Atlantic (West Indian) region (Ekman, 1953; Hyman, 1955). Sewell (1948) has listed many species of pelagic copepods common to the two areas and has also (1940, p. 354) pointed out the similarity of the littoral copepod fauna of the Suez Canal with that of the coasts of India and Ceylon. The littoral copepod fauna of the West Indian region is scarcely known, but Willey (1930) has shown the Bermudan harpacticoid fauna to be related to that of the Suez Canal. Nicholls (1944) has pointed out the striking similarity of Suez Canal and Bermudan species of *Pseudocyclops* (*P. magnus* Esterly, 1911, and *P. latens* Gurney, 1927). The closely allied Tortugas and Bermuda species of *Ridgewayia* emphasize the relationship of these two areas of the West Indian region, and, through their demonstrated relationship to species of the Suez Canal and the Indian coast, are another example of littoral animals zoogeographically linking the Indo-West-Pacific and West Indian regions.

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REVISION OF THE MILLIPED GENUS PACHYDESMUS (POLYDESMIDA: XYSTODESMIDAE)

By Richard L. Hoffman [1]

Southeastern United States, from South Carolina and Tennessee to Louisiana, is the home of *Pachydesmus*, a xystodesmid genus whose species include the largest known polydesmoids of North America. Despite their great size and the relatively wide range of the group, however, individuals of *Pachydesmus* appear to be scarce or secretive. Since the first species was appropriately named *Polydesmus crassicutis* by H. C. Wood in 1864, only nine names have subsequently been founded upon members of the genus, and less than a hundred specimens are at present contained in the major collections.

It is, in a way, fortunate that no more extensive work has been done on the genus—at least work of the careless descriptive kind which has been characteristic of American diplopodology and which is still being published by a few investigators. Although no attempt has ever been made to assemble what is known about *Pachydesmus*, and the published descriptions and drawings are nearly useless for comparative purposes, the scarcity of specimens has at least limited the confusion to a fraction of that which prevails in certain other genera.

The general plan of the present study is not pretentious. The two primary considerations affecting its course have been the evaluation of all specific names based upon pachydesmids and the provision of accurate illustrations of those forms which appear to be valid—these being the aspects of diplopod taxonomy most in need of immediate

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[1] Department of Biology, Virginia Polytechnic Institute, Blacksburg, Va.

attention. In addition, however, it has been possible to devote some attention to the secondary considerations such as variability, geographic distribution, and relative taxonomic status of the various forms.

In addition to establishing a degree of stability in the genus, and providing a means for other workers to identify their specimens with confidence, the present paper may serve another purpose, that of emphasizing the desirability that such studies might become the rule rather than the exception. It is a matter of regret that most of the work still being done on diplopods consists merely of brief descriptions of miscellaneous new forms, with little or no attempt at integration with existing facts. This approach is in no way different from, much less superior to, the work of the catalogers of the early 19th century, and serves only the isolated purpose of providing names for taxonomic entities with as little consideration as possible. Furthermore, it contributes nothing to the general knowledge of evolution in the Diplopoda, it confuses an already difficult situation (particularly from the standpoint of the beginner), and produces a volume of unrelated facts which must eventually be assembled, evaluated, and reorganized before they acquire any significance. By contrast, the treatment of entire genera with some concern for thoroughness requires only slightly more labor, and the result is undeniably more attractive and useful for all concerned.

For the preceding reasons, plus the fact that material of most of the named forms was at hand or readily available, I was prompted several years ago to undertake a revision of *Pachydesmus*, which is now offered to my colleagues and successors with the belief that I am leaving the genus in somewhat better condition than I found it.

Materials and Methods

During the preparation of this paper, I have examined a total of 68 specimens of *Pachydesmus*, representing all of the forms considered to be valid. This material is contained in seven collections, which are listed, with the abbreviations used for their designation, as follows:

AMNH:	American Museum of Natural History, New York, N. Y.
CNHM:	Chicago Natural History Museum, Chicago, Ill.
MCZ:	Museum of Comparative Zoology, Cambridge, Mass.
NBC:	Private collection of Nell B. Causey, Fayetteville, Ark.
RLH:	Private collection of R. L. Hoffman, Blacksburg, Va.
RVC:	Private collection of Dr. R. V. Chamberlin, Salt Lake City, Utah.
USNM:	U. S. National Museum, Washington, D. C.

In many instances, it happens that the value of a systematic paper is directly proportional to the number of type specimens examined by the author. This is particularly true in the case of diplopods, especially when the original description included inadequate illustrations or none at all. I have been fortunate, in this respect, in being able to study the types of five of the ten names based upon species of *Pachydesmus*. These are:

Fontaria clara Chamberlin 1918, in MCZ
Pachydesmus retrorsus Chamberlin 1921, in MCZ
Pachydesmus duplex Chamberlin 1939, in RVC
Pachydesmus simulans Chamberlin 1942, in RVC
Pachydesmus denticulatus Chamberlin 1946, in RVC

Material undoubtedly conspecific with the types has been seen of all of the remaining names except *Fontaria louisiana* Chamberlin, the status of which is still uncertain. The holotype of *Fontaria laticollis* Attems was in the Berlin Museum and not readily available, but in this case, as also with *Pachydesmus incursus* and *P. kisatchinsis* Chamberlin, specimens are at hand which match the original descriptions in every respect. Two very old specimens from Mississippi in the U. S. National Museum may possibly be part of the type series of *Polydesmus crassicutis* Wood.

The illustrations in this paper were made with the use of a binocular microscope fitted with an ocular reticule, with great care being taken to orient the structures into approximately the same position before the drawings were made. Copulatory structures were removed in all cases, and adherent membrane and muscle tissue dissected away. Measurements of total length of specimens were made as uniformly as possible, care being taken to avoid undue stretching or compressing of the animals. Such measurements are probably accurate to about a millimeter or two of being the correct length.

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Review of the Literature

The first species of *Pachydesmus* to be described was named in 1864 by H. C. Wood. His description of *Polydesmus crassicutis*, although brief, was quite accurate, and the woodcut illustration of the male gonopod published a year later in the "Myriapoda of North America" is detailed enough to show the characters now considered to be diagnostic for *crassicutis* in its present restricted sense. Wood's material, borrowed from the Smithsonian Institution, was collected in southern Mississippi.

No further reference to the genus appeared until 1888, when Charles H. Bollman recorded *Fontaria crassicutis* from Indian Springs, Ga.

In 1895, *crassicutis* was designated by O. F. Cook as the type species of his new genus *Pachydesmus*, one of the six genera originally included in Cook's family Xystodesmidae.

The great monograph of the polydesmoids written by Carl Attems and published in 1899 and 1900 contained the description of a second member of the genus. Since Attems did not recognize Cook's new genera, his species was proposed as *Fontaria laticollis*. The type specimen was said to have come from Illinois, doubtless through some kind of error, as *laticollis* is known with certainty only from central Tennessee, and no members of the genus have been found in or near Illinois.

In writing on miscellaneous American diplopods, Brolemann (1900) published a good figure of the gonopods of *crassicutis*, from a Louisiana specimen. Brolemann, as well as Attems, disregarded the name *Pachydesmus*, preferring to retain the old usage of *Fontaria* for most of the xystodesmid species.

Thus, during the half century following the description of *crassicutis*, only one additional species had been named, and less than half a dozen references to them had been made in the literature. During the very active career of R. V. Chamberlin, however, a considerable number of new forms have been described, and in recent years several other workers have dealt with the genus at least cursorily. Dr. Chamberlin described *Fontaria clara* and *F. louisiana* in 1918, *Pachydesmus retrorsus* in 1921, *P. duplex* and *P. incursus* in 1939, *P. simulans* and *P. kisatchinsis* in 1942, and *P. denticulatus* in 1946.

In his final great treatise on the Polydesmida, Count Attems (1938) accepted *Pachydesmus* as a valid genus, but combined with it the genus *Harpaphe* Cook of the Pacific Coast region! Although there is some similarity in the gonopods of the two genera, numerous other characters prohibit any close association of them, much less postulation of their identity. Attems included *crassicutis*, *laticollis*, and *intaminatus* in his treatment of *Pachydesmus*, with *retrorsus* added in the status of an "unsichere Art."

Loomis (1943) recorded *retrorsus* from northeastern Alabama, on the basis of material collected by Hubricht. In 1948, Loomis and Hoffman placed *Pachydesmus kisatchinsis* Chamberlin in the synonymy of *Fontaria clara* Chamberlin, bringing the latter name into *Pachydesmus* for the first time. Finally, Causey (1955) has recorded *P.*

clarus from several localties in western Louisiana, and recorded the color pattern of the species.

To the present time, therefore, ten specific names have been based upon specimens referable to the genus *Pachydesmus*, with characters of the male gonopods forming the sole basis for recognition. However, since published illustrations of the gonopods have been made from a diversity of aspects, rarely any two being the same, differences leading to the separation of presumed new species have been much more apparent than real, as the drawings made for this study will reveal. I believe that the genus contains but two species, *P. clarus* Chamberlin and *P. crassicutis* Wood, most of the other names representing merely geographic races of the latter.

TAXONOMIC CHARACTERS

Although its species can readily be distinguished by nonsexual characters from the species of other genera occurring in the same region, the genus *Pachydesmus* is diagnosed primarily upon the configuration of the male gonopods. The unusual secondary process of the telopodite, which appears to be derived from the strongly chitinized tibiotarsal region rather than from the prefemur, occurs in both of the species and serves as a unifying character although the body structure differs more between *P. clarus* and *P. crassicutis* than between species of various distinct genera in other sections of the Xystodesmidae. Although there can scarcely be any doubt that the two are congeneric, their dissimilarities indicate a very remote period of divergence and subsequent isolation.

Although members of the Crassicutis Group are immediately recognizable by their large size and laterally attenuated collum, it is difficult to formulate a generic diagnosis not based on gonopod structure since females of *clarus* do not present any unusual features and are not very similar to those of *crassicutis*. A peculiarity of females of both species, however, is the rather large cephalomesial lobe of the pleuron of the 3d segment (discussed further on in this section), which may prove to be constant and stable for generic recognition. Once a specimen is placed in *Pachydesmus*, the matter of its identification becomes rather simple.

SIZE OF BODY: Insofar as can be determined with the limited material at hand, variation in the size of mature specimens appears to be correlated with populations recognizable on the basis of structural features. Figure 2 indicates the range in length (to the nearest millimeter) of specimens of the recognized forms of the genus. Apparently an over-all range of about 10 mm. is to be expected for each, and although some cases of overlap occur, certain forms can be separated solely on the basis of length, and this variable should clearly be helpful in identifying females. Generally, the forms which are closest in body size are also quite similar in gonopod structure and are usually geographically approximate. Variability of size is thus one of interest in the consideration of phylogeny and relationships within the genus. There is a distinct tendency for the smaller forms to be dispersed around the periphery of the generic range (fig. 3).

Shape of collum: In the subspecies of *crassicutis* the collum is attenuated laterally and extends as much as a millimeter or more beyond the paranota of the following segments (fig. 1,*a*). This character was noted by Attems in the pachydesmid which he described in the "System der Polydesmiden" and is the basis of the name *laticollis*. In *clarus*, however, the collum is of normal shape (fig. 1,*b*) and thus provides a fundamental means of distinguishing between the two species. No variation in shape has been noted between any of the eight geographic races of *crassicutis*, nor does there seem to be any sexual dimorphism in this character.

Color pattern: Very little is known of the colors of living individuals of *Pachydesmus*, and therefore little can be said about the taxonomic value of pigmentation. Judging from recently preserved specimens, the large forms related to *laticollis* (*retrorsus*, *hubrichti*, *adsinicolus*) appear to be light brown dorsally, with the paranota rather testaceous. Around the periphery of the range, the colors become more distinctive, *clarus* being black with the paranota coral red or pink, *duplex* blackish with yellow paranota, and *incursus* brown with either pink or yellow paranotal markings. The presence of reds and yellows is almost universal in the Xystodesmidae, so that the loss of such hues may be considered a specialization concomittant with increase in size.

Interzonal furrow: The interzonal furrow is quite similar in both *clarus* and *crassicutis*, at least that part which crosses the dorsum. Ventrally, however, it becomes a well-defined and sharply margined groove in *clarus*, but is reduced to a mere transverse suture across the sterna in the forms of *crassicutis*.

Gonopods: Characters afforded by the conspicuous external gonopods of many diplopods were utilized in the diagnosis of new species as long ago as 1832, but did not receive real emphasis until a half-century later. Since about 1884 there has developed a tendency to rely more and more exclusively upon male genitalia, despite which fact numerous workers have never given more than superficial sketches of the appendages, accompanied by no description whatever. That such important structures should have received so little close study is somewhat astonishing. An attempt has been made in this study to illustrate the gonopods from the same aspect for accurate comparisons, and to devise a tentative terminology by which differences can be expressed verbally in an intelligible manner. Although H. C. Wood, the describer of the first known pachydesmid, himself recognized the taxonomic value of female genitalia, and provided woodcut illustrations of them in his "Myriapoda of North America" (1865), only sporadic attempts to develop the knowledge of the structure and systematic utility of the cyphopods have been made by his American successors. These structures, as shown in the accompanying drawings, pronounce their own silent indictment of their long and unseeming neglect.

The gonopods of the male sex in *Pachydesmus* are unusual in their development of a secondary tibiotarsus which equals or exceeds the primary branch in size. In other respects the gonopods are more or less typical for the family. The coxae are large, and loosely attached to each other by membrane only.

On the anterior surface each coxa bears two long macrosetae and a fairly large coxal apophysis or condyle of various shape. As a general rule, this process is largest in specimens from the center of the generic range, where it is often crenulate as well. In *clarus*, the coxal apophysis is smallest, forming merely a small subconical lobe.

The telopodite joint is massive and composed of three distal branches. The smallest of these is the prefemoral process, arising adjacent to the swollen and setose prefemoral portion, and directed distad, bent at an obtuse angle at about its midlength, becoming attenuated and acuminate terminally. The main division of the telopodite is nearly straight and is divided into a densely setose basal portion probably consisting of the prefemur and femur, and a thin, bladelike distal portion representing the tibiotarsus. On the lateral side of the telopodite, near its base, a large process originates, directed first proximad and then, by a strong bend, distad parallel to the main blade. This large process is structurally similar to the chitinized tibiotarsal area, and may be tentatively considered as a secondary tibiotarsus. Distally it may be simple and acuminate, or bifid and elaborated.

The telopodite portion of the gonopod presents several variable features. The relative length of the prefemoral portion with respect to the entire joint (as determined with an ocular micrometer) varies geographically, and again the variation is centrifugal in that in *laticollis* and *retrorsus* the prefemur attains its greatest proportion of the total length—70 percent. Toward the periphery, this ratio decreases to 60 percent in *crassicutis* and *incursus*, and 58 percent in *clarus*, the decrease being roughly proportional to the magnitude of the geographic separation involved. Another feature showing strikingly similar geographic parallelism is the denticulation of the anterior edge of the tibiotarsus. This edge becomes serrate in most of the marginal forms, including *duplex, crassicutis, denticulatus,* and *incursus,* while remaining smooth and entire in *laticollis, retrorsus, hubrichti,* and *adsinicolus* (fig. 4).

The secondary tibiotarsus is bulkiest near the center of the generic range, where it is also distally modified into a T or Y shape. The marginal forms tend to have a smaller process, with the terminal modification much simpler. In *crassicutis crassicutis* the subterminal process is rather small and visible only in a sublateral aspect, in *crassicutis duplex* it is missing entirely. The secondary tibiotarsus of *clarus* is reduced to a rather short acicular process much smaller than the primary branch.

Aside from the obvious differences mentioned in the preceding paragraphs, the general shape of the gonopods in the different forms is distinctive for each, embodying numerous elements of shape and proportion difficult to describe verbally.

Sternal knobs: In males of the *crassicutis* group, the podosternites of the midbody segments are produced into transversely elongated swellings between the posterior legpair. Usually two or three of the sternites posterior to the gonopods are flat, with a median cruciform impression, caudad of which the sternal knobs form a continuous series back to the 16th or 17th segment. These swellings are not present in males of *P. clarus.* Their appearance in the males of some species of *Epeloria* suggest a line of relationship which is augmented by the presence of a somewhat broadened collum in certain forms of that genus.

Cyphopod aperture: Females of *Pachydesmus* appear to be characterized by a specialization affecting the vicinity of the 2d legpair. The anterior margin of the pleurotergite of the 3d segment is produced cephalomesiad into a distinct rounded lobe on each side of the body, these lobes extending partially in front of the coxae of the 2d pair of legs. The margin of the pleurotergite immediately posterior to the lobes is raised into a high marginal flange.

Cyphopods: In the material available to me, females of only five forms are represented. In these, however, the shape of the cyphopods is so distinctive that the structures would seem to be readily available for diagnostic purposes. Furthermore, there seems to be structural divergence and similarity on a par with, and correlated with, variation in the gonopods. For instance, the females of the closely related forms *laticollis, hubrichti,* and *retrorsus* obviously are quite similar in genital characters (fig. 5,*a,c*), in that the receptacle (R) is not longer than the valves, and is distinctly obliquely excavated distally, leaving a pronounced shelf just beneath the outer valve. In the female of the more disjunct *P. crassicutis duplex,* the receptacle (fig. 5,*e*) is extended distad considerably beyond the ends of the valves, and its entire shape is quite different from that of the other three subspecies enumerated.

Genus *Pachydesmus* Cook

Pachydesmus Cook, 1895, p. 5.—Pocock, 1909, p. 188.—Attems, 1938, p. 153.—Chamberlin and Hoffman, 1958, p. 42.

TYPE SPECIES: *Polydesmus crassicutis* Wood 1864, by original designation.

DIAGNOSIS: A genus of moderate to large, rather bulky xystodesmids of variable structure with the following characteristics:

Head smooth and polished, the vertigial groove terminating anteriorly in a small but distinct interantennal depression; two frontal, two subantennal, and four supra-antennal setae present; antennae slender and moderately long, extending caudad to middle of 3d tergite, with four sensory cones; genae somewhat swollen and with distinct median grooves.

Paranota moderately developed, slightly less than a third as wide as diameter of body cavity, continuing or but slightly interrupting slope of dorsum. Pores normal in distribution, opening on the dorsal side of the peritremata. Tergites very finely coriaceous, often with several transverse rows of very tiny setiferous tubercules.

Sterna smooth and completely glabrous, not produced at the bases of legs, podosterna appreciably raised above level of prozonites. Pleura finely granular, without ridges or clusters of tubercules. No processes or knobs between 3d and 6th legpairs of the male.

Coxae of gonopods large, connected only by sclerotized membrane, there being no zygomatic structure; each coxa with two elongate macrosetae and a coxal apophysis of variable size above the origin of the solenite. Prefemur elongated from a slightly globose base, densely setose, with a moderately large, slender, weakly chitinized prefemoral process which is bent at an obtuse angle at about its midlength. Acropodite of gonopod (coalesced femur and tibiotarsus) a thin, heavily sclerotized blade with distinct seminal groove and distally bent at a right angle. A large secondary tibiotarsal branch originates at the base of the telopodite, and is bent strongly distad, subparallel to and usually as long as the main branch, often modified distally with a subterminal spur of variable size and shape.

Anterior edge of ventral ends of pleurotergites of the 3d segment in females produced cephalomesiad into a large rounded elongate lobe which partially extends in front of the coxae of the second pair of legs. Immediately caudad to these lobes the pleurotergite is produced into a rather high, thin, marginal flange.

Cyphopods large and conspicuous, of the characteristic polydesmoid form and not strikingly different from those of other xystodesmid genera, although manifesting distinct specific and subspecific characters in the shape of the receptacle and valves.

RANGE: Southeastern United States, from extreme western South Carolina and eastern Tennessee south and west through Georgia and Alabama to Mobile Bay, the Mississippi Delta, and the upland parishes of northwestern Louisiana, north through Mississippi into extreme southwestern Tennessee.

SPECIES: Two, separable by the characters stipulated in the following key.

Key to the species of *Pachydesmus*

1. Small species, less than 50 mm. in length; collum not wider than the following tergite; interzonal furrow open and distinct across sternites; femora of legs longer than coxae and prefemora combined; podosterna of males without transverse ridge between the second legpair . . . **clarus** Chamberlin (p. 190)

Larger species, from 50 to 80 mm. in length; collum considerably wider than the following tergite; interzonal furrow reduced to a mere suture across sternites; femora of legs about equal in length to the prefemora; podosterna of segments 10–17 of males with distinct transverse ridge between the caudad legpair . . . . **crassicutis** Wood (p. 195)

Pachydesmus clarus (Chamberlin)

FIGURES 1,*b*, 6

Fontaria clara Chamberlin, 1918b, p. 372.—Attems, 1938, p. 167.

Pachydesmus kisatchinsis Chamberlin, 1942, p. 4, fig. 8 (Kisatchi, Natchitoches Parish, La., type in Chamberlin collection).

Pachydesmus clarus Loomis and Hoffman, 1948, p. 53.—Causey, 1955, p. 25.—Chamberlin and Hoffman, 1958, p. 43.

TYPE SPECIMENS: Male holotype and paratypes of both sexes (MCZ), male paratype (USNM 2323), collected at Creston, Natchitoches Parish, La., by Karl P. Schmidt in February and March 1915.

DIAGNOSIS: A small species of *Pachydesmus* separable from *crassicutis* by the characters stipulated in the foregoing key to species. The reduction of the secondary tibiotarsus to a shortened acicular spine and the corresponding diminuation of the coxal apophysis are additional specific characters peculiar to the male sex.

DESCRIPTION: Of male paratype: Length, 48 mm., width of 10th segment, 9.0 mm. Segments 5–15 of approximately same width.

Front of head smooth and polished, vertigial groove rather deep just above level of antennae; genae inflated and with distinct median impressions. Two frontal, two subantennal, and four supra-antennal setae present. Antennae set rather close at base, separated by a distance considerably less than length of 2d article. Articles 2–4 similar in size and shape, 6th about same length but less clavate, 7th semiglobose with four well-separated bacilliform sensory cones. Articles 1–3 almost glabrous, 1–5 with five or six macrosetae at their distal

FIGURE 1.—Structural details of *Pachydesmus: a,* anterior end of body, lateral aspect, of *P. crassicutis crassicutis; b,* same, of *P. clarus; c,* male gonopods, in situ, of *P. c. retrorsus; d,* pleural lobe of 3d segment of female of *P. c. duplex; e,* caudal aspect of a midbody segment of *P. c. crassicutis.*

end, 5–7 becoming more setose, the setae of article 7 fine, short, and procumbent.

Collum not quite as wide as 2d tergite, its anterior and posterior margins straight and parallel across the middle, both edges tapering laterally (fig. 1,*b*). Anterior half of lateral ends bent obliquely cephaloventrad; anterior edge slightly sinuate, distinctly margined. Surface of collum very finely coriaceous, with a row of eight widely separated, very small setae near the anterior margin and a similar row of ten such setae paralleling the caudal margin.

Paranota of segments 2–4 swept forward, those of segments 5–8 nearly transverse, the remainder becoming increasingly bent caudad. Anterior corners of all paranota rounded, the posterior corners obtusely angled back to 7th segment, caudad of which the angle becomes increasingly acute. Paranota moderately wide, about a third the diameter of the body cylinder, those of anterior segments continuing slope of dorsum but becoming nearly horizontal toward the rear of the body; anterior edges set off by an acute ridge and shallow depression, lateral edges merely tumid and shining; pores opening on the dorsal side of swelling, exactly halfway along its length; caudal edges slightly convex, meeting the edge of metazonite proper at a re-entrant angle. Paranota of 18th segment forming elongate triangular lobes which extend caudad to level of the caudal margin of 19th, lobes of the latter segment short, broadly rounded.

Dorsal surface of metatergites finely but distinctly coriaceous, set with a large number of very tiny setiferous tubercules. Interzonal furrow broad, deep, and finely costulate. Anal segment much broader than long, its median projection short and distally truncate, with a large setiferous knob at the base on each side. Anal valves with very distinct swollen margins, surface of valves with fine vertical striations and a pronounced knob in the center of each near the base. Preanal scale semicircular, with a slight median projection; lateral setiferous tubercules very small and removed from the margin.

Sternites smooth and completely glabrous, sternal area of metazonites raised between the legs into a platform much higher than level of prozonite (the new term "podosternum" is suggested with reference to this modification). Interzonal furrow sharply defined, its anteriormost portion partly overhung by the caudally reflected edge of the prozonite. Pleurites very finely granular, without other sculpture.

Legs relatively long and slender, the coxae without distal spines but those of prefemora long and sharp, distinctly curved caudad. Femora clavate, about as long as coxae and prefemora combined, postfemora short and thick, tibiae much longer and more slender, tarsi slender and gradually tapering, more than half as long as femora; tarsal claw nearly straight, slender, more than half the length of tarsus. Leg joints becoming increasingly setose distally, tip of tarsus set with numerous long macrosetae. Sternites of segments 4–6 not produced or modified in any way. Sternal aperture of 7th segment broadly oval, the entire caudal margin with a raised rim; anterior margin distinctly emarginate at the middle.

Gonopods in situ directed cephalomesiad, their apices in contact and overlapping, extending forward between the legs of the 6th segment. Coxae rather small and subcylindrical, slightly shorter than telopodite, with small coxal apodemes and weakly developed coxal apophyses just above the origin of the solenite. Telopodite elongate and slender, of the form typical of the genus but with a rather small and slender secondary tibiotarsus which is only a little larger than the prefemoral process. Primary tibiotarsus short, only 58 percent of the total length of the telopodite. Distal end of primary tibiotarsus slightly curved proximad of the terminal subdeltoid region (fig. 6).

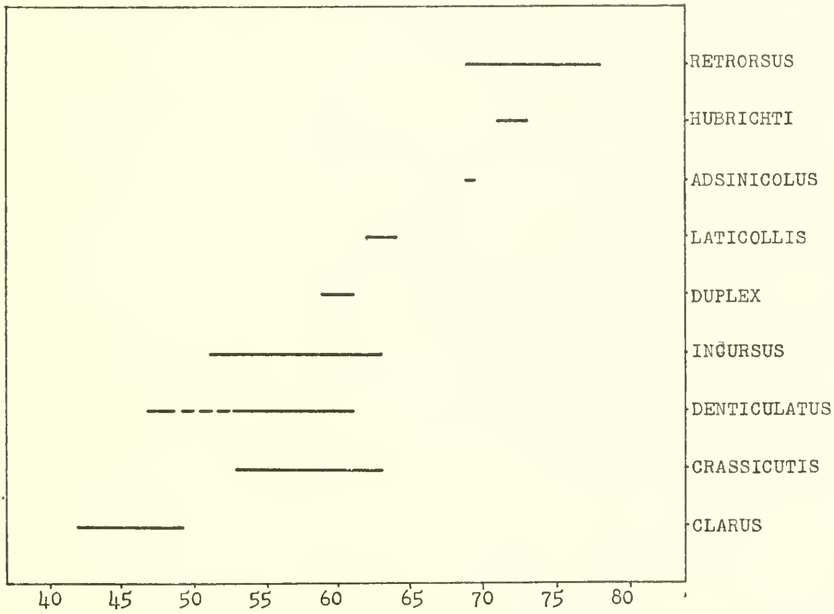

Figure 2.—Graphic representation of variation in total length of the recognized forms of *Pachydesmus*, the horizontal scale divided into units of 5 mm.

Female: Similar in all external details of sculpture to the male, except for the more vaulted bodyform and slightly wider sternites. Cephaloventral edge of the 3d segment on each side produced into a distinct rounded lobe. Cyphopods similar to those of the *Pachydesmus crassicutis* forms, the valves about equal in length to the receptacle.

Color: I have seen no living specimens of this species. According to the original description, "When in full color the dorsum is very dark, black or nearly so, with the carinae sharply contrasting by their lighter, in preserved specimens yellowish color . . . Under surface and legs yellowish." Causey (op. cit.) notes that the color ". . . is as follows: dorsum black-brown, keels coral, venter and legs pale yellow."

Variation: The material I have examined is quite homogeneous in structure, there being no perceptible geographic variation. Ranges of from 42 to 49 mm. in the length of mature specimens and from 8 to 10 mm. in the width has been recorded. There is no sexual dimorphism in this respect.

Synonymy: *Pachydesmus clarus* was originally described without illustration of the gonopods, and it eventually fell into a sort of obscurity owing to the difficulty of visualizing its generic attributes from a brief verbal description. The types were collected at Creston, Natchitoches Parish, in the upland hill region of western Louisiana, and were placed in the collection of the Museum of Comparative Zoology.

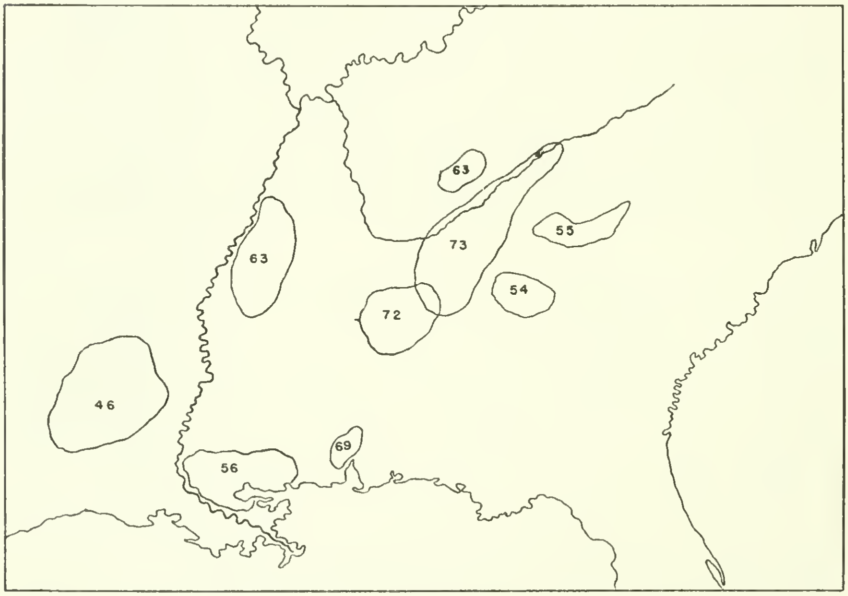

Figure 3.—Geographic variation of average length in nine populations of *Pachydesmus*. Known ranges are represented by the outlined areas; the enclosed figures indicate the average length of the specimens of that form measured.

Twenty-two years after the description of *clarus*, Leslie Hubricht obtained a single male (virtually a topotype), at Kisatchi, also in Natchitoches Parish, La. This male was sent to Dr. Chamberlin and became the type of *Pachydesmus kisatchinsis*. Several years later, H. F. Loomis examined the material of *clarus* at Harvard and recognized its identity with *kisatchinsis*, the synonymy being recorded in a short note published in 1948.

DISTRIBUTION: *P. clarus*, the only member of the genus known from west of the Mississippi River, is endemic to the upland parishes of western Louisiana above the Kisatchi escarpment. A single Texan locality is known, and it seems likely that the species will eventually be discovered in southern Arkansas. Material has been seen from the following localities:

LOUISIANA. *Grant Parish:* west of Pollock, 3 ♀♀, July 9, 1955, Leslie Hubricht (RLH); Dry Prong, 2 ♀♀, May 9, 1954, H. S. Dybas (CNHM). *LaSalle Parish:* Jena, 4 ♂♂, 5 ♀♀, Feb. 28, 1954, J. Stone (NBC). *Lincoln Parish:* Ruston, 1 ♂, 1 ♀, Feb. 15, 1952, W. J. Harmon (NBC). *Natchitoches Parish:* Creston, 3 ♂♂, 6 ♀♀, TYPES, February-March 1915, K. P. Schmidt (MCZ, USNM); Bellwood, 1 ♀, Oct. 3, 1953, J. D. Montgomery (NBC); Chastine, 2 miles north of Creston, 1 ♂, 3 ♀♀, Apr. 29, 1947, J. M. Schmidt (CNHM). *Rapides Parish:* Forest Hill, 2 ♀♀, Nov. 11, 1945, R. L. Wenzel (CNHM).

TEXAS. *Newton County:* Weirgate, 1 ♀, Mar. 28, 1943, Barth A. Maina (CNHM).

This species has also been recorded as *Pachydesmus kisatchinsis*, from Kisatchi, Natchitoches Parish, La. (1 ♂, Mar. 29, 1937, Leslie Hubricht), by Chamberlin (1942).

Pachydesmus crassicutis (Wood)

Under this name I propose to associate all of the large pachydesmids known from the region east of the Mississippi River. In the past, each has been considered a full species, but the evidence of morphology and geographic distribution now available indicates that all of the valid forms represent only geographic races of a single widespread species. It has also become obvious, through direct comparison of the different forms, that the structural peculiarities upon which the names were based are much less real than apparent.

Although there seems to be a great difference between such forms as *P. c. laticollis* and *P. c. incursus*, other subspecies largely bridge the gap between them, and there is actually a geographic gradation to be observed in every character which might be considered diagnostic of a species.

No two forms of the *crassicutis* group occupy the same territory. Instead, the ranges are now known to be entirely complimentary, and one definite case of intergradation is known. Specimens taken between the ranges of *P. c. laticollis* and *P. c. retrorsus* are clearly intermediate as regards the structure of the gonopods.

Despite the general picture of geographic variability, I believe that most of the forms here considered valid will prove to be stable subspecific units. Except for minor, presumably individual variations, specimens taken through the extent of the range of a given subspecies are essentially alike, and there is no reason to believe that we are dealing with populations picked at random along an evenly grading geographic cline.

A recent attempt on the part of two entomologists to discredit and abolish the concept of subspecies seems to be founded upon the idea that every species is somewhat comparable to a normal spectrum, and that subspecies names represent only narrow strips of color chosen haphazardly and without consideration of intervening gradations of shade. But in those instances where populations of a species are known to maintain their characteristic features over a considerable area without particular intrapopulation variation, and tend to merge with adjoining populations where their ranges meet, I can not see how anyone can reasonably consider the naming of such infraspecific groups as superfluous and misleading. This seems the more true when it is recalled that the same critics of the Latin trinomial suggest replacing it by vernacular names alluding to the range of the population being considered.

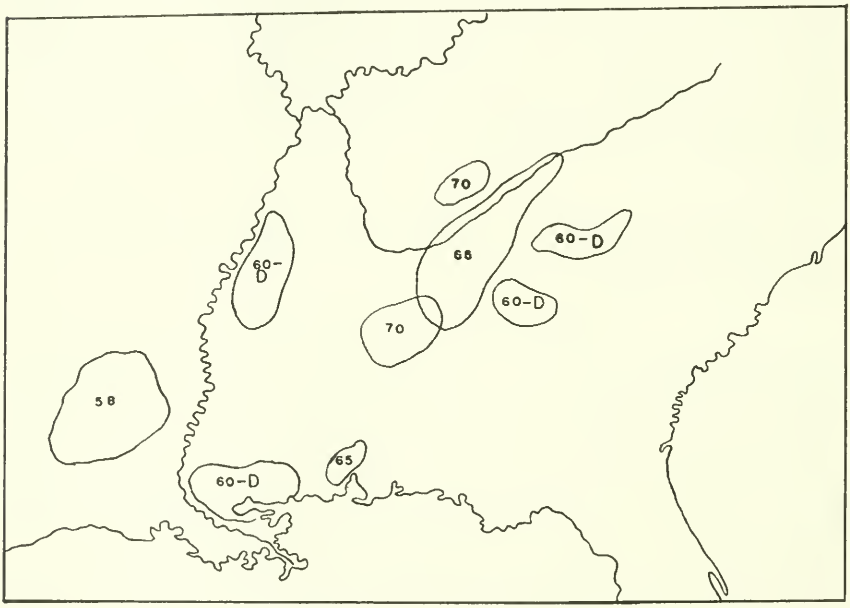

Figure 4.—Geographic variation in the gonopods in nine populations of *Pachydesmus*. Known ranges are represented by the outlined areas; the enclosed figures represent the length of the prefemoral region in terms of percentage of the total length of the telopodite. The letter "D" indicates that the leading edge of the primary tibiotarsus is denticulate or serrate.

Within the specific limits of *Pachydesmus crassicutis*, I recognize eight subspecies, separable chiefly on the basis of the gonopods, although supplementary correlated differences obtain in the size of the animals and, to a certain extent, their color pattern. Although these are all considered subspecies of a single form, two main groups of populations are easily recognizable, indicating that evolution has not been uniform throughout the range of the species. Near the

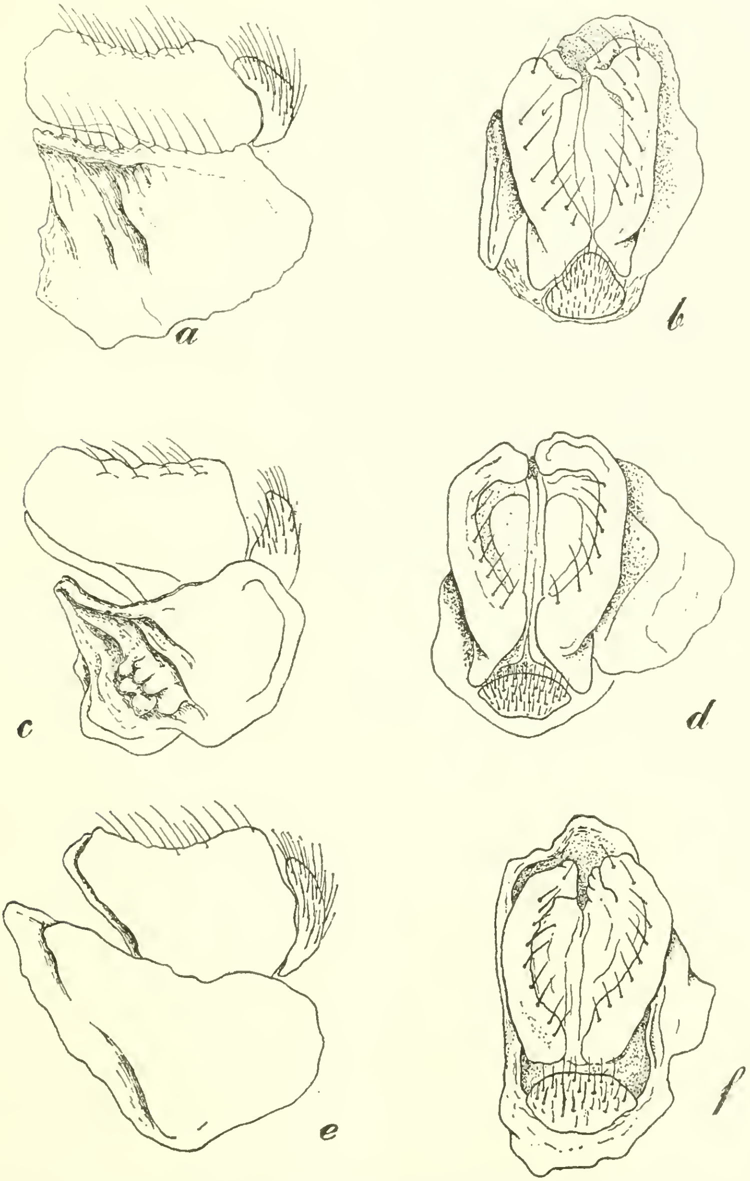

Figure 5.—Cyphopods of three subspecies of *Pachydesmus crassicutis*: *a*, *b*, distal and mesial aspects of *P. c. laticollis*; *c*, *d*, same, of *P. c. hubrichti*; *e*, *f*, same, of *P. c. duplex*.

center of the range occurs a phratry of four closely related subspecies: *laticollis*, *retrorsus*, *hubrichti*, and *adsinicolus*. These are similar in their large size, testaceous color pattern, and in several particulars of the gonopods. Around the periphery occur four other subspecies: *crassicutis*, *duplex*, *denticulatus*, and *incursus*, all of which are smaller, more colorful, and similar in gonopod structure, sharing, for instance, a serrated tibiotarsal blade. These marginal forms may be considered representatives of the ancestral stock, now more or less isolated by the centripetal evolution producing the larger, more specialized, interior forms.

It is interesting to note that in the several races of which female specimens are available, the cyphopods show differences and similarities in almost the same magnitude as do the gonopods of the corresponding males.

Key to the subspecies of *Pachydesmus crassicutis*, based on males

1. Prefemur of gonopod shorter, 60 percent or less the total length of the telopodite joint; mesial edge of tibiotarsal blade serrate or dentate (fig. 7, *a–d*); secondary tibiotarsus usually straight and subparallel to the main branch, its subterminal tooth generally much reduced or absent, if present usually directed distad, making the end of the process Y-shaped; animals smaller, adult generally less than 65 mm. in length (*crassicutis* phratry) 2

   Prefemur longer, 65–70 percent of the total length of the telopodite; mesial edge of tibiotarsal blade smooth; secondary tibiotarsus usually sinuate and divergent from the main branch, its subterminal tooth well developed and usually retrorse, directed proximad, making the end of the process T-shaped; animals larger, adults generally more than 65 mm. in length (*laticollis* phratry) 5

2. Subterminal tooth of secondary tibiotarsus completely absent; length, 59 to 61 mm. (northern Mississippi) . . . . . . **crassicutis duplex** Chamberlin

   Subterminal tooth of secondary tibiotarsus present but variable in form, occasionally quite small 3

3. Secondary tibiotarsus distinctly longer than primary, its subterminal tooth reduced to a small subtriangular lobe or spur; length, 51 to 65 mm. (western South Carolina, northern Georgia) . . . . . **crassicutis incursus** Chamberlin

   Secondary tibiotarsus not longer than primary, its subterminal tooth larger, in the form of a definite projection 4

4. Secondary tibiotarsus slightly sinuous, its subterminal tooth perpendicular to the main axis; coxal apophysis elongated, distally rounded with the margin entire; length, 50 to 61 mm. (north-central Georgia).
   crassicutis denticulatus Chamberlin

   Secondary tibiotarsus almost straight, its subterminal tooth directed distad; coxal apophysis short, its distal edge distinctly indented; length, 53 to 63 mm. (southern Mississippi, eastern Louisiana).
   crassicutis crassicutis (Wood)

5. Tibiotarsus of gonopod shorter, bulkier, more triangular distally, only 30 percent of the length of telopodite 6

   Tibiotarsus of gonopod longer, more slender, less enlarged distally, 35 percent of the length of telopodite 7

6. Prefemoral process heavy, very thick in the region of its angulation, distally almost straight; subterminal tooth of secondary tibiotarsus smaller; coxal apophysis smaller; length, 55 to 64 mm. (east-central Tennessee). **crassicutis laticollis** (Attems)

 Prefemoral process slender throughout, distally sinuate subterminal tooth of secondary tibiotarsus larger; coxal apophysis larger; length, 71 to 73 mm. (central Alabama) . . . . **crassicutis hubrichti,** new subspecies

7. Tip of secondary tibiotarsus directed distad, the entire process nearly straight, broader, and strongly twisted at about the midlength; length, 69 to 70 mm. (northern Alabama, eastern Tennessee). **crassicutis retrorsus** Chamberlin

 Tip of secondary tibiotarsus directed proximad, the entire branch more slender and bisinuate, slightly twisted near its base; length, 69 mm. (southern Alabama) . . . . **crassicutis adsinicolus,** new subspecies

The *crassicutis* phratry [2]

Pachydesmus crassicutis crassicutis (Wood)

FIGURES 1,*a*, 7,*a*, 8,*a*, 9

Polydesmus crassicutis Wood, 1864, p. 7; 1865, p. 224, fig. 55.

Pachydesmus crassicutis Cook, 1895, p. 5.—Pocock, 1909, p. 188.—Attems, 1938, p. 153, fig. 174.

Fontaria crassicutis Brolemann, 1900, p. 101, pl. 6, figs. 28, 29.

?*Fontaria louisiana* Chamberlin, 1918a, p. 363 (Covington, La., type apparently lost).

Pachydesmus simulans Chamberlin, 1942, p. 4, figs. 9, 10 (Gonzales, Ascension Parish, La.; type in Chamberlin collection).

TYPE SPECIMENS: Wood's type series consisted of "numerous" specimens from Mississippi, and was borrowed from the Smithsonian Institution. No labeled material now appears to be extant, but in the U. S. National Museum collection are two very old fragmented specimens labeled only "E. Miss.," which may be remnants of the types. Unfortunately the gonopods are lost from both.

DIAGNOSIS: A medium-sized pachydesmid (55–65 mm. in length) in which the leading edge of the primary tibiotarsus is serrate and the apices of the secondary tibiotarsus are unequal in length and directed divergently distad.

DESCRIPTION: Male specimen from Port Hudson, La.: length about 53 mm., width, 11.5 mm.

Front of head smooth and polished, evenly convex, with a small indistinct triangular flattened area between and below the antennal sockets. Genae large, extending slightly beyond edge of head capsule, each with a median impression. Vertigial groove distinct, ter-

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[2] The term "phratry" is here introduced (to the best of my knowledge for the first time) to designate a group of closely related subspecies which appear to form a natural group definable by several characters. Since most of the subspecies of *P. crassicutis* are quite similar in structural characters, it seems adequate to introduce extended descriptions only of a representative of each phratry.

The terms "group" and "section" appear to be more useful to designate assemblages of species below the level of, or in place of, the subgenus category.

minating in a rather prominent rounded depression between the antennae. Two paramedian clypeal setae rather close to the labrum, and a pair of supra-antennal setae on each side of head. Antennae widely separated at base by a distance slightly less than length of 2d antennal article. Antennae long, extending back to front of 3d tergite; 2d, 3d, and 6th articles similar in size and shape, 4th and 5th a little shorter. The 7th article hemispherical, with four small terminal sensory cones. Antennae becoming increasingly setose distally, the first two articles almost glabrous.

Collum large, considerably wider than the following segment, its lateral ends strongly narrowed and bent cephalomesiad, entirely concealing base of mandibles when head is depressed. Surface of collum polished, not becoming coriaceous near the ends. Anterior edge straight, margined up as far as base of mandibles. Posterior edge straight across back, thence abruptly and sinuously swept forward.

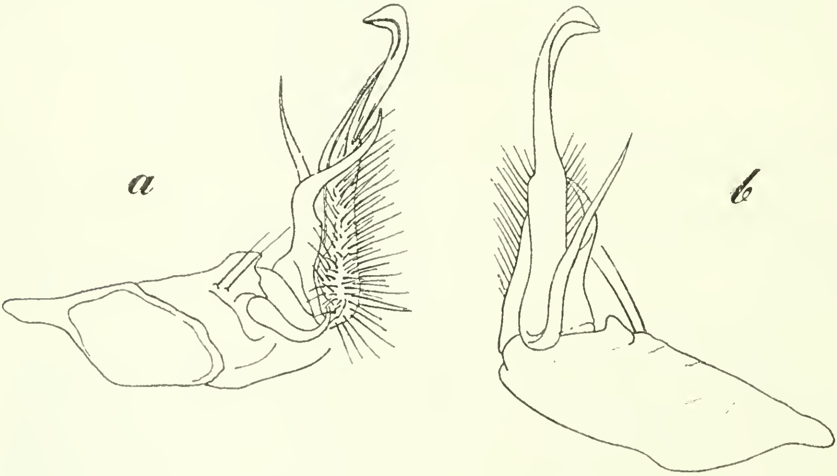

FIGURE 6.—Gonopods of *Pachydesmus clarus: a*, mesial, *b*, lateral aspect.

Paranota of first eight segments directed forward, their corners broadly rounded, those of segments 9–15 transverse, those of last segments becoming increasingly produced caudad. Paranota narrow, less than one-third diameter of body cavity, subhorizontal but tilted cephaloventrad. Tergites of both prozonites and metazonites finely coriaceous, paranotal surfaces slightly more so. Peritreme swollen and polished, not set off by a groove. Anterior edges of paranota strongly margined, the posterior edges acute, not margined, those near the caudal end of body slightly convex, meeting caudal edge of metazonite at a slightly re-entrant angle. Interzonal furrow very distinct across dorsum and finely striate longitudinally.

Paranota of 18th segment forming acute subtriangular lobes, those of 19th bluntly rounded and very slightly convergent. Telson short, granular, with evenly converging sides and a distinct setiferous knob near the base on each side. Anal valves moderately convex, with a small swelling near the base of each, the mesial margins with strongly compressed edges. Preanal scale large, about twice as wide

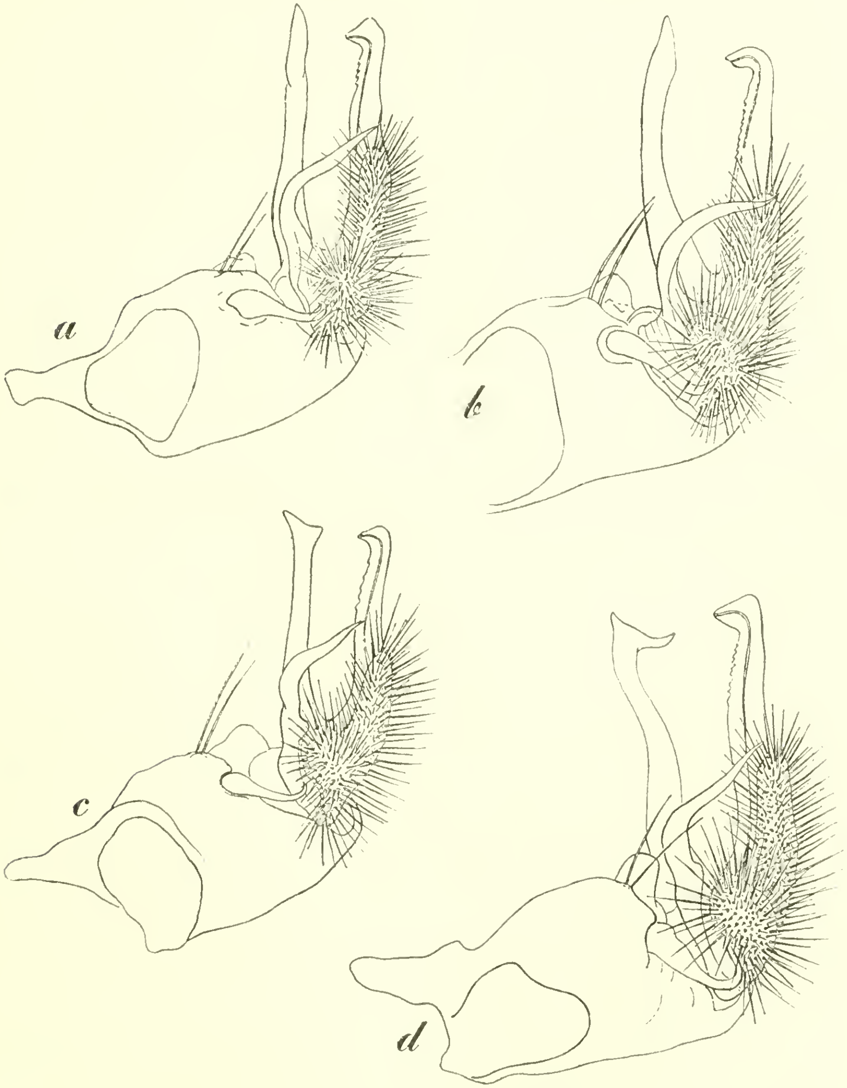

Figure 7.—Mesial aspect of male gonopods of *Pachydesmus: a, P. crassicutis crassicutis* from Port Hudson, La.; *b, P. c. duplex* from Grenada, Miss.; *c, P. c. incursus* from Easley, S. C.; *d, P. c. denticulatus* from Atlanta, Ga.

as long, the caudal edge evenly curved, the setiferous tubercules small and set back from the edge.

Sternites smooth and glabrous, sternal area of metazonites raised between legs into a platform higher than level of prozonites, segments 8–10 each with a distinct cruciform impression, segments 11–16 with a large transverse knob between the second legpair. Interzonal furrow broad and well defined on sides, curving in front of spiracles, and reduced to a narrow suture across sternal area. Spiracular opening large and reniform, its edges low and rounded. Pleural areas finely granular, those of midbody segments swollen and more tuberculate just above the legs. Caudal edge of metazonites margined down the sides. Prozonites smooth and polished ventrally.

Legs massive, the coxae without distal armature, prefemora with short but acute distal spines and a characteristic knob on the dorsal side. Femora robust, about twice as long as thick and little longer than the other leg joints. Tarsal claw long and slightly curved, with several very fine parallel ridges on the dorsal side. Legs, especially anterior pairs, covered on the ventral sides with very thick pubescence, the dorsal surfaces almost glabrous. Sternites of anterior segments without modification except for very low knobs between the 4th legpair.

Gonopod aperture broadly transverse, about twice as wide as long, with a raised margin in front of each coxite and caudally bounded by the elevated sternal area between the 7th legpair.

Coxae of gonopods heavy and subyclindrical, with short coxal apodemes. Coxal apophysis small and distally indented. Telopodite about same length as coxa, its prefemoral division 60 percent of length, and densely setose, prefemoral process rather long and slender, evenly curved instead of medially geniculate. Tibiotarsus slender and laminate, the leading edge finely fimbriate or serrate distally. Secondary tibiotarsus slender, nearly straight, a little longer than primary, its subterminal process normally smaller than the tip, and oblique to it, both distally divergent.

VARIATION: The few specimens that have been available for study afford practically nothing tangible in the way of variation. The total length ranges from 53 to 62 mm. in three intact specimens. In general the gonopods are remarkably alike in all three males, except for what is apparently individual variation affecting the end of the secondary tibiotarsus. As shown in figure 9, one of the prongs tends to be longer than the other, but the type specimen of *P. simulans* departs slightly in that the prongs are more approximate in size and length. Aside from this, the remainder of the gonopod and the rest of the animal is so similar to the other specimens of *crassicutis* that *simulans* can scarcely be maintained as a distinct entity. The specimen came from a locality directly between those from which the other two illustrated millipeds originated.

Synonymy: Of the early references to *crassicutis*, only those of Wood and Brolemann seem to apply to the typical subspecies. The latter author described and illustrated material from Louisiana, and his account was abridged by Attems (1938) for his treatment of the species.

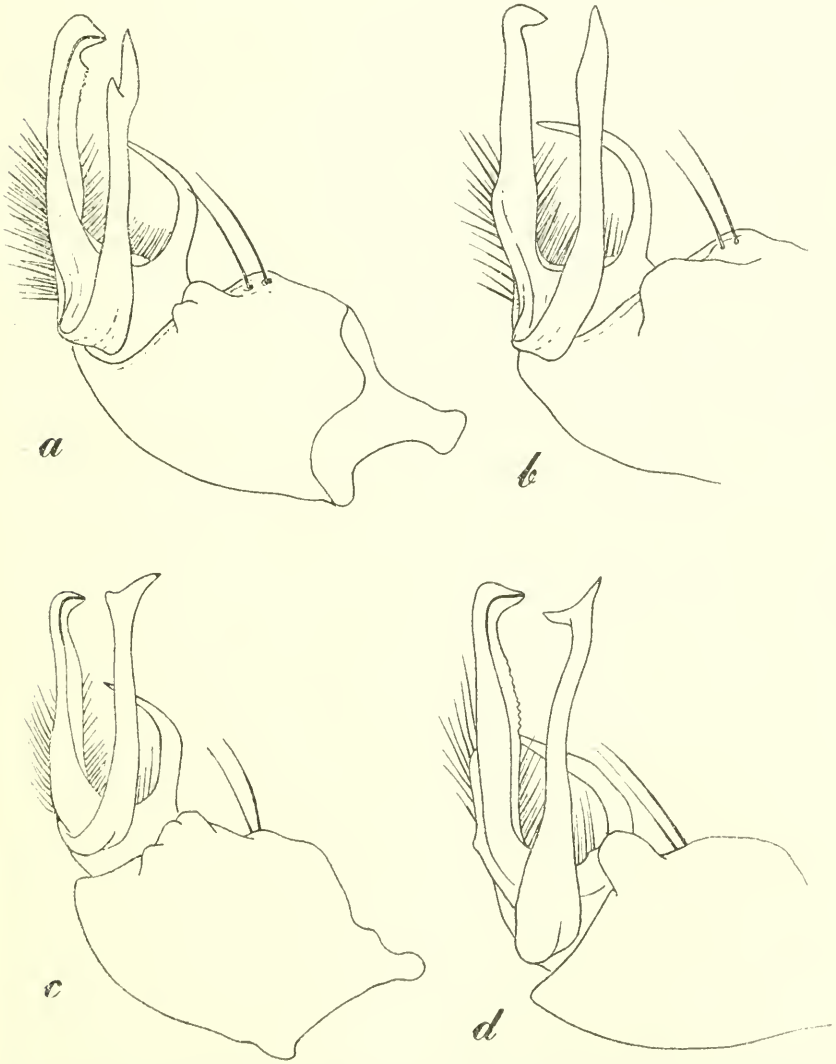

Figure 8.—Lateral aspects of male gonopods of *Pachydesmus*, the same specimens depicted in figure 7: *a*, *P. crassicutis crassicutis; b*, *P. c. duplex; c*, *P. c. incursus; d*, *P. c. denticulatus.*

Fontaria louisiana Chamberlin is included as a doubtful junior synonym partly on the basis of its type locality and partly because there is nothing in the original description to preclude such an association. The name was proposed without diagnosis, comparison to any other species, or illustration, and, to make matters worse, I have been unable on two occasions to locate the type at the Museum of Comparative Zoology. The description of the gonopods of *louisiana* is quoted in full:

> Characterized by the structure of the gonopods of the male. In these the posterior or principal limb of the telopodite is bifid, the branches long, slender, and subequal and cross those of the other gonopod; of the two branches of prongs the mesal one is geniculate near tip with the latter acute, while the ectal one is straight, its tip also acute. The proximal, undivided and less chitinous stalk is thick, densely hairy, and is prolonged along the mesal side of the mesal prong. The anterior or lesser spine is much shorter than the bifid branch, it is much narrowed distad, is moderately sigmoidally flexed, and crosses that of the other gonopod.

According to this verbal characterization, both tibiotarsal branches are distally simple. I find, however, that in *crassicutis* the subapical process of the secondary tibiotarsus is usually concealed when the gonopods are viewed in place. Until the holotype, or additional specimens from the type locality, can be examined and the status of *louisiana* settled conclusively, I feel that the evidence is entirely on the side of treating the name as a junior syonym of *P. c. crassicutis*.

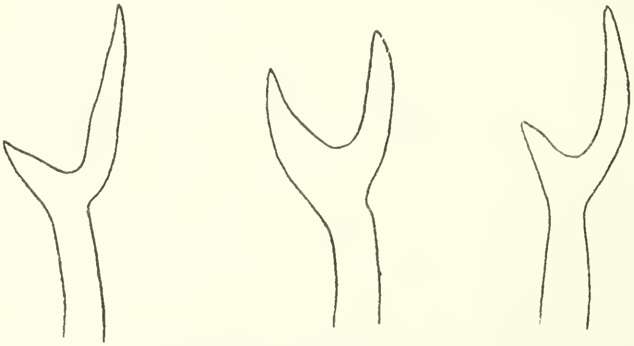

FIGURE 9.—Distal end of the secondary tibiotarsus of three specimens of *Pachydesmus crassicutis crassicutis* from Louisiana. Left to right: from Port Hudson, East Baton Rouge Parish; Gonzales, Ascension Parish; and New Orleans Parish.

Through the kindness of Dr. Chamberlin, I was priviledged to study the type specimen of *Pachydesmus simulans*. This name was based upon a male from the vicinity of Gonzales, Ascension Parish, La., a locality bracketed by the known localities for *crassicutis*. Chamberlin's (1942) original description stated that *simulans* is—

> A species apparently very close to *P. retrorsus*, known from Knox County, Tennessee. It seems distinct, however, in the details of the gonopods, although these are of the same type. The two branches are more slender, and relatively longer and closer together. The distal prongs of the outer branch form an acute angle with each other instead of a very obtuse one or a semicircle, and the bent portion at end of inner branch is shorter.

The differences stipulated above are quite valid ones to distinguish *simulans* from *retrorsus*, but no consideration was made, apparently, of the pachydesmid previously known from southern Louisiana. The three specimens I have seen from that area are all identical in gonopod structure except for a slight variation affecting the secondary tibiotarsus in the type specimen of *simulans* (figure 9). This difference, probably only an individual variation, is hardly of sufficient magnitude to warrant recognition of *simulans* as a valid name.

DISTRIBUTION: Insofar as presently known, *P. c. crassicutis* is restricted to the Gulf Coastal Plain in the vicinity of the Mississippi Delta country. There are no definite localities known for Mississippi, although the form certainly must occur there. Material has been seen from the following localities:

LOUISIANA. *East Baton Rouge Parish:* Port Hudson, 1 ♂, Dr. Leavitt (MCZ)· *Ascension Parish:* 4 miles north of Gonzales, 1 ♂, Aug. 31, 1940, Stanley and Dorothea Mulaik (RVC). *Orleans Parish:* New Orleans, 1 ♂, H. E. Hubert (MCZ).

MISSISSIPPI. "E. Miss." with no further data, 2 ♂♂ (USNM).

Pachydesmus crassicutis denticulatus **Chamberlin**

FIGURES 7,*d*, 8,*d*.

Fontaria crassicutis Bollman, 1888, p. 344.
Pachydesmus denticulatus Chamberlin, 1946, p. 152, figs. 8, 9.—Chamberlin and Hoffman, 1958, p. 43.

TYPE SPECIMENS: Male holotype, female allotype, and two male paratypes (RVC); from the vicinity of Atlanta, Ga., collected at intervals between 1939 to 1943 by the late Prof. Perry W. Fattig.

DIAGNOSIS: A medium-sized subspecies of the *crassicutis* phratry characterized primarily by the slender, sinuous secondary tibiotarsus, which terminates in two equal-sized processes, and by the simple, rather elongated coxal apophysis. The color in life is not known, but is probably brown with yellow paranotal maculae.

VARIATION: I have seen but a single specimen definitely referable to this form, the paratype kindly loaned for study by Dr. Chamberlin. The gonopods of this milliped appear to be identical in every respect with those figured in the original description. The length of 47 mm. cited for the holotype seems somewhat short in relation to the width of 12.5 mm., suggesting that perhaps the caudalmost segments are telescoped. The paratype examined measures 61 mm. in length and 13 mm. in width. The specimen recorded from Indian Springs, Ga., by Bollman (1888) measures 70 mm. in length and 15 mm. in width.

DISTRIBUTION: *P. c. denticulatus* is known only from the Piedmont region of north-central Georgia. Aside from the type locality, the only known station is Indian Springs, Bibb County, Ga., where a single male was collected by Prof. Lucien M. Underwood. Unfortunately the gonopods of this individual were removed and lost at some time in the past, making a conclusive determination impossible. However, considering the proximity of Indian Springs to Atlanta, and the similarity of size and structure in specimens from the two places. I think that my allocation will eventually be verified by collections made in the region concerned.

***Pachydesmus crassicutis duplex* Chamberlin**

FIGURES 1,*d*, 5,e,*f*, 7,*b*, 8,*b*,

Pachydesmus duplex Chamberlin, 1939, p. 5, fig. 8.—Chamberlin and Hoffman, 1958, p. 43.

TYPE SPECIMEN: Male holotype (RVC), from Grenada, Grenada County, Miss., collected in July 1910 by Dr. Chamberlin.

DIAGNOSIS: A medium-sized member of the *crassicutis* phratry, characterized by the long, slender, simple secondary tibiotarsus, which completely lacks any remnant of the subapical process and which equals or slightly exceeds the primary branch in length. The cyphopods are distinct from those of members of the *laticollis* phratry in that the receptacle is roughly triangular in mesial aspect, its distal end acuminate and considerably exceeding the ends of the valves. In life the color is dilute black, with clear yellow paranotal maculae.

VARIATION: Four adult specimens studied showed the normal range of variation in size. The largest is the male holotype, with a length of 72 mm. and a width of 15 mm. The other three specimens, a male and two females, measure 61 and 59 mm. in length, respectively. The male, from Memphis, Tenn., differs slightly from the holotype in that the secondary tibiotarsus is slightly sinuous instead of nearly straight, but this can at present be considered little more than within the normal range of variability.

DISTRIBUTION: *P. c. duplex* appears to be endemic to the upper half of the Cretaceous embayment region in northern Mississippi and western Tennessee. It seems probable that collecting in the future will reveal the presence of the subspecies in the western tip of Kentucky. Specimens have been examined as follows:

MISSISSIPPI. *Grenada County:* Grenada, 1 ♂ (holotype), July 1910, R. V. Chamberlin (RVC). *Marshall County:* Holly Springs, 1 ♀, Sept. 17, 1955, L. Hubricht (RLH).

Tennessee. *Shelby County:* Overton Park, Memphis, ♂ and ♀, Oct. 1, 1955, Hubricht (RLH).

Pachydesmus crassicutis incursus **Chamberlin**

Figures 7,*c*, 8,*c*

Pachydesmus incursus Chamberlin, 1939, p. 5, fig. 7.—Chamberlin and Hoffman, 1958, p. 43.

Pachydesmus retrorsus (not of Chamberlin 1921) Hoffman, *in* Wray, 1950, p. 44 (misidentification).

Type specimen: Male holotype (RVC) from Taylors, Greeneville County, S. C., collected Aug. 3, 1910, by Dr. Chamberlin.

Diagnosis: a moderate to large member of the *crassicutis* phratry characterized particularly by the shape of the secondary tibiotarsus of the gonopod, in which the subapical process is reduced to a rather small marginal spur, and the main termination somewhat exceeds the tip of the primary tibiotarsus. The leading edge of the latter is finely denticulate as in the three other members of the phratry, and the coxal apophysis is low and bilobed or trilobed. Paranotal markings apparently pinkish in life.

Variation: A range in body length of from 51 to 63 mm. has been noted, the width varying from 10 to 13.5 mm. The gonopods of the three males at hand exactly match each other and the original illustration given for this form, except that in one, possibly only aberrant, the subapical process of the secondary tibiotarsus is enlarged at the expense of the terminal tip, so that the effect is a complete reversal of the appearance here figured as typical for the race.

The original description states that the paranota of the living animal are yellow. The specimen from Easley, S. C. (not far from the type locality), is accompanied by a label indicating that in life the specimen was "grayish brown with pinkish carinae." It will certainly be of interest to learn the living colors of material of *incursus* obtained in the future.

Distribution: This form, the easternmost representative of the genus, seems to be an upcountry and foothill milliped, as the known collection stations are in or closely adjacent to the southeastern end of the Blue Ridge range. I have examined three male specimens from the following localities:

South Carolina. *Pickens County:* Easley, 1 ♂, November 1913, C. S. Marshall (USNM).

Georgia. *Habersham County:* Tallulah Falls, 1 ♂, August 1887, Lucien M. Underwood (USNM).

North Carolina. "Mtns. of N. C.," 1 ♂, without date, Roland Thaxter (USNM). This locality is probably either near Tryon, in Polk County, or in Macon County between Franklin and Clayton, Ga.

The *laticollis* phratry

Pachydesmus crassicutis laticollis (Attems)

FIGURES 5,*a*,*b*, 10,*d*, 11,*d*

Fontaria laticollis Attems, 1899, p. 258, pl. 13, fig. 312.
Pachydesmus laticollis Pocock, 1909, p. 189.—Attems, 1938, p. 154, fig. 176.—Chamberlin and Hoffman, 1958, p. 44.
Pachydesmus retrorsus Loomis, 1943, p. 403.

TYPE SPECIMEN: Male, in the Berlin Museum, labeled only "Illinois."

DIAGNOSIS: A medium-sized subspecies of the *laticollis* group, in which the tibiotarsus is only 30 percent of the telopodite length, with a small angulation on its leading edge; prefemoral process conspicuously thickened at the geniculation and nearly straight in its distal half; secondary tibiotarsus long, slender, and sinuous, with both its tip and subterminal process slightly recurved proximad. The distal margin of the receptacle of the cyphopod is straighter than in females of other known forms, and the valves longer in proportion to their height. Color in life medium to dark brown, with yellowish or testaceous paranota.

VARIATION: Despite the fairly large range occupied by this form, there is no perceptible variation in gonopod structure or in other details of body form. In the material studied the length varied from 62 to 70 mm., width from 12 to 14 mm. There is apparently some geographic variation in size, with a decrease from south to north. Specimens from the Tennessee River valley, in Marion County, Tenn., and Jackson County, Ala., range from 66 to 70 mm. in length; those from the Cumberland Plateau of central Tennessee from 62 to 65 mm. Attems' type specimen is stated to be only 55 mm. long and 10 mm. wide, considerably smaller than any I have examined.

REMARKS: Fortunately, although Attems' original drawing of the gonopod of *laticollis* is made from low magnification and a difficult aspect, the characters peculiar to the subspecies are clearly shown. It is to be regretted that nothing is known of the history of the type specimen, for it seems unusual that a scarce milliped from a relatively remote area such as central Tennessee would find its way to the Berlin Museum. The specimen, according to Attems, was originally labeled "*Fontaria virginiensis*," although by whom is unknown.

DISTRIBUTION: This subspecies is known to occur from Jackson County, Ala., north to Cumberland County, Tenn., chiefly through the Cumberland Mountain Range but also to the west of it in the Highland Rim area of central Tennessee. Presumably the great bend of the Tennessee River marks the southern limits of the range. Specimens have been examined from the following localities:

TENNESSEE: *Cumberland County:* Grassy Cove, 12 miles southeast of Crossville, 1 ♂, Sept. 15, 1957, P. C. Holt (RLH). *White County:* Sparta, 1 ♂, July 15, 1933, W. J. Gertsch (AMNH); 2 miles west of Bon Air, 1 ♂, May 9, 1951, L. Hubricht (RLH). *Warren County:* McMinnville, 1 ♀, May 9, 1951, L. Hubricht (RLH). *Marion County:* west fork of Pryor Cove, 2 miles northeast of Jasper, 2 ♂ ♂, June 27, 1957, L. Hubricht (RLH). *Coffee County:* 4 miles southeast of Manchester, 1 ♂, June 26, 1957, L. Hubricht (RLH).

Alabama. *Jackson County:* Russell Cave, 1 ♂, May–August 1957, Carl F. Miller (USNM); near Blowing Cave, 5 miles southeast of Limrock, 1 ♂, June 19, 1957, L. Hubricht (RLH).

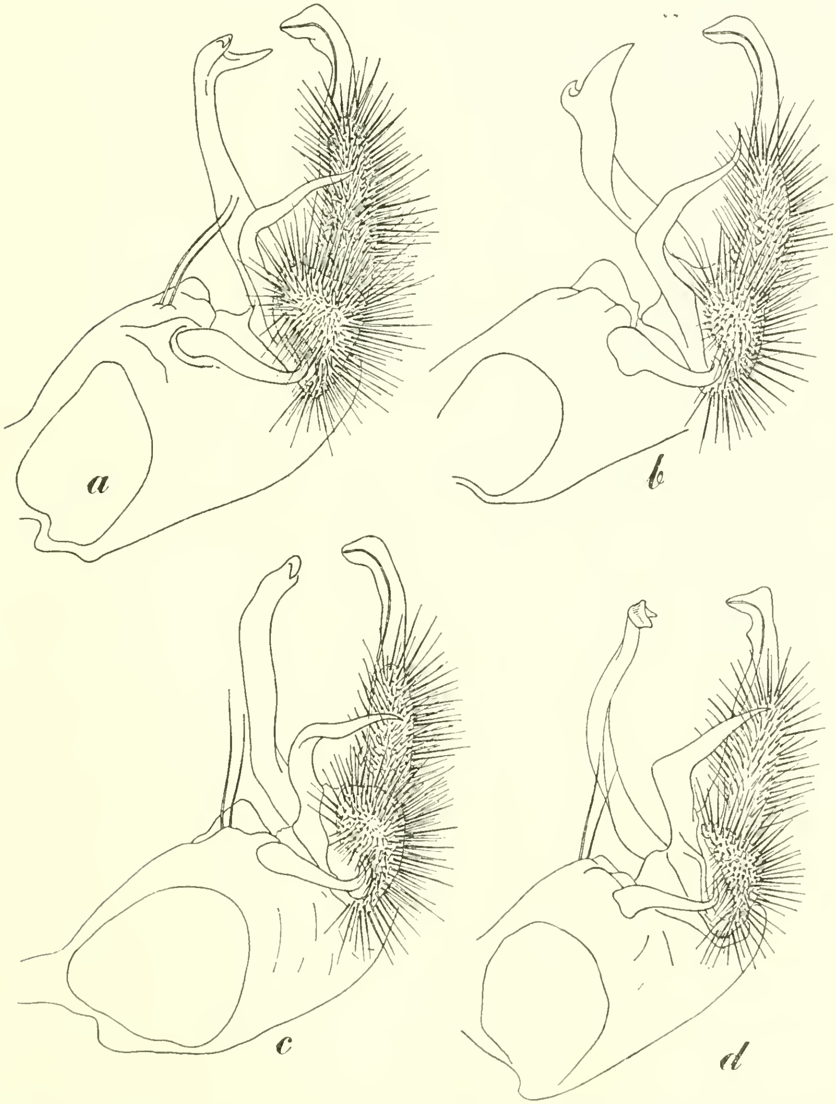

Figure 10.—Mesial aspects of the left male gonopods of *Pachydesmus: a, P. crassicutis hubrichti* from Tuscaloosa, Ala.; *b, P. c. retrorsus* from Knox County, Tenn.; *c, P. c. adsinicolus* from Mobile, Ala.; *d, P. c. laticollis* from Sparta, Tenn.

The Tennessee specimens agree closely with the subspecies as defined by the drawings. Those from Alabama, however, tend to approach *P. c. retrorsus* both in size and gonopod characters, and the specimen taken by Hubricht near Limrock is so thoroughly intermediate in characters that it might easily be considered closer to *retrorsus* than to *laticollis*. It seems probable that the specimens reported (Loomis, 1943) as *retrorsus* from Madison County, Ala., are actually referable to *laticollis* on the basis of their provenance, somewhat west of Jackson County.

***Pachydesmus crassicutis hubrichti*, new subspecies**

FIGURES 5,*c*,*d*, 10,*a*, 11,*a*

TYPE SPECIMENS: Male holotype (USNM 2272) from Tuscaloosa, Tuscaloosa County, Ala., collected Mar. 30, 1948, by George E. Ball; two female paratypes (USNM 2272) collected at Woodstock, Bibb County, Ala., May 4, 1953, by Leslie Hubricht.

DIAGNOSIS: A large form (more than 70 mm. long) characterized by the short, distally subdeltoid tibiotarsus of the male gonopod, as well as by the very large subterminal tooth of the secondary tibiotarsus.

DESCRIPTION OF HOLOTYPE: Length of body, 71 mm., width of midbody segment, 15.5 mm. Segments 4–16 of about equal width.

Front of head smooth and polished, evenly convex except for a distinct subtriangular flattened clypeal area. Genae large, extending well beyond lateral edge of head capsule, each with a prominent broad median impression. Vertigial groove distinct, becoming more so anteriorly, terminating in a small bipunctate depression centered between the antennae. Two paramedian frontal setae, two subantennal setae, and four supra-antennal setae present. Antennae widely separated at base by a distance slightly greater than length of 2d antennal article. Antennae long, extending back to middle of 3d tergite. The 2d, 3d, and 6th articles similar in size and shape, 4th and 5th slightly shorter. The 7th article hemispherical, with four sensory cones.

Collum large, 5.0 mm. long at middorsal line, almost 2 mm. wider on each side than following tergite, the lateral ends strongly narrowed and bent cephalomesiad, entirely concealing base of mandibles when head is depressed. Surface of collum polished, the disk with very fine scratches, becoming coriaceous toward the ends. Anterior edge straight, margined up as far as base of mandibles. Posterior edge straight across back, thence abruptly and sinuously swept forward.

Paranota of first eight segments swept forward, their corners broadly rounded, those of segments 8–15 transverse, those of last segments becoming increasingly produced caudad. Paranota narrow,

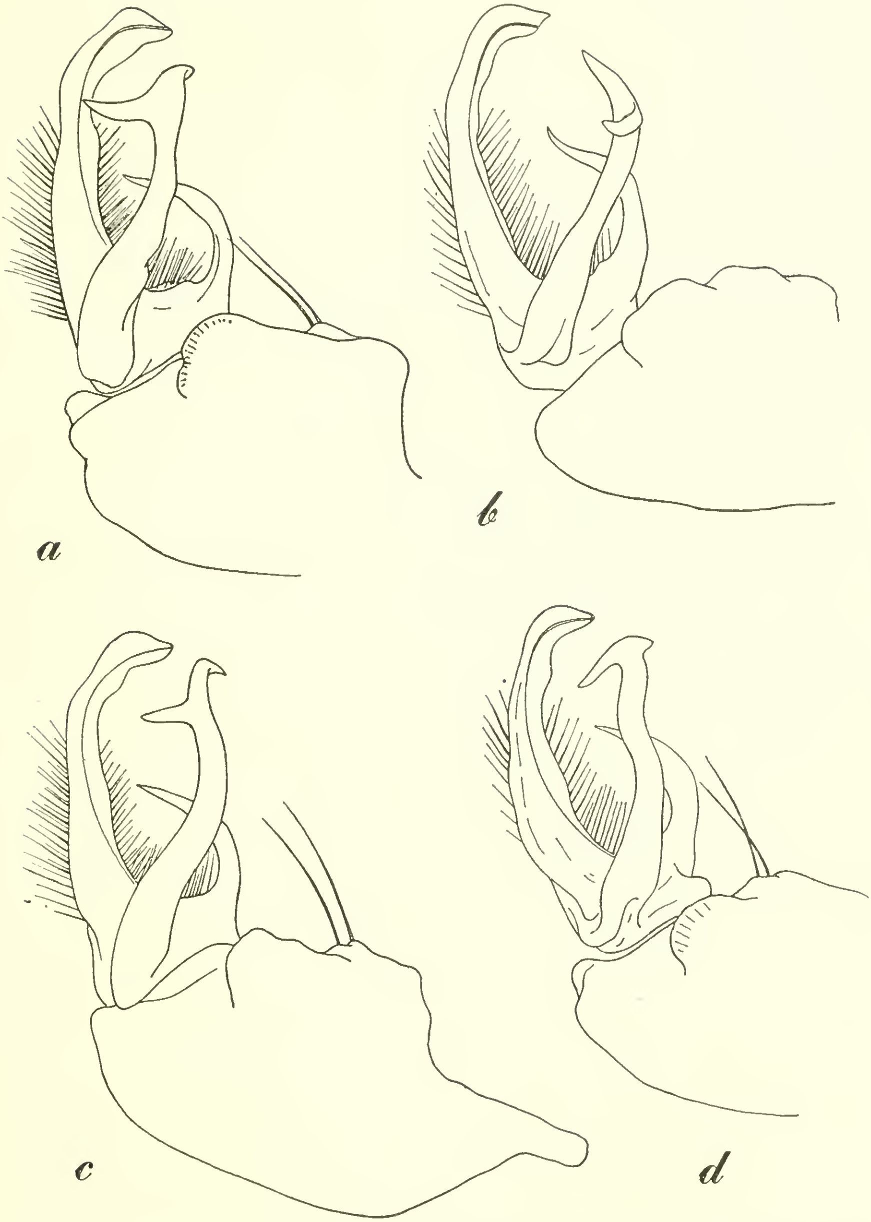

Figure 11.—Lateral aspects of left male gonopods of *Pachydesmus*, from the same specimens depicted in figure 10: *a*, *P. crassicutis hubrichti*; *b*, *P. c. retrorsus*; *c*, *P. c. adsinicolus*; *d*, *P. c. laticollis*.

less than one-third the diameter of body cavity, almost horizontal but tilted cephaloventrad. Tergites of both prozonites and metazonites finely coriaceous, becoming more so on the paranota. Peritremata swollen and polished, but not set off by a submarginal groove, their surfaces thus continuous with rest of paranota except in texture. Anterior edges of paranota set off by a deep marginal groove, the posterior edges acute, not margined, and on the caudalmost segments are convex, meeting the caudal edge of the metatergite at a slight re-entrant angle. Interzonal furrow very distinct across dorsum, and finely costulate.

Paranota of 18th segment forming acute subtriangular lobes, those of 19th more broadly rounded. Telson short, finely granular, its sides evenly converging, the median process distally truncate with the terminal setae set in a small median impression. No distinct setiferous knobs near the base of telson on each side. Anal valves moderately convex, vertically striate, with a small swelling near the base of each, the mesial margins with strongly compressed, obliquely striate edges. Preanal scale large, about half as long as broad, its caudal edge evenly curved without distinct median projection. Lateral setiferous tubercules very small and indistinct, well removed from edge. Anterior edge of preanal scale slightly overlapping onto caudal edge of the preceding segment.

Sternites smooth and completely glabrous, sternal areas of metazonites raised between legs into a platform, the podosternum, which is appreciably higher than level of prozonite, those of segments 8–10 each with a distinct cruciform impression and those of segments 11–16 with a large transverse knob between the caudal pair of legs. Interzonal furrow broad and sharply defined down sides, curving forward in front of spiracles, but reduced to a mere suture across the venter. Spiracular opening large and auriculate, with raised and flared edges. Pleural areas finely granular, those of midbody segments swollen and more tuberculate immediately above legs. Caudal edge of metazonite with a distinct raised rim down the sides. Prozonites smooth and polished.

Legs stout and massive but rather long, the coxae without traces of ventral armature, prefemora with short but acute distal spines and a characteristic knob on the dorsal side. Femora very robust, less than twice as long as thick and but little longer than any other leg joint. Tarsal claw long and slightly curved, with four to six distinct parallel ridges on its dorsal side. Legs covered on the ventral side with very thick short pubescence, dorsal sides, except of tarsal joints, almost glabrous. Sternites of anterior segments without knobs.

Gonopod aperture very broadly transverse, about 2½ times as wide as long, laterally with a short raised rim in front of each coxite, and caudally bordered by the greatly elevated sternal area of the 7th legpair.

Coxae of gonopods rather massive, somewhat longer than the telopodites, the coxal apophysis large but not elevated, its margin nearly smooth. Prefemur of telopodite large, 70 percent of the length, densely setose, prefemoral process slender and bisinuate, poorly sclerotized. Tibiotarsus short and stout, constricted at its midlength, distally expanded and subdeltoid. Secondary tibiotarsus shorter than primary, nearly straight, terminally directed mesiad and slightly hooked, the subterminal process large, perpendicular to the main axis, and directed laterad.

FEMALE: Similar to the male in external structure, aside from a slightly more arched dorsum. The pleural lobes of the 3d segment are very pronounced and conspicuous. Cyphopods large, the valves in lateral aspect being nearly as large as the mesial face of the receptacle. Latter strongly concave on its inner distal surface, and provided there with a small cluster of prominent rounded tubercules and rugosities. Inner valve slightly shorter than outer.

COLOR: The color in life is not known, but recently preserved specimens are light brown or tan, with the caudolateral halves of the paranota dilute yellow.

VARIATION: The three known specimens, a male and two females, measure 71, 72, and 73 mm. in length, respectively. The male appears to be slightly broader in proportion to its length, being 15.5 mm. wide in contrast to 14.3 and 14.5 mm. for the females. The latter are entirely similar in details of the cyphopods.

DISTRIBUTION: Known so far only from central Alabama, at the edge of the Piedmont. Specimens from slightly to the east, in Talladega County, Ala. (2.7 miles north of Sylacauga, 3 ♂♂, May 5, 1954, L. Hubricht; and 1 mile east of Renfro, ♂ and ♀, May 7, 1954, Hubricht), appear to be intermediate in gonopod structure between *hubrichti* and *retrorsus*, and are so indicated on the map. These five specimens are very massive; the largest male, 78 mm. long and 16 mm. wide, is the largest North American polydesmoid thus far recorded.

Pachydesmus crassicutis retrorsus Chamberlin

FIGURES 1,*c*, 10,*b*, 11,*b*

Pachydesmus retrorsus Chamberlin, 1921, p. 232, figs. 3, 4.—Chamberlin and Hoffman, 1958, p. 44.

TYPE SPECIMEN: Male (MCZ), from Knoxville, Knox County, Tenn., collected by C. N. Ainslie.

DIAGNOSIS: A very large subspecies of the *laticollis* phratry, characterized particularly by the rather long and slender primary tibiotarsus of the male gonopod, and the somewhat flattened and massive secondary tibiotarsus, its distal half twisted about 90 degrees to the basal half. The cyphopod resembles that of *P. c. hubrichti* but lacks the cluster of tubercules on the side of the receptacle.

VARIATION: The male specimen from Mentone, Ala., agrees closely with the holotype in gonopod structure as well as other details. The apex of the secondary tibiotarsus is directed distad, instead of slightly oblique, and the subterminal process is concealed in mesial aspect. These minor departures, however, are little more than individual variations. Farther south in Alabama, the gonopods become more definitely intermediate between those as figured for *retrorsus* and *hubrichti*. The male at hand is 74 mm. in length and 15 mm. in width; the female from Georgia is 69 mm. in length.

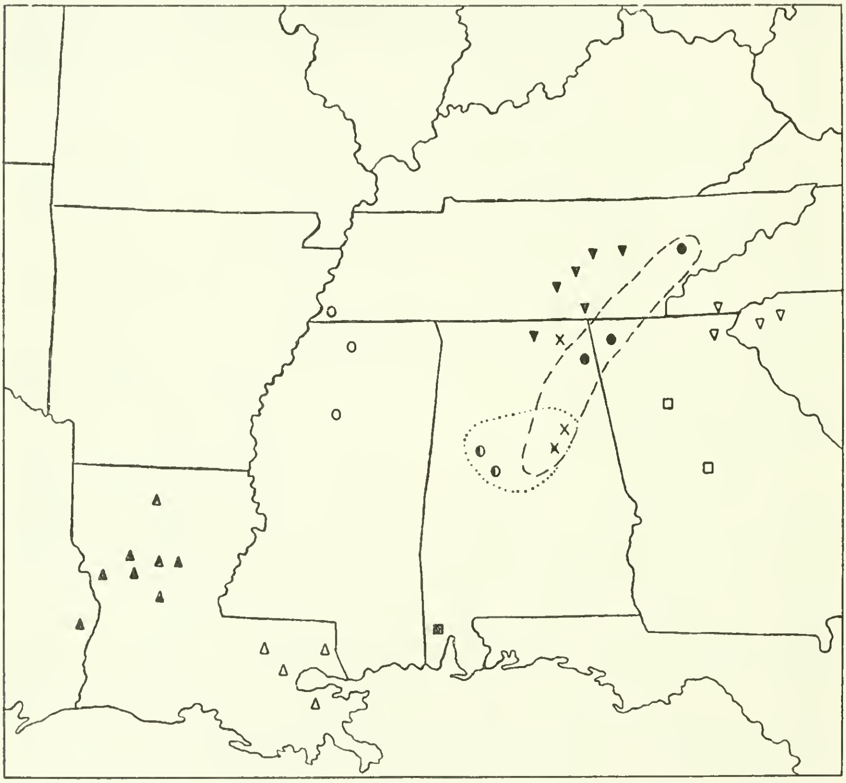

FIGURE 12.—Distribution of the known forms of *Pachydesmus*. Solid triangle, *P. clarus;* hollow triangle, *P. crassicutis crassicutis;* hollow dot, *P. c. duplex;* hollow square, *P. c. denticulatus;* inverted hollow triangle, *P. c. incursus;* solid square, *P. c. adsinicolus;* solid inverted triangle, *P. c. laticollis;* half-shaded dot, *P. c. hubrichti;* solid dot, *P. c. retrorsus;* symbol X, intermediate populations.

DISTRIBUTION: *P. c. retrorsus* seems to be endemic to the middle portion of the Tennessee Valley, ranging from the vicinity of Knoxville south into adjacent parts of Georgia and northern Alabama. Specimens from the following localities have been examined:

TENNESSEE. *Knox County:* Knoxville, 1 ♂, C. N. Ainslie (MCZ, holotype).

ALABAMA. *DeKalb County:* Mentone, 1 ♂, August 1952, Lindsey S. Olive (RLH).

GEORGIA. No precise locality, but inferentially from the extreme northwestern corner, 1 ♀, Apr. 1, 1950, B. D. Valentine (RLH).

Pachydesmus crassicutis adsinicolus, new subspecies

FIGURES 10,*c*, 11,*c*

TYPE SPECIMEN: Male holotype (USNM 2273) from Mobile, Mobile County, Ala., collected Mar. 29, 1948, by William R. M. Mason.

DIAGNOSIS: One of the smaller members of the *laticollis* phratry, judging from the dimension of the single known specimen. It is certainly closest to *retrorsus*, differing chiefly in the shape of the secondary tibiotarsus. In *adsinicolus* this structure is quite slender and nearly parallel to the primary branch, the two converging distally. In *retrorsus* the terminal elements of the secondary tibiotarsus are strongly unequal in size and both are directed distad, whereas in *adsinicolus* the terminal tip is bent mesiad and proximad. The holotype, which is 69 mm. in length and 14.5 mm. in width, agrees in nearly every particular with specimens of *retrorsus*.

DISTRIBUTION: Known only from the type locality. This form is of considerable interest in emphasizing the curious north-south distributional pattern of the *laticollis* phratry. The subspecific name is given in reference to the habitat of the form near Mobile Bay.

RELATIONSHIPS

GENERIC RELATIONSHIPS: The generic affinities of *Pachydesmus* are not as obvious as have been surmised by previous investigators. The superficial similarity of the gonopods to those of the species of *Harpaphe* misled both Attems and Verhoeff to combine the two genera, despite a marked structural dissimilarity in other respects. Actually, *Harpaphe* is a member of the *Rhysodesmus-Boraria* complex, it being difficult to separate females of *Harpaphe* from those of *Boraria carolina* except by locality. The gonopods in *Harpaphe* are distinctly diminutive, as is also the gonopod aperture, and I assume that the secondary tibiotarsal process of *Harpaphe* must be the result of independent convergent evolution.

Attems (1938, p. 151) stated that the genera *Takakuwaia* (=*Xystodesmus*), *Rhysodesmus*, and *Pachydesmus* are very closely related but he did not mention the basis for his opinion. I suspect his association must have been founded upon species really not congeneric with *Rhysodesmus limax* and *Pachydesmus crassicutis*, although lumped with them in his rather unwieldly classification.

In my own opinion, the existing genus most closely allied to *Pachydesmus* is *Epeloria* (Chamberlin, 1939), at least the species related to *E. ficta*, *E. dela*, and *E. leiacantha*. In this genus the podosterna of the males are produced into distinct transverse ridges, and the collum is definitely broader than the following tergite. The gonopods appear bifid near their ends, an effect readily achieved by the basal coalescence of the primary and secondary tibiotarsi. From a generalized ancestral stock, perhaps similar to *P. clarus*, it is quite feasible to derive two specialized groups, one represented by the large races of *P. crassicutis*, the other by *Epeloria talapoosa* and its relatives, which have remained small and developed a simplified gonopod but which are otherwise rather similar in body form and coloration to *P. crassicutis*. Their distribution around the southeastern periphery of the *crassicutis* group adds a certain amount of credence to the possibility of a common origin. For the present it is sufficient to indicate that if the telopodite of the gonopod of *Epeloria ficta*, for example, was bifid entirely to the base instead of only halfway, the result would be almost identical to the gonopod of *P. clarus*, and the similarity of body structure is so close that it need scarcely be changed to approximate that of a true *Pachydesmus*.

SPECIFIC RELATIONSHIPS: As already implied, *P. clarus* seems to represent clearly the ancestral stock from which *P. crassicutis* and its subspecies evolved. It presents none of the specializations peculiar to the larger species, such as more complex gonopods, increase in size, broadened collum, and podosternal ridges of the male. Specific evolution has perhaps been accelerated and almost certainly facilitated by the Mississippi flood plain, which so far as now known completely isolates *P. clarus* in the hill parishes of western Louisiana.

The eight recognized subspecies of *P. crassicutis* fall into two distinct ensembles which have been defined above. Of these two phratries, that including *crassicutis*, *duplex*, *denticulatus*, and *incursus* is the more primitive. The species are smaller, with less specialized genitalia, and occupy peripheral locations on the range of the genus.

During the Cretaceous embayment of the Coastal Plain province, animal life which had occupied that region must have been forced to withdraw to inland areas. Subsequent invasion of the emerged coastal plain would provide the opportunity for the ancestral pachydesmid stock to spread southeastward probably from Ozarkian and Appalachian refuges. The conservative elements remained west of the Mississippi in the form of *P. clarus*, the more aggressive produced first the progenitors of the present *crassicutis* phratry and then the group now recognized as *Epeloria*. Of the existing pachydesmids, *incursus* and *duplex* have gonopods most like those of *clarus*, and are in fact very similar to each other. They occupy respectively the northwestern and northeastern corners of the generic range, suggesting slightly modified remnants of their ancestral stock. Near the center of the range, a population reinvaded the southern end of the Appalachians along the old north-south course of the Tennessee River. This population evolved a greater size and more complex gonopod structure, and now, as the *laticollis* phratry, separates the eastern and western subspecies of the older *crassicutis* phratry.

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A REVISION OF THE EELS OF THE GENUS CONGER WITH DESCRIPTIONS OF FOUR NEW SPECIES

By Robert H. Kanazawa

This study redefines the genus *Conger* Oken and describes 14 species, with 2 subspecies. The leptocephalus larvae referred to this genus were excluded from this study.

The most important studies of the genus were by Kaup (1856*a*,*b*), who distinguished nine species. Günther (1870) recognized four species, but included in *vulgaris* forms from almost the whole world and since then many authors have followed his conclusions.

Subsequent authors have made studies on a regional basis: Jordan and Davis (1892) referred the three Atlantic species to *Leptocephalus* Gronovius, instead of *Conger;* Jordan and Evermann (1896) combined the conger eels of the Americas and Europe into two species under *Leptocephalus;* Jordan and Snyder (1901) recognized seven species in *Leptocephalus* from Japanese waters; Evermann and Kendall (1906) concluded that *C. orbignyanus* Castelnau from South America is distinct from North American species; Weber and de Beaufort (1916) distinguished but two species in *Conger* and included with *C. conger* forms from all over the world; Jordan and Hubbs (1925) placed two species from Japan in *Conger* and erected the new genus *Astroconger* for *myriaster;* Griffin's (1936) revision of New Zealand eels lists two species; Ginsburg (1951), following Jordan and Evermann (1896), synonymized *Ariosoma* Swainson and *Ophiosoma* Swainson with *Conger* and distinguished two species from the Western North Atlantic.

The specimens in the collections of the following institutions form the basis of this study: American Museum of Natural History (AMNH), Academy of Natural Sciences of Philadelphia (ANSP), Chicago Natural History Museum (CNHM), George Vanderbilt Foundation (GVF), Museum of Comparative Zoology, Harvard University (MCZ), Stanford Natural History Museum (SNHM), University of Michigan, Museum of Zoology (UMMZ), and U. S. National Museum (USNM).

I wish to acknowledge my thanks to the authorities of the above mentioned institutions for the loan of specimens and to the following individuals: Dr. L. P. Schultz and Dr. E. A. Lachner of the U. S. National Museum for their kind help and advice; Dr. J. Böhlke, Academy of Natural Sciences of Philadelphia; Dr. L. Bertin, Museum National d'Histoire Naturelle, Paris; Dr. N. B. Marshall, British Museum (Natural History), Dr. T. Kamohara, Kochi University, Japan; and W. C. Schroeder, Museum of Comparative Zoology, for meristic counts, measurements, and information on types deposited in their collections; Dr. and Mrs. J. L. B. Smith for specimens from South Africa; Dr. R. Zangerl, Chicago Natural History Museum; the X-ray laboratory staff of the Federal Bureau of Investigation, Washington, D. C., for radiographs used in vertebral counts; and the Smithsonian Institution's photographic laboratory for numerous photographs.

PROCEDURES: The total length and distance from tip of snout to anus were taken by extending the specimens on a table and sticking a pin into the table at the tip of snout, anus, and tip of caudal fin; the distances between the pins then were measured. All other measurements were made with a vernier caliper to the nearest one-tenth of a millimeter. The length of head was measured from tip of snout to upper edge of gill opening; distance from origin of dorsal fin to insertion of pectoral fin was measured between a line drawn from the insertion of the left pectoral fin to the insertion of the right fin and a vertical line was drawn from this line to the origin of dorsal fin. The longest pectoral fin was measured. All measurements are expressed in thousandths of total length except the distance from tip of pectoral fin to origin of dorsal fin, which is expressed in percent of pectoral fin length. Lateral line pores were counted in front of a perpendicular line through anus. The pectoral rays were counted after the skin was dissected from the bases of these rays, otherwise the small rays at the ventral edge of the fin base might have been overlooked. All of the compressed teeth in the outer row of one half of the upper jaw were counted. The first vertebra that has a complete haemal arch was counted as the first caudal vertebra.

Quantitative characters which are diagnostic on a subspecies level are presented graphically in figure 3, following the methods of Hubbs and Hubbs (1953, p. 51).

Diagnostic Characters

Origin of dorsal fin: The congers can roughly be separated into three groups on the basis of the position of the origin of dorsal fin: (1) species with origin of dorsal fin anterior to pectoral fin tip—*cinereus*, *erebennus*, and *myriaster;* (2) species with origin of dorsal fin posterior to tip of pectoral fin—*jordani*, *orbignyanus*, *wilsoni*, and *philippinus;* and (3) species with origin of dorsal fin above posterior tip of pectoral fin—all the remaining species. There is great variation within species and considerable overlap among some species in regard to this character; however, within limits of variation, it is of importance (table 1). Previously the origin of dorsal fin in relation to pectoral fin tip had been the main character for distinguishing species.

Pectoral fin rays: The range of variation for all species is from 14 to 21 rays, but for a single species only 4 to 5 rays (table 2).

Vertebrae: The range of variation of the number of vertebrae (table 3) is from 127 to 163, with *philippinus* and *esculentus* on the lower end of this range and *orbignyanus*, *conger*, *verreauxi*, and *triporiceps* on the upper end. Great care must be taken in order to recognize eels with regenerated tails for they have great powers of forming new ones; however, new vertebrae are not regenerated. The joining of the new caudal fin with the dorsal and anal fins is so well blended at times that it is difficult to distinguish some specimens with regenerated tails.

Sensory pores and organs: The sensory pores of the lateral line and cephalic pore systems provide characters which differ in several species. The terminology used in the description is shown in figure 1a–c and was adapted from Allis (1903). The external pores on the head open directly into a pouchlike tube (y) which connects it with the lateral sensory canal; however, some of these pouches lack this external opening. There are generally six infraorbital pores in the genus; however, two species, *cinereus* and *triporiceps* have an additional one to three more pores in the postorbital series which is the dorsal extension of the infraorbital series (i^7, i^8, i^9). All the species have the sixth infraorbital pore directly behind the rictus of jaw except *cinereus*, which has it above and behind the rictus (e). All the species have two ethmoidal pores at tip of snout. The second ethmoidal pore is fused with the first supraorbital pore to form a single exterior pore (e^2 S^1). Generally two supraorbital pores occur on the snout, (S^1, S^2); however, only four are present in *triporiceps* (S^1, S^2, S^3, S^5). There are 9 to 11 preoperculo-mandibular pores present: *cinereus* has 10 (11th missing), *triporiceps* has 11, *orbignyanus* has 9 or 10, and all others have 9 (pm^7, pm^{11} missing). There is generally one supratemporal pore (st) in the genus, but only *triporiceps* has three. The range of variation interspecifically for the lateral line pores on the body is from 35 to 47; the fewest numbers are found in *esculentus*, *oligoporus* and *macrocephalus* and the greatest numbers in *orbignyanus* and *conger* (table 2). In addition to these sensory pores, surface sensory organs (x), which are in series, also are developed.

In *myriaster* these sensory pores and organs are accentuated by a light area surrounding them. Usually this character is important to distinguish this species, but in some old specimens these light areas are not discernible, thus making identifications difficult. See remarks under the species *myriaster* for further discussion.

PREORBITAL BONE: The shape of the preorbital bone in *Conger* is significantly different than those of other genera in the family. It is a flat triangular bone, the longest side presented ventrally with a groove at the lower side. The dorsal apex is generally presented toward one side; but in *myriaster* it is more toward the middle than in other species (pl. 1,A). *Conger cinereus* (pl. 1,I) shows the greatest ossification, whereas *myriaster* shows the least. More ossification develops with increased age. In adult *triporiceps*, *wilsoni*, and *jordani* this ossification has bridged over the sensory groove, but in young *jordani* this ossification has not developed. In *erebennus* and *myriaster* this groove is not bridged over by bone even in the largest specimens. Tough connective tissues bridge over this groove in all species, but these tissues were removed to show the underlying ossification.

DENTITION: The number of rows of teeth, the number of compressed teeth, and the shape of the vomerine tooth-patch are of importance in distinguishing some species of *Conger*. One or two rows of teeth occur laterally on the jaws. The outer row is compressed to form a cutting edge. In those species with a single row of teeth, two or three teeth may be found where the inner row would be expected. The inner row in those species with two rows of teeth varies from a few teeth anteriorly in young specimens to almost a complete row in the larger specimens. The number of teeth in the jaws increases directly with age (table 4 and fig. 2). The greatest numbers are found in *triporiceps*. The vomerine tooth-patch is generally triangular in shape; however, in small *triporiceps* this patch is a single irregular row and becomes triangular in shape in larger specimens.

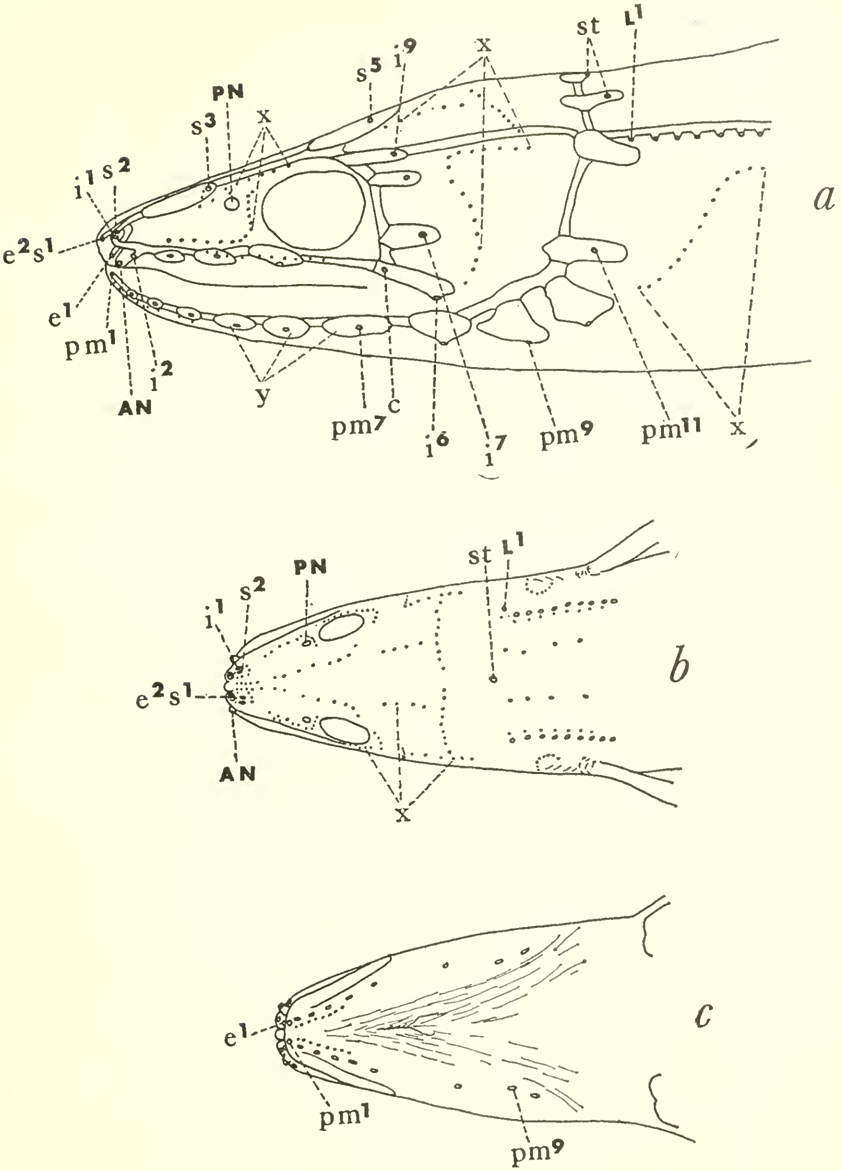

Figure 1.—Views of head of the genus *Conger* (*a*, lateral; *b*, dorsal; and *c*, ventral) showing position of surface sensory organs, pores, and sensory pouches. Symbols: AN, anterior nostril; c, position of sixth infraorbital pore for subspecies *Conger cinereus cinereus* and *C. c. marginatus;* e^1, first ethmoidal pore; e^2s^1, compound pore, second ethmoidal pore, and first supraorbital pore; i^1, first infraorbital pore; L^1, first lateral line pore; pm^1, first preoperculo-mandibular pore; PN, posterior nostril; st, supratemporal pores; x, surface sensory organs; y, sensory pouches. (All after Allis, 1903.)

Proportional measurements: Body proportions have been overemphasized by various authors; however, within limits of variation, they are still important characters in identification. Certain body proportions—such as head length, snout length, body length, and distance from tip of snout to origin of dorsal—increase directly with growth; also, some eels lose a portion of their tail, which regenerates a new caudal fin (but no new vertebrae) to form a new tail. Thus, great errors result when ratios are determined from such measurements. In the past, some new species have been described on the basis of these erroneous measurements.

Genus *Conger* Oken

Les Congres Cuvier, 1817, p. 231, vernacular.

Conger Oken, 1817, pp. 1781, 1782 (misprints for pp. 1181, 1182) (Cuvier's French name Latinized); Bosc, 1817, p. 450; Cuvier, 1834 (English translation), p. 221 (type species, *Muraena conger* Linnaeus by absolute tautonomy).

Congrus Richardson, 1844–1848, p. 107 (a variant spelling of *Conger*).

Isognatha Gill, 1861, p. 56 (type species, *Anguilla oceanica* Storer).

Microconger Fowler, 1912, p. 9, fig. 1 (type species, *Leptocephalus caudalis* Fowler).

Astroconger Jordan and Hubbs, 1925, p. 194 (type species, *Conger myriaster* Brevoort).

Forskalichthys Whitley, 1935, p. 219 (type species, *Conger cinereus* Rüppell).

In Opinion 44 of the International Rules of Zoological Nomenclature, the Commission recognized *Leptocephalus* Gronovius 1763 as the genus for conger eels; however, in Opinion 93 this action was reversed under the plenary power of the Commission for suspension of the rules and the Commission recognized the genus *Conger* Cuvier 1817 and designated the name *Leptocephalus* to the larval form. Direction 87 of the International Commission on Zoological Nomenclature, February 1958, deleted from the official list of generic names in zoology the entry relating to the name *Conger* Cuvier 1817, made by the ruling given in Opinion 93, and in its place inserted *Conger* Oken 1817 (gender: masculine), with the type species *Muraena conger* Linnaeus 1758, by absolute tautonomy.

Diagnosis: Scaleless, with confluent vertical fins, well developed pectorals, vertical gill cleft wide, upper edge of gill opening near middle of pectoral base; mouth large, maxillary extending at least to middle of eye; one or two rows of teeth in jaws laterally, outer row of teeth compressed, forming a cutting edge; a flat triangular preorbital bone (pl. 1); fingerlike processes in nasal bone; anterior nostrils tubular, posterior nostrils above middle of eye, otic bulla absent, ethmoidal process cartilaginous.

Description: Body formed as in *Anguilla*, elongate, posteriorly compressed, head depressed; mouth large, maxillary extending at least to below a perpendicular line from middle of eye; origin of dorsal fin above pectoral base to one pectoral length behind posterior tip of

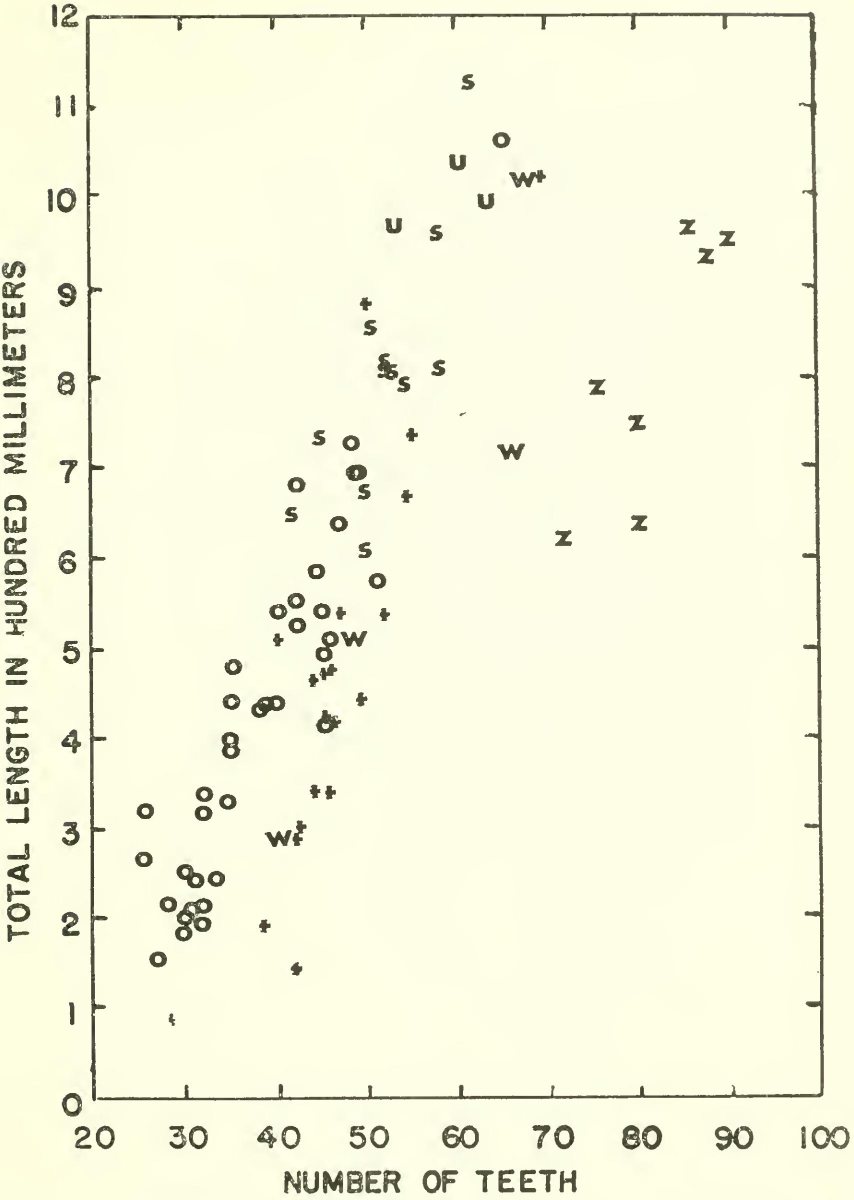

FIGURE 2.—Number of compressed teeth in one side of upper jaw for the various species of *Conger* found in the Atlantic Ocean. Symbols: o, *oceanicus;* +, *conger;* s, *orbignyanus;* u, *esculentus;* z, *triporiceps;* and w, *wilsoni.*

pectoral fin; lateral line pores present, extending along side of body, pores in lateral line anterior to a perpendicular line through anus number from 30 to 50; anterior nostrils tubular at tip of snout; posterior nostrils not tubular adjacent to eye and above level of middle of eye; gill opening large, the upper edge of gill opening near middle of pectoral fin base; sensory pores on head present, 6 to 9 infraorbital pores, 9 to 11 preoperculo-mandibular pores, 1 or 3 supratemporal pores, 2 ethmoidal pores, 2 to 4 supraorbital pores; teeth in jaws in one or two series, outer row of teeth compressed, incisorlike and in contact basally, forming a cutting edge, inner row and other teeth conical, no canines present; anus situated in anterior half of total length; nasal bone thin and translucent with numerous fingerlike structures anteriorly, preorbital bone flat, triangular, overlapping outer surface of the maxillary bone; otic bulla absent; ethmoidal process cartilaginous.

Body uniform brownish or dusky, lighter ventrally, a single species may have wide barring; distal edge of vertical fins black in adult, light in young; black on edge of vertical fins progresses anteriorly with growth; pectorals black or whitish; in young specimens a row of pigment spots are located above base of anal fin and continue across abdomen; as growth progresses these spots diminish in numbers and finally disappear.

RELATIONSHIP WITH OTHER GENERA: The genus *Conger* has no close relationship to the other genera of the family. *Ariosoma, Bathycongrus, Gnathophis, Uroconger, Chiloconger,* and *Coloconger* have the otic bulla, whereas *Conger* does not. Regan (1912, p. 379), in his classification of the order Apodes, used this character as a major division on a family level. *Conger* differs further in being more elongate than the forms of the *Ariosoma* group.

Since *Conger caudilimbatus* Poey has an otic bulla, ethmoidal process ossified, upper edge of gill opening in line with upper edge of pectoral fin base, preorbital bone not triangular, and body shape stubbier than other species of *Conger,* I refer it near the genus *Chiloconger.*

In *Conger myriaster* the sensory pores and organs are accentuated by a white area surrounding them. Jordan and Hubbs (1925, p. 194) used this character as the basis for a new genus *Astroconger* but this character should be used only at a specific level.

SPECIES RELATIONSHIPS: Interspecifically the species *Conger cinereus* shows the greatest degree of differentiation in the barring on body, greater number of infraorbital pores, the higher position of the sixth infraorbital pore, the greatest ossification of the preorbital bone, and the greatest development of the black spot on the pectoral fins. Next, *C. triporiceps* differs most from all other species by having three supratemporal pores instead of the usual one, seven or eight infraorbital pores instead of five, four supraorbital pores instead of the usual two, the greatest number of compressed teeth in jaws, and the young having a single irregular row of vomerine teeth instead of the usual triangular patch of teeth. *C. myriaster* follows by having numerous whitish spots around the surface sensory pits and pores on head and body, the shape of the preorbital bone different, and the preorbital bone with the least amount of ossification among the species of *Conger*.

Doubtful species: The proportions and counts made on the holotype of *Congrus* [*Conger*] *leucophaeus* Richardson (1844–1848, p. 108) that Dr. N. B. Marshall of the British Museum kindly sent to me are similar to those of *Conger oceanicus* and *C. myriaster*, which are found, respectively, along the Atlantic coast of the United States and the coast of Japan. The original description of *leucophaeus* lacks the type locality but Richardson (1844–1848, p. vi) lists the locality as Bahamas. The data that Dr. Marshall sent do not agree with the proportions and counts made on *triporiceps*, the only species so far recorded from the Bahamas. *C. leucophaeus* has only one supratemporal pore whereas *C. triporiceps* has three; at 476 mm. in total length *leucophaeus* lacks a single irregular row of vomerine teeth whereas *triporiceps* has one row at that size. Therefore, without further examination of the holotype, I am unable to place the species *leucophaeus*.

The counts and measurements of the holotype of *leucophaeus* sent by Dr. Marshall are as follows: total length 476 mm., head length 73, snout to origin of dorsal fin 92, snout length 17, diameter of eye 11, pectoral fin length 25, teeth in jaws in two rows, vomerine teeth not in single row, origin of pectoral fin to origin of dorsal fin 21, pores in lateral line 41, supratemporal pore 1, and pectoral rays 18.

Geographical distribution: The genus *Conger* is found in tropical and subtropical marine waters throughout the world except in the eastern Pacific along the American coast. The distribution of any species of *Conger* is not as wide as was believed by some authors. Only one species, *C. cinereus*, has a wide distribution, but it has differentiated into two subspecies, *C. cinereus cinereus* from Africa eastward to the Christmas Islands in the Central Pacific and *C. cinereus marginatus* in the Hawaiian Islands (fig. 4). All of the other species have a more restricted distribution. In this paper a geographical range—as far as known or as indicated by material examined—is given under each species.

There is no actual record of capture of any species of the genus *Conger* from the Atlantic coast of Central America. Meek and Hildebrand (1923, p. 138) state that it doubtlessly occurs on the Atlantic coast of Panama; however they had no specimen from that area.

Figure 3.—Map showing distribution of the various species of *Conger* found in the Atlantic Ocean.

On the American coast of the Pacific Ocean, two doubtful records occur. The first such doubtful record, by Jordan and Gilbert (1882, p. 378), is of a specimen (USNM 30930) 6½ inches in length recorded as *Leptocephalus conger* from Cape San Lucas, Lower California, collected by L. Gelding. Jordan and Davis (1892, p. 665) reidentified this specimen as *Ophiosoma balericum*, and Ogilby (1898, p. 288) made it one of the types of the new species *Congrellus gilberti.* The second doubtful record of a species of *Conger* occurring on the American coast of the Pacific Ocean was made by Fowler (1912, p. 9). He described a new species, *Leptocephalus caudalis* (ANSP 1055), from off Lower California, collected by Dr. W. H. Jones with no date. He placed it in a new subgenus, *Microconger.* I examined the holotype and found it to be *Conger cinereus.* I cast doubt on the validity of the above

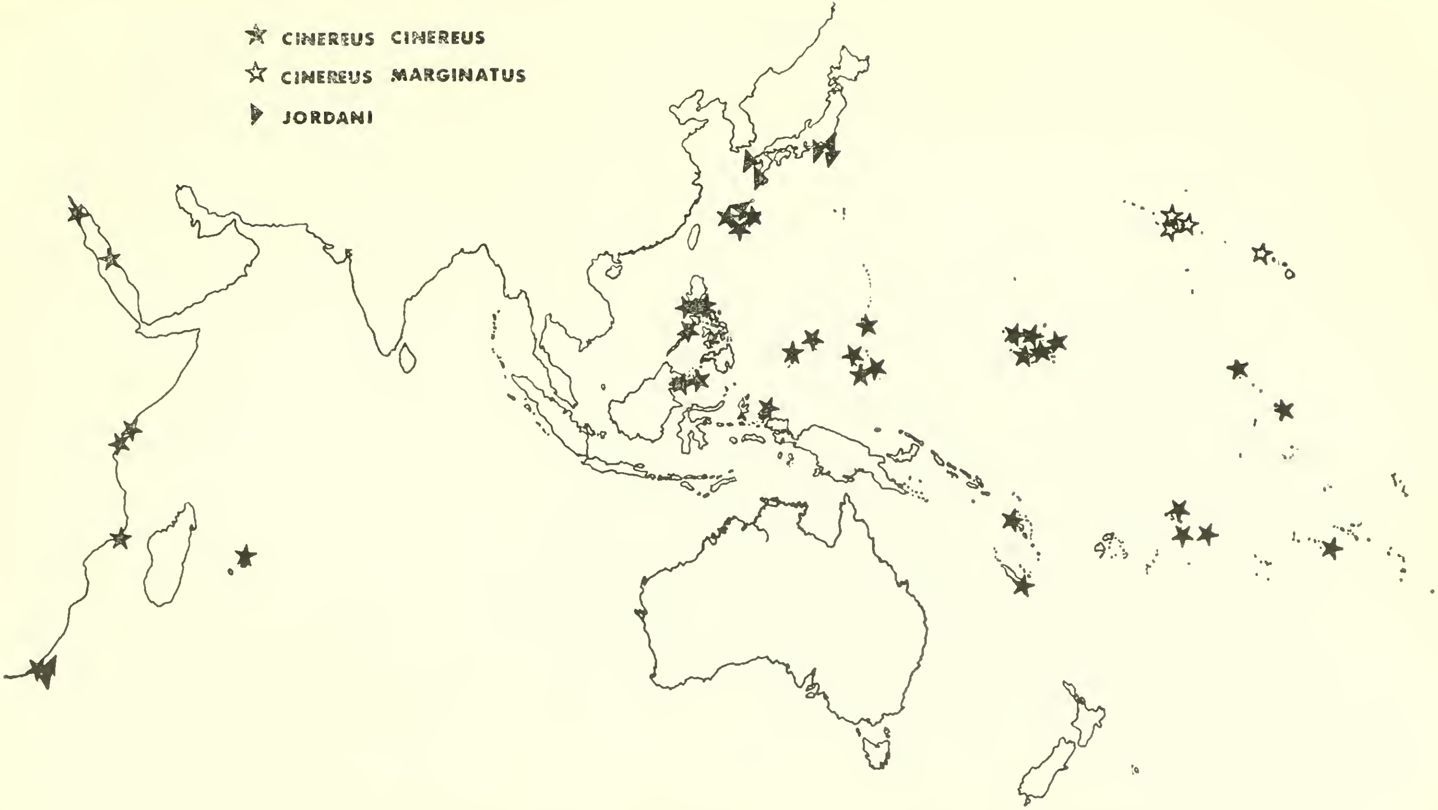

FIGURE 4.—Map showing distribution of one species and two subspecies of *Conger* in the Indian and Pacific Oceans.

type locality because in the same collection there were two other specimens of *Conger cinereus* (ANSP 15326 and 15327) about the same length as the holotype of *Leptocephalus caudalis*, also collected by W. H. Jones and with no date, but collected at Christmas Island. These two specimens were listed by Fowler (1912, p. 9) as *Leptocephalus marginatus*. In the catalog entry, locality was given as "Christiana Isla, west coast of Mexico." I find no Christiana Island on the west coast of Mexico. The holotype of *Leptocephalus caudalis* may have come from the same lot as the other two specimens. Unless newly collected specimens from the eastern Pacific along the American coast corroborate the presence of *Conger* there, one must conclude that the genus is absent in the area.

Key to species and subspecies of the genus *Conger*

1a. Sixth suborbital pore above level of rictus of jaw ("c" of fig. 1, A); a black diagonal streak below eye generally present; one to three pores behind eye in a vertical row; sometimes wide vertical light brown bars present on body (pl. 2,B) . . . . **C. cinereus** Rüppell

2a. Pectoral rays modally 17 (range 15 to 19, mean 17.03); pores in lateral line modally 39 (range 36 to 41, mean 38.39); pectoral rays plus lateral line pores (range 54 to 58, mean 55.94); vertebrae 139 to 146; distance between the upper postorbital pore to edge of eye is generally greater than distance between the lower pore to edge of eye; black spot on pectoral when present generally distinct. Indo-Pacific, Africa, Red Sea.
C. cinereus cinereus Rüppel (p. 234)

2b. Pectoral rays modally 19 (range 17 to 21, mean 18.52); pores in lateral line modally 40 (range 39 to 42, mean 40.23; pectoral rays plus pores in lateral line (range 56 to 61, mean 58.75); vertebrae 148 to 152; distance between the upper postorbital pore to edge of eye is generally equal in distance between the lower pore to edge of eye; black spot on pectoral when present is generally more diffused. Hawaii.
C. cinereus marginatus Valenciennes (p. 232)

1b. Sixth suborbital pore in line with rictus of jaw; black streak below eye absent; no pores behind eye in a vertical row (except *triporiceps* which has 1 or 2 postorbital pores); wide barring on body never present.

3a. Three supratemporal pores present; 1 or 2 postorbital pores present; 4 supraorbital pores present; premaxillary tooth-patch squarish; vomerine teeth in a single irregular row in small to medium sized specimens and in large ones a triangular patch. Bermuda, Bahamas, Cuba, Brazil.
C. triporiceps, new name (p. 243)

3b. One supratemporal pore present; postorbital pore absent; 2 supraorbital pores present; maxillary tooth-patch wider than long; vomerine tooth-patch triangular in shape at all sizes.

4a. A whitish area surrounds sensory pores and organs, forming a series below dorsal fin, on lateral line, and on head (pl. 3,A). Japan, China, Korea . . . . **C. myriaster** [1] (Brevoort) (p. 244)

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[1] In some preserved specimens these light spots are not discernible. For distinguishing these specimens see remarks under *Conger myriaster*.

4b. Whitish spots as above not present.
  5a. Pores in lateral line more than 43 (except *oceanicus*, which has 39 to 44).
    6a. Diameter of eye less than 1.75 percent of total length (2 to 3 into snout), pectoral fin rays 15 to 17, origin of dorsal fin one-fifth of pectoral fin or more behind posterior tip of pectoral fin. Atlantic South America . . . . . **C. orbignyanus** Valenciennes (p. 247)
    6b. Diameter of eye more than 1.75 percent of total length (1.36 to 2.11 into snout), pectoral rays 17 to 20, origin of pectoral fin two-fifths of pectoral fin length behind posterior tip of pectoral fin tip anteriorly. European waters . . **C. conger** (Linnaeus) (p. 248)
  5b. Pores in lateral line fewer than 44.
    7a. Teeth in maxillary generally in one row, sometimes 3 or 4 in inner row; in small specimens mandibular teeth in one row, some may have 3 to 6 teeth in inner row.
      8a. Length of head 125 to 148; diameter of eye less than 2.50 percent of total length (or eye into snout 1.46 to 1.99 times); pores in lateral line modally 38, range 36 to 40; vertebrae 141 to 144. Japan, Africa . . . . **C. jordani,** new species (p. 250)
      8b. Length of head 141 to 157; diameter of eye more than 2.25 percent of total length (or eye into snout 1.21 to 1.42 times); pores in lateral line modally 36, range 35 to 36; vertebrae 137 to 139. Hawaii . . . . **C. oligoporus,** new species (p. 251)
    7b. Teeth in maxillary generally in two rows; in small specimens maxillary may have 1 row but the mandibular teeth in 2 rows.
      9a. Pores in lateral line fewer than 37.
        10a. Pectoral rays 18 to 19; compressed teeth in upper jaw fewer in number, see table 4. West Indies
        C. esculentus Poey (p. 253)
        10b. Pectoral rays 17; compressed teeth in lower jaw more numerous, see table 4. Philippines and East Indies.
        C. macrocephalus, new species (p. 254)
      9b. Pores in lateral line 37 or more.
        11a. Pectoral rays 19 to 21; origin of dorsal fin anterior to a vertical line through pectoral fin tip. Japan.
        C. crebennus (Jordan and Snyder) (p. 254)
        11b. Pectoral rays less than 19.
          12a. Vertebrae less than 136, Philippines and East Indies.
          C. philippinus, new species (p. 255)
          12b. Vertebrae more than 139.
            13a. Vertebrae more than 150, diameter of eye less than 1.50 percent of total length. New Zealand, South Australia.
            C. verreauxi Kaup (p. 257)
            13b. Vertebrae less than 147, diameter of eye more than 1.50 percent of total length.
              14a. Origin of dorsal fin less than 50 percent of pectoral fin length behind pectoral fin tip; compressed teeth in upper jaw fewer in number (fig. 2). Western Atlantic on the United States coast.
              C. oceanicus (Mitchell) (p. 258)
              14b. Origin of dorsal fin more than 20 percent of pectoral fin length behind pectoral fin tip; compressed teeth in upper jaw more numerous (fig. 2). South Australia.
              C. wilsoni (Block and Schneider) (p. 256)

Conger cinereus marginatus Valenciennes

FIGURES 4–6

Conger marginatus Valenciennes, 1841, p. 201, pl. 9, fig. 1 (type locality, Hawaii).—Kaup, 1856b, p. 114.

Leptocephalus marginatus Jordan and Evermann, 1905, p. 76.—Fowler, 1912, p. 9 (Hawaii).

Conger cinereus Fowler, 1928, p. 37 (in part).

SPECIMENS STUDIED: 74 specimens, from the various islands of the Hawaiian chain, 115 mm. to 1004 mm. in total length.

DIAGNOSIS: Sixth infraorbital pore above rictus of jaw; 7 to 9 infraorbital pores; preoperculo-mandibular pores 10; supraorbital pores 2; preorbital bone shows the greatest amount of ossification; pectoral rays 17 to 20; pores in lateral line 39 to 42; black spot on pectoral fully developed at total length about 215 mm., and black spot diffused; vertebrae 148 to 152.

DESCRIPTION: Distance from tip of snout to origin of dorsal fin 132 to 160, length of upper jaw (to rictus) 42 to 56, length of pectoral 29 to 49; supratemporal pore 1; infraorbital pores 7 to 9; preoperculo-mandibular pores 10; supraorbital pores 2; compressed teeth in upper jaw 30 to 62; in lower jaw 30 to 60; vertebrae 148–152; two rows of teeth in jaws; premaxillary tooth-patch wider than long. Additional counts and proportional measurements are recorded in tables 1–3, 5, 6 and in figure 5.

The black pectoral spot begins to appear at a total length of about 115 mm. and is fully developed at about 215 mm. (fig. 6); the black on distal edge of anal and dorsal fins is fully developed at about 140 mm.

GEOGRAPHICAL RANGE: Hawaiian Islands.

REMARKS: The number of vertebrae may prove to be a good character to separate *Conger cinereus cinereus* and *C. c. cinereus* as full species; however, more counts from the various localities are needed. The two forms will be left as subspecies for the present. Vertebrae counts taken of the two forms, by localities, are as follows: Marshall Islands, Rongerik Island 139; Samoa, Tau Island 144; New Hebrides 139, 140; Guam 141; Okinawa 141, 145; Red Sea 141; South Africa 146, 146; Hawaiian Islands, Oahu, Honolulu 148, 148, 150, 151, and Waimea Bay 148, 151, 152, and Hawaii 149, 151.

In *Conger cinereus marginatus* the distance from the upper postorbital pore (ninth infraorbital pore) to edge of eye is usually equal to the distance from the lower postorbital pore (seventh infraorbital pore) to eye, whereas in *C. c. cinereus* the former distance is usually greater than that of the latter distance.

In *C. c. marginatus* the black spot is fully developed when the eels are about 215 mm. long, whereas in *C. c. cinereus* it is not fully developed until the eels are about 280 to 480 mm. long. There is population divergence in this development in *C. c. cinereus* from the various geographical localities (fig. 6). Specimens from the Marshall Islands show the full development at a length of about 480 mm., whereas those from Okinawa show full development at about 280 mm.

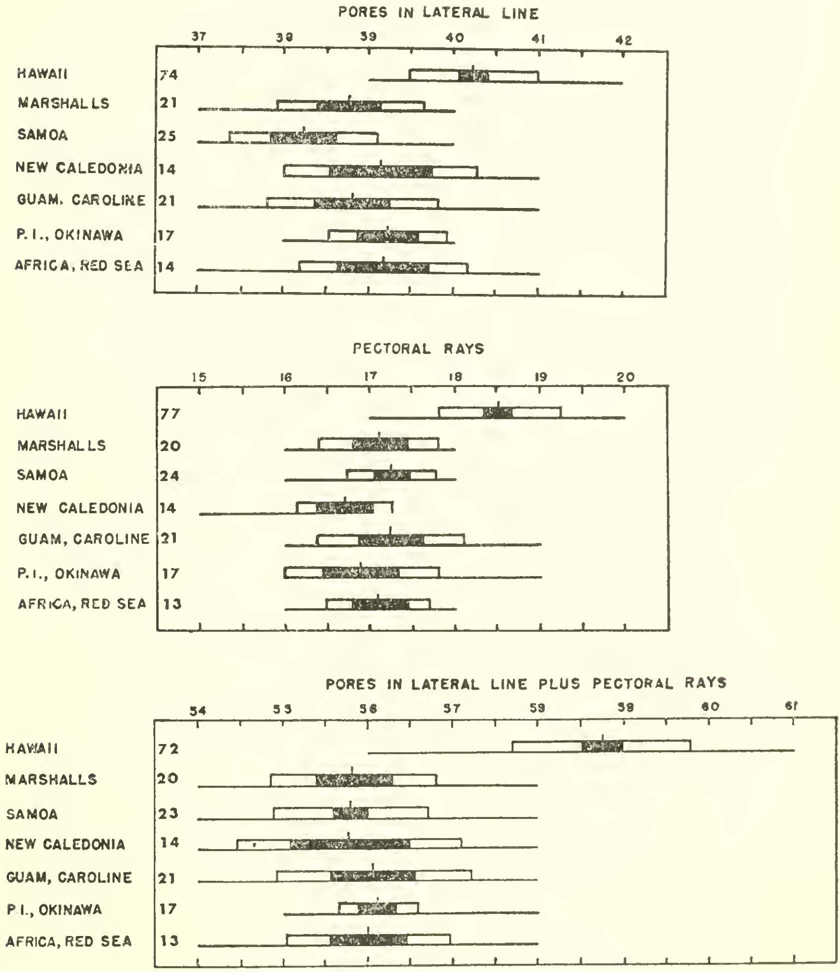


Figure 5.—Pores and pectoral rays in the subspecies *Conger cinereus cinereus* and *C. c. marginatus* from the various geographical areas. All specimens found in Hawaii are of *C. c. marginatus*, while all the specimens found in the other areas are of *C. c. cinereus*. Numbers at the left indicate the number of specimens examined from each area. In each horizontal bar-graph the range of variation is represented by the solid bottom line; the mean is represented by the small vertical line at the tip; twice the standard error on either side of the mean is represented by half the solid rectangle; and one standard deviation on either side of the mean is represented by the hollow rectangle plus half the solid rectangle.

There may be a correlation between this development and the temperature of the water, since specimens in colder waters develop this spot at a shorter length than those found in warmer waters.

The mean for the number of pectoral rays is 18.52 in *C. c. marginatus* and 17.03 in *C. c. cinereus;* the mean for the number of pores in lateral line is 40.23 in *C. c. marginatus* and 38.39 in *C. c. cinereus;* and the mean for the character index of pectoral rays plus pores in lateral line is 58.75 in *C. c. marginatus* and 55.94 in *C. c. cinereus* (fig. 5).

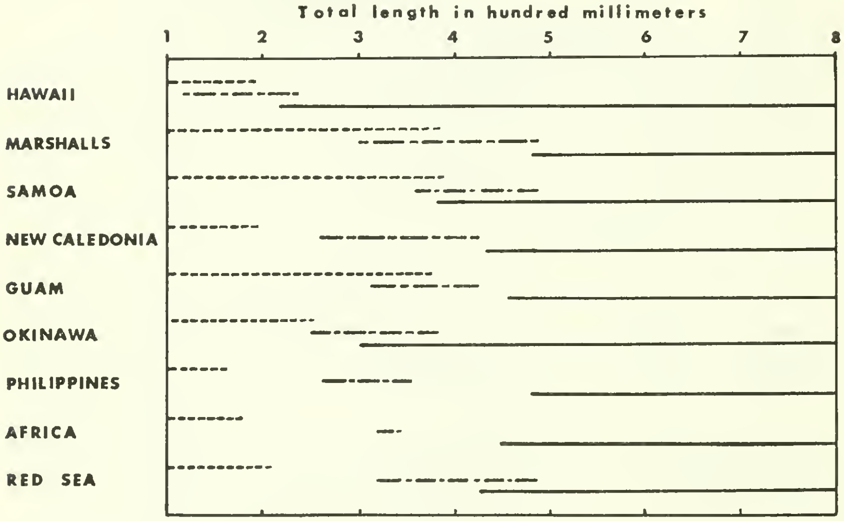


Figure 6.—The relationship of body length with development of black spot on the pectoral fin in *Conger cinereus cinereus* and *C. c. marginatus*, by locality. All specimens found in Hawaii are of the subspecies *C. c. marginatus*, while all the specimens found in the other areas are of the subspecies *C. c. cinereus.* Lines indicated by short dashes represent pectoral fins all pale; those indicated by short dashes and long dashes represent pectoral fins with traces of black. The solid line represents the black spot fully developed.

Also, *C. c. cinereus* differs from *C. c. marginatus* in that the former has the origin of dorsal fin situated slightly more anteriorly (table 1) and the length of the head is slightly shorter (fig. 5).

Conger cinereus cinereus Rüppell

FIGURES 4–6; PLATE 2

Conger cinereus Rüppell, 1828, p. 115 (type locality, Red Sea).—Klunzinger, 1871, p. 607.—Weber, 1913, p. 43.—Weber and de Beaufort, 1916, p. 258.—Jordan and Hubbs, 1925, p. 193.—Barnard, 1925, p. 187 (Natal coast).—Schultz, 1943, p. 44 (Phoenix and Samoan Islands).—Aoyagi, 1943, p. 5, fig. 1.—J. L. B. Smith, 1949, p. 393, pl. 99, fig. 1111.

Conger altipinnis Kaup, 1856a, p. 72 (type locality, Isle of Bourbon).—Kaup, 1856b, p. 114.—Playfair and Günther, 1866, p. 125.

Conger noordzieki Bleeker, 1857, p. 86 (type locality, Ambon); 1864, p. 26, pl. 167, figs. 2, 3.—Schultz and Collaborators, 1953, p. 83 (Marshall Islands).

Leptocephalus riukiuanus Jordan and Snyder, 1901, p. 852, fig. 4 (type locality, Riu Kiu Islands).

Leptocephalus caudalus Fowler, 1912, p. 9 (type locality, coast of California?).

Leptocephalus marginatus Fowler, 1912, p. 9 (Christmas Island).

Conger marginatus Günther, 1870, p. 38.

Leptocephalus cinereus Herre, 1934, p. 16 (Philippines: Manila, Culion, Jolo).

Forskalichthys cinereus Whitley, 1935, p. 219.—Fowler, 1944b, p. 187 (New Hebrides).

SPECIMENS STUDIED: 112 specimens, from 90 mm. to 923 mm. in total length, from the Marshalls, Phoenix, Guam, Okinawa, Philippines, Africa, and the Red Sea.

DIAGNOSIS: Vertebrae 139 to 146; sixth infraorbital pore above rictus of jaw; infraorbital pores 7 to 9; preoperculo-mandibular pores 10; supraorbital pores 2; preorbital bone show the greatest amount of ossification; pectoral rays 15 to 19; pores in lateral line 37 to 41; black spot on pectoral fin more distinct and fully developed at total length of about 280 mm. to 480 mm.

DESCRIPTION: Distance from tip of snout to origin of dorsal fin 127 to 156; length of upper jaw (to rictus) 34 to 51; length of pectoral fin 29 to 42; supratemporal pore 1; infraorbital pores 7 to 9; preoperculo-mandibular pores 10; supraorbital pores 2; compressed teeth in upper jaw 32 to 76; in lower jaw 31 to 72; vertebrae 139 to 146; two rows of teeth in jaws laterally; premaxillary tooth-patch wider than long. Bleeker (1864, p. 26) states anal rays 258 to 280, dorsal rays 288 to 296. Additional counts and proportional measurements are recorded in tables 1–3, 5, 6, and figure 3.

Dr. J. Randall (in litt.), who has observed the subspecies in the field, believes it to be nocturnal. He states that at night it displays the barred color pattern, broad dark gray bands showing on lighter gray ground color.

GEOGRAPHICAL RANGE: Marshall, Phoenix, and Christmas Islands, Palmyra, New Caledonia, Guam, Okinawa, Japan, Philippines, westward throughout the Indian Ocean, Red Sea, east coast of Africa, and South Africa. Whitley (1935, p. 219) mentions specimens from North Queensland, Australia.

REMARKS: For differences between *Conger cinereus marginatus* and *C. c. cinereus* see remarks under *marginatus*. Dr. J. Böhlke examined the type of *Leptocephalus riukiuanus* Jordan and Snyder (SNHM 6468) and informed me that the sixth infraorbital pore is above the rictus of jaw instead of behind it and that the black diagonal streak is present beneath the eye. These characteristics place this species in the synonomy of *C. c. cinereus.*

TABLE 1.—*Distances of origin of dorsal fin in front of or behind tip of depressed pectoral fin, recorded in percent of pectoral fin length*

Species of *Conger*	Dorsal fin origin in relation to tip of the pectoral fin																		
	Anterior to tip									Tip	Posterior to tip								
	90 to 81	80 to 71	70 to 61	60 to 51	50 to 41	40 to 31	30 to 21	20 to 11	10 to 1	0*	10 to 1	20 to 11	30 to 21	40 to 31	50 to 41	60 to 51	70 to 61	80 to 71	90 to 81
cinereus cinereus	2	13	9	5	4	1													
cinereus marginatus		5	20	19	17	6	2	1											
triporiceps											2	2	3			1			
myriaster					2	4	30	20	10	5	3								
orbignyanus												1	2	3	4	1		1	
conger								1	1	3	4	5	8	1					
jordani (Japan)												3	9	3	6	2	2	2	
jordani (Africa)													1						
oligoporus											3	1	2						
esculentus (W. Atlantic)									1	1	1								
esculentus (St. Helena)												1							
macrocephalus												1							
erebennus						2		2		1	1								
verreauxi											1								
oceanicus								3	10	5	17	9	5	5	1				
wilsoni													1		1		1	1	
philippinus															2			3	1

* From .09 anterior to .09 posterior to tip of pectoral fin.

TABLE 2.—*Counts recorded for the various species and subspecies of* Conger

Species or subspecies	Lateral line pores													Pectoral fin rays							
	35	36	37	38	39	40	41	42	43	44	45	46	47	14	15	16	17	18	19	20	21
cinereus cinereus			6	31	45	24	6								1	22	57	27	2		
cinereus marginatus					11	39	20	4									5	33	33	6	
triporiceps					1	6	1							2	4	3	1				
myriaster					7	27	47	8	2						3	23	38	5			
orbignyanus										9	4	5			1	5	6				
conger										7	8	14	8				3	17	1	1	
jordani (Japan)		2	12	13	7	3									1	4	21	7			
jordani (Africa)						1										1	1				
oligoporus	1	5													1	5					
esculentus (W. Atlantic)	2	2																1	2		
esculentus (St. Helena)			1													1					
macrocephalus	1																1				
erebennus			1	1	3	1													3	1	2
verreauxi						1											1				
oceanicus					2	9	14	7	4	2						3	26	13			
wilsoni				1	2	4											5	2			
philippinus			3	5											3	3					

TABLE 3.—*Number of vertebrae for the various species and subspecies of the genus* Conger

	126–127	128–129	130–131	132–133	134–135	136–137	138–139	140–141	142–143	144–145	146–147	148–149	150–151	152–153	154–155	156–157	158–159	160–161	162–163
cinereus cinereus							2	4	x	2	2								
cinereus marginatus												4	4	1					
triporiceps																1	1	2	
myriaster										1	4								
orbignyanus																		3	
conger												x	x	x				x	
jordani (Japan)								2	4	1	1								
jordani (Africa)										1									
oligoporus						1	1												
esculentus				1															
macrocephalus						1													
erebennus						1				2	1								
verreauxi														x		x			
oceanicus								2	3	4	2								
wilsoni											3								
philippinus	1		1		2														

x, from literature.

TABLE 4.—*A positive correlation in the number of compressed teeth in one side of upper jaw with increase in body length of Pacific species of* Conger

(Arabic numerals, *myriaster;* Roman numerals, *jordani;* W, *wilsoni;* A, *oligoporus;* B, *philippinus;* E, *erebennus;* P, *macrocephalus;* U, *esculentus* (Atlantic species)

Total length in mm.	Number of teeth																										
	24 25	26 27	28 29	30 31	32 33	34 35	36 37	38 39	40 41	42 43	44 45	46 47	48 49	50 51	52 53	54 55	56 57	58 59	60 61	62 63	64 65	66 67	68 69	70 71	72 73	74 75	76 77
100–149			1	A																							
150–199	2		2	1	1	1			AI																		
200–249				1	1	1	3	B	AAB		BA	A															
250–299					4	2	1	2	W		B																
300–349				2	1	1	2	1	1					I													
350–399					3	1	2	2			I	III	I	I													
400–449					1	1	3	2E	2	2I		I	I		I												
450–499					1	3	1	1	E	1	1		II														
500–549								2	2	4			W	II		I											
550–599									1		1E			I		I	I										
600–649										2					I	I	II		I								
650–699															E						I						
700–749																		I					WI				
750–799																											I
800–849																						P					
850–899																											
900–949																											
950–999																U				U							
1000–1049																				U			W				

Table 5.—*Measurements made on species and subspecies of the genus* Conger *for certain characters, recorded in thousandths of total length*

Species and subspecies	Length of head																	
	110 to 114	115 to 119	120 to 124	125 to 129	130 to 134	135 to 139	140 to 144	145 to 149	150 to 154	155 to 159	160 to 164	165 to 169	170 to 174	175 to 179	180 to 184	185 to 189	190 to 194	195 to 199
cinereus cinereus	2	13	23	31	11	6	3											
cinereus marginatus			3	6	13	6	2	2										
triporiceps			1	3	3													
myriaster				2	3	9	31	26	15	4								
orbignyanus			1		1	5	2	3										
conger							3	7	8	4	1	3	1					
jordani (Japan)			1	3	4	10	8	1										
jordani (Africa)					1		1											
oligoporus							3	1	1	1								
esculentus (W. Atlantic)													2		1			
esculentus (St. Helena)												1						
macrocephalus																		1
erebennus											1	2	1	1	1			
verreauxi					1					1								
oceanicus					1	2	5	8	7	9	5	10	2		1			
wilsoni		1	2			1												
philippinus	1		1	1	1		1											

TABLE 5.—*Measurements made on species and subspecies of the* Conger *for certain characters, recorded in thousandths of total length*—Continued

Species and subspecies	Length of snout											Diameter of eye								
	22. 5 to 24. 9	25. 0 to 27. 4	27. 5 to 29. 9	30. 0 to 32. 4	32. 5 to 34. 9	35. 0 to 37. 4	37. 5 to 39. 9	40. 0 to 42. 4	42. 5 to 44. 9	45. 0 to 47. 4	47. 5 to 49. 9	10. 0 to 12. 4	12. 5 to 14. 9	15. 0 to 17. 4	17. 5 to 19. 9	20. 0 to 22. 4	22. 5 to 24. 9	25. 0 to 27. 4	27. 5 to 29. 9	30. 0 to 32. 4
cinereus cinereus	----	5	34	37	14	1	----	----	----	----	----	1	8	11	31	10	1	----	----	----
cinereus marginatus	----	----	9	12	7	2	1	----	----	----	----	----	2	5	19	5	----	----	----	----
triporiceps	1	----	----	1	4	----	----	----	----	----	----	----	----	2	4	----	----	----	----	----
myriaster	----	1	2	24	35	21	4	2	----	----	----	----	----	5	29	30	7	2	----	----
orbignyanus	----	1	----	3	5	3	----	----	----	----	----	1	5	6	----	----	----	----	----	----
conger	----	----	----	3	6	7	4	1	1	1	1	----	----	----	3	9	8	3	1	----
jordani (Japan)	----	----	1	7	14	5	----	----	----	----	----	----	----	----	8	16	3	----	----	----
jordani (Africa)	----	----	----	1	----	----	1	----	----	----	----	----	----	1	----	1	----	----	----	----
oligoporus	----	----	----	----	1	5	----	----	----	----	----	----	----	----	----	----	1	2	2	1
esculentus (W. Atlantic)	----	----	----	----	----	----	----	1	1	1	----	----	----	----	----	2	----	----	1	----
esculentus (St. Helena)	----	----	----	----	----	----	1	----	----	----	----	----	----	----	----	1	----	----	----	----
macrocephalus	----	----	----	----	----	----	----	----	----	----	1	----	----	----	----	----	1	----	----	----
erebennus	----	----	----	----	----	----	1	1	2	----	----	----	----	----	----	1	2	1	----	----
verreauxi	----	----	----	----	----	----	1	----	----	----	----	1	----	----	----	----	----	----	----	----
oceanicus	----	----	3	8	7	8	9	10	3	----	2	----	----	3	12	17	9	4	1	----
wilsoni	----	1	1	1	1	----	----	----	----	----	----	----	----	2	1	----	1	----	----	----
philippinus	----	2	2	1	1	----	----	----	----	----	----	----	----	2	----	1	1	2	----	----

TABLE 6.—*Body length from tip of snout to anus in the genus* Conger

Species and subspecies	Body lengths in thousandths of the total length														
	300 to 309	310 to 319	320 to 329	330 to 339	340 to 349	350 to 359	360 to 369	370 to 379	380 to 389	390 to 399	400 to 409	410 to 419	420 to 429	430 to 439	440 to 449
cinereus cinereus	2	13	39	22	5	5	2	1	----	----	----	----	----	----	----
cinereus marginatus	----	----	9	12	4	3	1	1	----	----	----	----	----	----	----
triporiceps	1	----	1	----	1	1	2	----	----	----	----	----	----	----	----
myriaster	----	----	----	----	----	----	7	35	25	12	7	1	1	----	----
orbignyanus	----	----	----	----	----	----	----	1	1	2	7	----	1	----	----
conger	----	----	----	----	----	----	1	----	2	6	3	8	1	4	----
jordani (Japan)	----	----	----	----	----	4	13	6	4	----	----	----	----	----	----
jordani (Africa)	----	----	----	----	----	----	----	1	1	----	----	----	----	----	----
oligoporus	----	----	----	----	2	2	1	1	----	----	----	----	----	----	----
esculentus (W. Atlantic)	----	----	----	----	----	----	----	----	----	----	3	----	----	----	----
esculentus (St. Helena)	----	----	----	----	----	----	----	----	----	----	----	1	----	----	----
macrocephalus	----	----	----	----	----	----	----	----	----	----	----	1	----	----	----
erebennus	----	----	----	----	----	----	----	----	2	1	3	----	----	----	----
verreauxi	----	----	----	----	----	----	----	----	----	----	----	1	----	----	----
oceanicus	----	----	----	----	----	1	2	4	6	11	11	11	1	2	1
wilsoni	----	----	----	----	1	1	----	2	----	----	----	----	----	----	----
philippinus	----	----	1	----	----	1	1	----	1	----	1	----	----	----	----

Fowler (1912, p. 9) described as new the species *Leptocephalus caudalus*, from the coast of California. I doubt the validity of this record and discuss this problem on page 228.

Dr. E. A. Lachner has examined Rüppell's type of *Conger cinereus* (No. 766, total length about 338 mm.) deposited in the Senckenberg Museum at Frankfort, Germany. He noted that the sixth infraorbital pore is above rictus of jaw, that the lateral line pores from anus forward are 39 in number, and that there may have been a dark streak under the eye.

***Conger triporiceps*, new name**

FIGURES 2, 3; PLATES 1,D, 4,A

Conger brasiliensis, Kaup, 1856b, p. 115 (type locality, Brazil).
Conger occidentalis (not De Kay) Kaup, 1856b, p. 114 (Martinique).
Leptocephalus conger Nichols, 1921, p. 22; Fowler, 1944a, p. 436 (in part).

SPECIMENS STUDIED: Eight specimens, ranging in total length from 622 to 950 mm., from the following localities: Brazil, holotype (PM 8427) of Kaup's *C. brasiliensis* (examined by Dr. E. A. Lachner at Museum National d'Histoire Naturelle, Paris); Cuba (USNM 24936, 9792, 19799); Bahamas, Turks Island (AMNH 7240); Bermuda (CNHM 48606, 48339, 48945).

DIAGNOSIS: Three supratemporal pores; 11 preoperculo-mandibular pores; four supraorbital pores; greater number of compressed teeth in jaws than in other species (fig. 2); in young specimens vomerine teeth in a single irregular row; premaxillary tooth-patch squarish; ossification developed across sensory canal of preorbital bone, one or two post orbital pores.

DESCRIPTION: Length of head 126 to 132; tip of snout to origin of dorsal fin 164 to 177; tip of snout to anus 301 to 366; snout length 24 to 35; diameter of eye 17 to 19; length of upper jaw (to rictus) 44 to 51; length of pectoral fins 36 to 42; pectoral fin rays 14 to 17; pores in lateral line 39 to 41; teeth in jaws in a single row, at times with a few scattered teeth on inner row; number of compressed teeth in upper jaw 72 to 90; in lower jaw 74 to 97; vomerine teeth in single irregular row, in large specimens in a traingular patch; premaxillary tooth-patch squarish, with 40 to 105 teeth; preoperculo-mandibular pores 11; supratemporal pores 3; supraorbital pores 4, infraorbital pores 7 or 8; vertebrae 157 to 160; origin of dorsal fin 4.3 percent anterior to pectoral tip to 28.35 percent posterior to pectoral tip; ossification developed across sensory canal of preorbital bone (see pl. 1,D); pectoral fins colored black with lower one-third of fin pale. Measurements and counts are recorded in tables 1 to 3, 5, 6 and in figure 2.

Geographical range: Brazil, Bermuda, Bahamas, Cuba, Martinique, and Pensacola, Fla.

Remarks: Ranzani (1840, p. 79, pl. 13, figs. 1,a,b) described a new species, *Conger brasiliensis*; however his species belongs with the muraenesocid eels. Kaup (1856a) described a new conger as *Conger brasiliensis*, which makes this name a junior primary homonym. According to Article 36 of the International Rules of Zoological Nomenclature, a rejected homonym can never be used again; therefore, I give Kaup's *C. brasiliensis*, a new name, *C. triporiceps*. This name refers to the three supratemporal pores on the head, which is a distinguishing character of this species.

Kaup's (1856b, p. 114) description of *C. occidentalis* states vomerine teeth 9, small and irregularly spaced. The only species that has such a few number of vomerine teeth is *triporiceps*; also, it has the greatest number of compressed teeth (fig. 2).

The head of one specimen (USNM 30710) was obtained from Pensacola, Fla. It was identified as this species by the ossification bridging across the sensory canal of the preorbital bone and the numerous compressed teeth in the jaws. This is the only species in the Atlantic that has the preorbital bone with ossification bridging across the sensory canal.

Conger myriaster (Brevoort)

Figure 7; Plates 1,a, 3,a

Anguilla myriaster Brevoort, 1856, p. 282, pl. 11, fig. 2 (type locality, Hakodate, Japan).

Congromuraena myriaster Günther, 1870, p. 40, footnote.

Ophiosoma? myriaster Bleeker, 1879, p. 26.

Conger japonica Bleeker, 1879, p. 32, pl. 2, fig. 2.

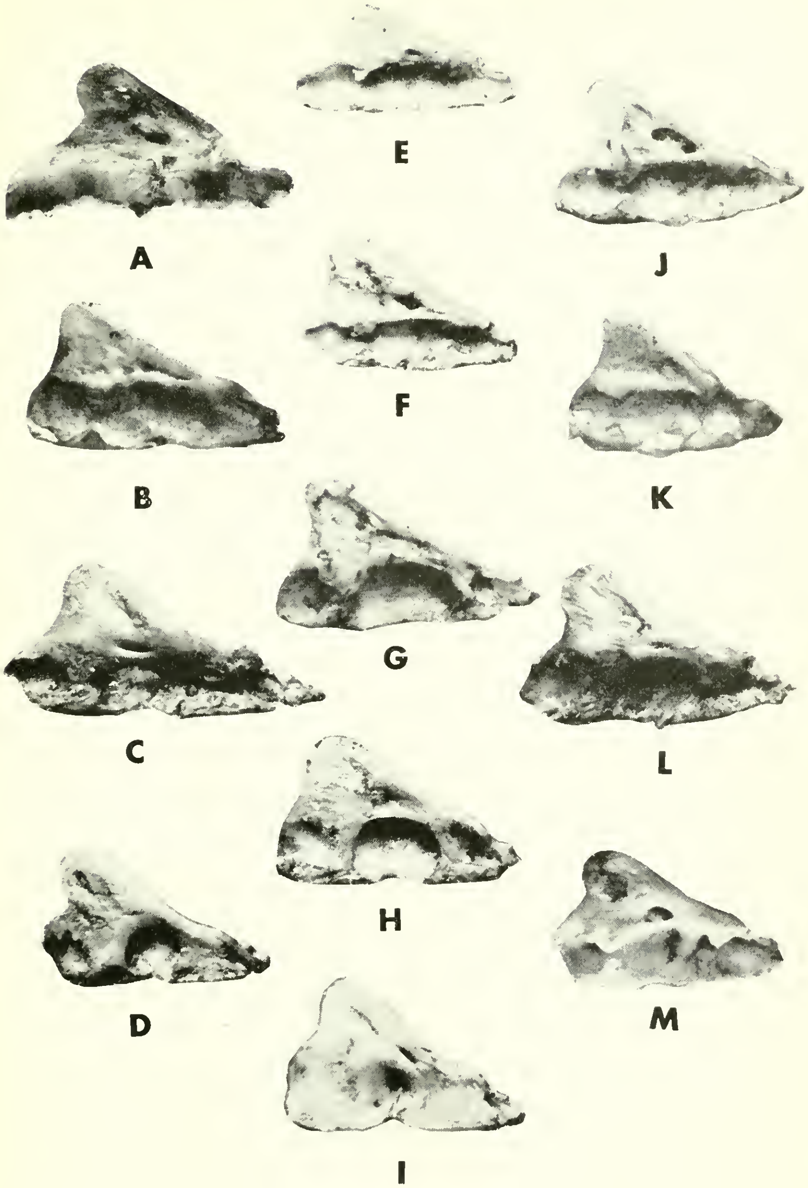
Conger myriaster Steindachner, 1896, p. 222, pl. 4, fig. 2.

Leptocephalus myriaster Jordan and Snyder, 1901, p. 849.—Tanaka, 1911, pl. 19, figs. 69, 70; pl. 20, fig. 77; 1912, p. 78.—Fowler, 1912, p. 9.

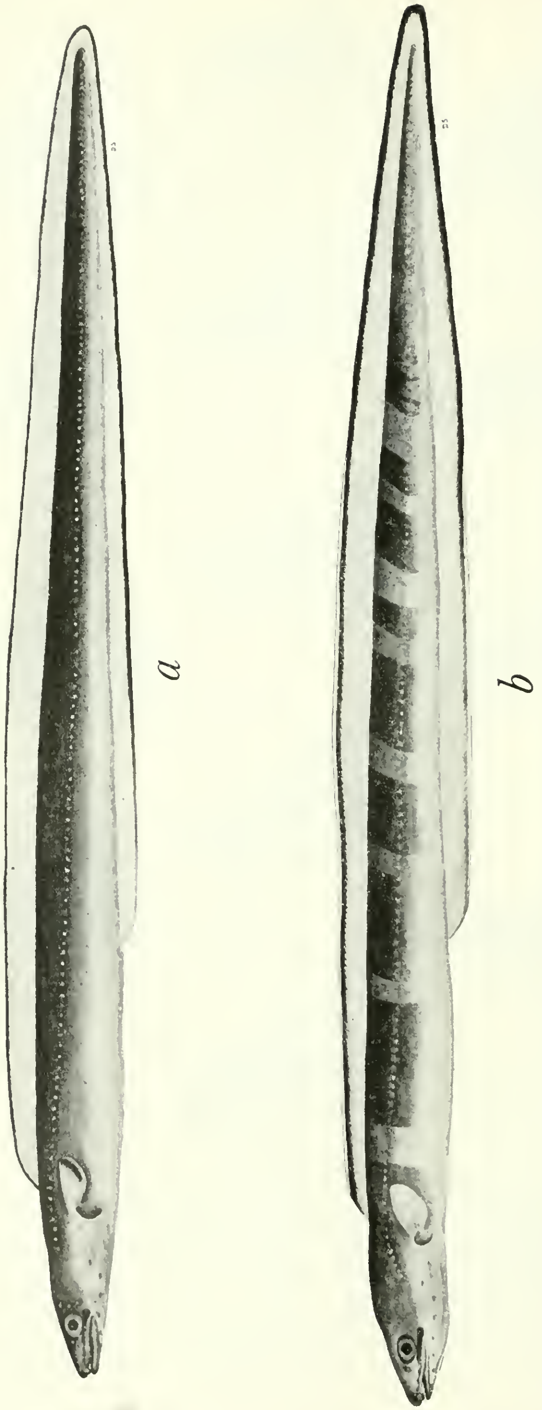
Astroconger myriaster Jordan and Hubbs, 1925, p. 194.—Mori, 1952, p. 64.—Matsubara, 1955, p. 337.

[?]*Leptocephalus kiiensis* Ui, 1931 (not seen).

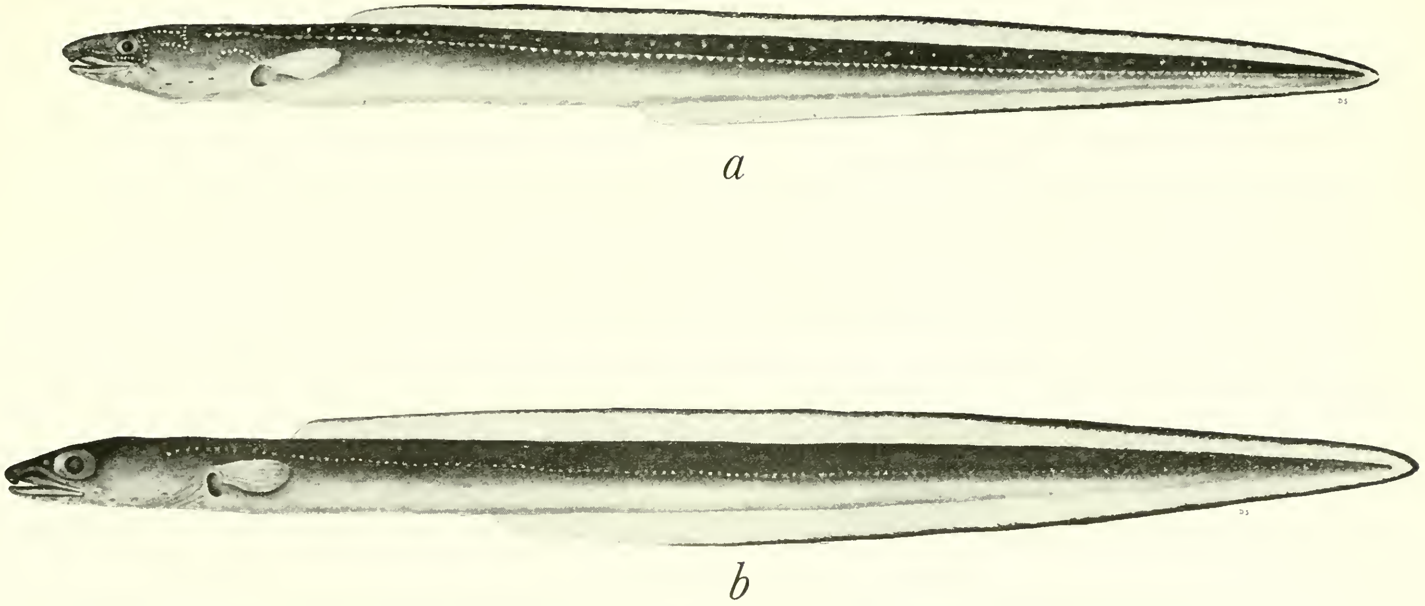
Specimens studied: 152 specimens from 129 to 606 mm. in total length from the following localities: Japan: Mororan, SNHM 6798 (5 specimens); Hakodate USNM 48194, 49898, 71027, 163410 (4); Aomori Ken, Pacific coast UMMZ 165496, 165505; Sendai, Shiogama USNM 71823 (2), UMMZ 165512 (2); coast of Boshyu, Chiba Ken UMMZ 165528; Tokyo Bay UMMZ 165515 (3); Tokyo market, USNM 49977 (3), 38806 (2), 71870, 151844 (2), SNHM 6696 (21); Yokohama market, SNHM 30624 (41), 26779, USNM 151793; Sagami Sea, Shimoda USNM 57596; Misaki, USNM 71868, MCZ 29018 (2); Suruga Bay UMMZ 177297, USNM 163411, 163412;



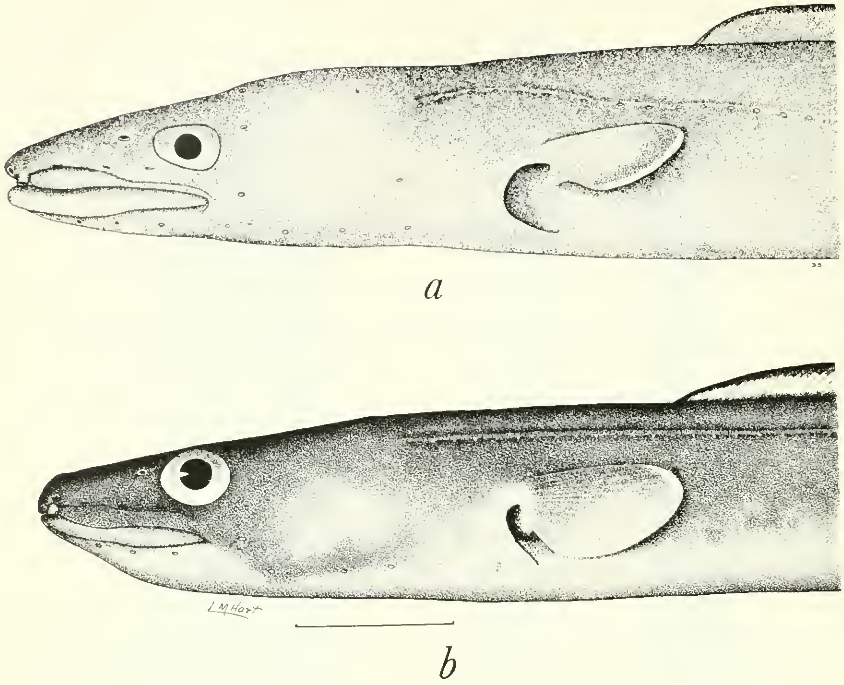
Preorbital bone in 13 species of *Conger*. A, *myriaster;* B, *oligoporus;* C, *oceanicus;* D, *triporiceps;* E, *orbignyanus;* F, *esculentus;* G, *jordani;* H, *wilsoni,* I, *cinereus;* J, *erebennus;* K, *philippinus;* L, *conger;* M, *macrocephalus.* Magnification: F, L, natural size; C–E, H–J, M, times 2; A, G, times 3; B, K, times 7.



Conger cinereus cinereus: a, an adult form, USNM 114724, from Society Island with a total length of 815 mm.; *b*, a young form, USNM 164209, from New Caledonia with a total length of 314 mm., showing the wide bars on body.



Conger myriaster and *C. oligoporus.* A, *myriaster*, USNM 151740, from Fukui Ken, Japan, with a total length of 575 mm., showing the white spots characteristic of this species; B, the holotype of *oligoporus*, USNM 162512, from Oahu, Hawaii, with a total length of 237 mm.



Conger triporiceps and *C. erebennus*. A, triporiceps, USNM 9792, from Cuba with a total length of 950 mm.; B, holotype of *erebennus*, SNHM 6466, from Misaki, Japan, with a total length of 483 mm.

Oigawa 75981; Kobe market USNM 151820 (4), SNHM 30611 (5); Wakanoura SNHM 6968; Nagasaki, UMMZ 165513 (2); Tsushima Straits UMMZ 165533, 165534; Hamada UMMZ 165491, 165536; off Miyazu UMMZ 165519 (3); Wakasa Bay UMMZ 165520 (2); Fukui Ken USNM 151740. KOREA: Fusan USNM 163469 (2), UMMZ 165502, 165522 (18). CHINA: Tsingtao, Shantung USNM 130468 (3); Ningpo USNM 130525 (2); Chusan Island SNHM 32422 (3).

DIAGNOSIS: Whitish areas surround the sensory pores and pits on head and body; origin of dorsal fin 8.14 percent behind to 43 percent of pectoral fin in front of pectoral tip; number of compressed teeth 25 to 45; least amount of ossification developed in preorbital bone; pores in lateral line 39 to 43, head length 133 to 160.

DESCRIPTION: Distance from tip of snout to origin of dorsal fin 172 to 209; length of pectoral fin 51 to 70; vertebrae 144 to 147 (50 to 56 + 90 to 96); in five specimens dorsal fin rays 272 to 287 and anal rays 187 to 218; compressed teeth in upper jaw 25 to 45, in lower jaw 29 to 43; generally two rows of teeth laterally in jaws, inner row of teeth from a few teeth to five-sixths the length of outer row; premaxillary tooth-patch wider than long; origin of dorsal fin from 8.14 behind posterior tip of pectorals to 43 percent in front of pectoral tip (table 1); peritoneum silvery to silvery with black specks; ossification not bridging over sensory canal in preorbital bone; white areas around lateral line pores and sensory pits; preorbital bone shows the least ossification when compared to other species. Additional measurements and counts appear in tables 1–6.

GEOGRAPHICAL RANGE: In Japan from Mororan and Hakodate on the Island of Hokkaido southward on the Pacific coast of Japan to Nagasaki, northward to Fukui Ken in the Sea of Japan, to Korea southward to Chekiang Province of China.

REMARKS: This species can be distinguished by the white areas surrounding the sensory pores and organs on head and body. In some preserved specimens these white areas are not discernible, thus making this species frequently misidentified with *C. jordani*. The two species can be distinguished by the number of compressed teeth in upper jaw (table 4) and by the position of the origin of dorsal fin (table 1). The number of pores in lateral line is 39 to 43, whereas in *C. jordani* there are 36 to 40 (table 2).

The description of *Conger japonica* Bleeker (1879, p. 32, pl. 2, fig. 2) gives the number of dorsal rays as 260, anal 170; inner row of teeth of both jaws well developed; Bleeker's illustration shows the dorsal origin slightly in front of pectoral tip. These characters agree with *C. myriaster*; therefore, I have placed *C japonica* as a synonym of that species.

Figure 7.—Distribution of *Conger myriaster.*

The paratype of *Leptocephalus erebennus* Jordan and Snyder (SNHM 6968) from Wakanoura is a young specimen of *C. myriaster.*

Dr. Kamohara has been very kind in giving me the description of *kiiensis* Ui which was not available to me. Following is the translation of the description as transmitted to me. Dorsal fin inserted slightly behind and above posterior end of pectoral fin; caudal long, tapering, acute, head about 5 in its length, head and trunk together a little less than 2; back of body pale darkish brown; minute white spots along lateral line; dorsal and anal pale, both fins margined with black posteriorly; total length about 40 cm., rare.

I am placing this species with *C. myriaster* until the type can be examined.

Conger orbignyanus Valenciennes

FIGURES 2, 3, 5; PLATE 1,E

Conger orbignyanus Valenciennes, 1847, p. 10, Atlas, pl. 12, fig. 1 (type locality, South America).—Evermann and Kendall, 1906, p. 76.—De Buen, 1950, p. 66.

Conger multidens Castelnau, 1855, p. 84, pl. 44, fig. 1 (Rio de Janeiro).—Günther, 1870, p. 40.

Conger vulgaris Günther, 1870, p. 38 (in part), item "k" (South America).—Perugia, 1891, p. 656 (Montevideo).—Berg, 1895, p. 23 (Mar del Plata, Montevideo).

Conger conger Günther, 1870, p. 13 (La Plata).—Tortonese, 1939, p. 72 (Montevideo).

Leptocephalus conger Jordan and Davis, 1892, p 684 (coast of Brazil).

Leptocephalus orbignyanus Devincenzi, 1924, p. 183 (Banco Inglés, Maldonado, Montevideo).—Devincenzi and Barattini, 1928 pl. 16, fig. 4.—Carvalho, 1943, p. 43.

SPECIMENS STUDIES: 12 specimens ranging in total length from 603 to 1125 mm., from the following localities: URUGUAY: USNM 87737; Montevideo USNM 22625, SNHM 13492 (2); Rio Plata USNM 86726, MCZ 4701. ARGENTINA: Buenos Aires USNM 55580 (3), SNHM 31617 (2). BRAZIL: Rio de Janeiro MCZ 4711.

DIAGNOSIS: Pores in lateral line from 44 to 46; vertebrae 160–161; origin of dorsal fin one-tenth to 1 pectoral fin length behind posterior tip of pectoral fin; diameter of eye 12 to 17.

DESCRIPTION: Tip of snout to origin of dorsal fin 178 to 200, length of upper jaw (to rictus) 39 to 52; length of pectorals 40 to 51; number of compressed teeth in upper jaw 41 to 61; in lower jaw 51 to 59; vomerine tooth-patch triangular, 30 to 45 teeth; premaxillary tooth-patch wider than long, with 31 to 45 teeth; vertebrae 55 to 56 precaudal, and 106 to 104 caudal (in 2 specimens); 9 or 10 preoperculomandibular pores; a single supratemporal pore; in one specimen dorsal rays 368, anal 301; preorbital bone does not have ossification bridging over sensory canal, pl. 1,E. Additional counts and measurements are recorded in tables 1–3, 5, 6 and in figure 2.

GEOGRAPHIC RANGE: South America, from Uruguay and Argentina northward to Brazil.

REMARKS: The distribution of *C. orbignyanus* may ovrleap with that of *C. triporiceps* and *C. esculentus;* however, it can easily be separated by the number of lateral line pores. Also, it may be further distinguished from *C. triporiceps* by the single supratemporal pore and absence of postorbital pores. This species is more closely related to *C. conger* from Europe, but it can be distinguished by the following characters:

Character	*C. orbignyanus*	*C. conger*
Eye diameter	12 to 17	20 to 28
Head length	122 to 150	143 to 168
Eye into snout	2.06 to 2.90 times	1.36 to 2.11 times
Pectoral rays	16 to 17	17 to 19
Origin of dorsal in relation to pectoral fin tip	one-tenth to 1 pectoral fin length behind	one-fifth in front to one-third behind

The origin of dorsal fin in relation to pectoral fins in the specimens I have examined are from one-tenth to two-thirds pectoral fin length behind posterior tip of pectoral fin; however, in literature it has been described as 1 pectoral fin length behind.

Dr. E. A. Lachner has examined the type of *Conger multidens* Castelnau (in the Muséum National d'Histoire Naturelle, Paris, No. 8428), 704 mm. in total length, and states that lateral line pore counts from a vertical from anus anteriorly was 43 on the right side and 45 on the left side, which places this species in the synonymy of *C. orbignyanus*.

***Conger conger* (Linnaeus)**

FIGURES 2, 3; PLATE 1,L

Muraena conger Linnaeus, 1758, p. 245 (based on Artedi; type locality, Mediterranean Sea).

Conger verus Risso, 1826, p. 201 (Nice).

Conger vulgaris Yarrell, 1831, p. 158.—Bleeker, 1864, p. 26.—Günther, 1870, p. 38 (in part).—Day, 1880–1884, p. 250.—Moreau, 1881, p. 565.—Stassano, 1890, p. 32 (Spanish Sahara).—Vinciguerra, 1893, p. 333.—Chabanaud and Monod, 1926, p. 249 (Port-Etienne).—Duncker et al, 1929, p. f.60.

Congrus vulgaris Lowe, 1837, p. 192 (Madeira).—Richardson, 1844–1848, p. 107.

Conger rubescens Ranzani, 1840, p. 82, pl. 12.

Leptocephalus conger Fowler, 1912, p. 9 (in part).—Jordan and Gunn, 1899, p. 339.

Conger conger Fowler 1923a, p. 33 (Funchal Bay).—Nobre, 1935, p. 383.—Cadenat, 1937, p. 437.—Navarro, 1942, p. 196; 1943, p. 125 (Cabo Bojadar, Cabo Blanco).—Fowler, 1936, p. 268 (in part).

SPECIMENS STUDIED: 25 specimens, from 83.5 to 87.7 mm. in total length, from the following localities: Sardinia, USNM 143454 (2); Naples, Italy, USNM 48482 (2), 48470, SNHM 20614 (3); Nice, France, MCZ 9326, 9332 (2); Madeira, USNM 6522, SNHM 24032; Azores, USNM 94503; Canary Islands, SNHM 10566, 10586; Bergen, Norway, USNM 17488; Europe, USNM 43123, 43587, MCZ 2554 (4), 2468A (2).

DIAGNOSIS: Pores in lateral line 44 to 47; pectoral rays 17 to 20; diameter of eye 20 to 28; origin of dorsal fin from 19.30 percent before to 33.74 percent behind pectoral fin tip.

DESCRIPTION: Distance from tip of snout to origin of dorsal fin 186 to 222; length of pectorals 37 to 70; supratemporal pore 1; preoperculomandibular pores 9; compressed teeth in upper jaw 25 to 62, in lower jaw 24 to 58; 2 rows of teeth laterally in jaws; inner row from one-quarter to whole length of outer row; premaxillary tooth-patch wider than long; upper edge of gill opening opposite middle of pectoral fin base; ossification not developed over sensory canal of preorbital bone. Additional counts and proportional measurements are recorded in tables 1–3, 5, 6 and in figure 2.

Geographical range: Norway southward to Cape Blanco, Africa, and the Canary Islands, throughout the Mediterranean Sea, and occurring in the western half of the Black Sea. Kyle and Ehrenbaum (in Duncker, et al, 1929, p. f.62) state that this species is found as far north as Trondhiem Fjord, Norway, is seldom found in the Baltic Sea in the Kattegat and in the Skaggerak, and is found mainly south and west of the British Isles, in the Biscayne west of Spain, and in the Mediterranean Sea.

Remarks: There may be some population divergence in the Atlantic and Mediterranean forms in regards to snout and head length; however, more specimens are needed to reach definite conclusions. The following tabulations show the comparative snout and head lengths (in thousandth of total length) of the Mediterranean and Atlantic forms:

Area	Snout length in thousandths of total length							
	30.0	32.5	35.0	37.5	40.0	42.5	45.0	47.5
Mediterranean	2	2	5	2				
Atlantic				2	1	2		1

Area	Head length in thousandths of total length							
	140	145	150	155	160	165	170	175
Mediterranean	2	3	3	2		1		
Atlantic			1	1		2		2

This species is related to *C. orbignyanus* from the Atlantic coast of South America; however, in *C. orbignyanus* the diameter of eye is smaller, pectoral rays fewer, and origin of dorsal fin more posterior in position. See remarks under *C. orbignyanus.*

Günther (1870, p. 39) records under the species *Conger vulgaris* a specimen from St. Helena, but this specimen is identified tentatively as *C. esculentus.*

Yarrell (1831, p. 158) and subsequent authors based their *vulgaris* on *Anguilla vulgaris* Cuvier (1817, p. 231), which is not a *Conger* but a freshwater eel.

Conger jordani, new species

FIGURE 4; PLATE 1,G

Leptocephalus erebennus Jordan and Snyder, 1901, p. 849 (in part).
Conger japonicus Jordan and Hubbs, 1925, p. 194 (in part).
[?] *Conger vulgaris* Barnard, 1925, p. 187 (Agulhas Bank, off South Africa).
[?] *Conger conger* Smith, 1949, p. 392, fig. 1110 (Cape of Good Hope to Mozambique).

HOLOTYPE: USNM 71844, 606 mm. in total length, collected in 1906 at Misaki, Japan, by the *Albatross*.

PARATYPES: JAPAN: USNM 26250; Misaki USNM 49866, 71843, 71715, 71716, 71845, 72003, 71963, UMMZ 14280, 165503–4, SNHM 12924–5, 23466; Kagoshima USNM 163467; Tokyo market USNM 71818, UMMZ 165537, 165521; Suruga Bay, Shimizu Market UMMZ 165508; Nagasaki UMMZ 165517 (3), 165535; OKINAWA: USNM 71819.

DIAGNOSIS: One row of teeth in jaws; origin of dorsal from 11 to 80 percent of pectoral fin behind posterior tip of pectoral fin; vertebrae 141 to 144; pores in lateral line 36 to 40; diameter of eye 18 to 26.

DESCRIPTION: In the following description the first figure is for the holotype; the figures in parentheses refer to paratypes. Length of head 144 (125 to 148); tip of snout to origin of dorsal fin 200 (180 to 217); tip of snout to anus 379 (352 to 388); snout length 35 (30 to 37); diameter of eye 21 (18 to 26); length of pectoral fin 49 (40 to 56); upper jaw (to rictus) 49 (36 to 51); pores in lateral line 37 to 38 (36 to 40); supratemporal pore 1; preoperculo-mandibular pores 9; vertebrae 141 to 143 (48 to 50 precaudal, + 92 to 94 caudal); in two specimens dorsal rays 301 and 307 and anal rays 225 and 240; pectoral rays 17 (15 to 18); compressed teeth in upper jaw 42 to 77; 1 row of teeth in upper jaw, occasionally a few teeth in inner row anteriorly; premaxillary tooth-patch wider than long. In large specimens the ossification of preorbital bone bridges over sensory canal; in small specimens ossification not bridged over (Pl. 1,G). Origin of dorsal fin 28.58 percent of pectoral fin behind posterior tip of pectoral fin (14.65 to 76.95 percent behind pectoral tip). Color notes taken by Dr. C. L. Hubbs for specimen UMMZ 165504 is as follows: Purplish brown fins, blue gray at base and inky black in margin.

GEOGRAPHICAL RANGE: From Tokyo Bay southward to Nagasaki, Okinawa, and Africa.

REMARKS: The paratypes of *Leptocephalus erebennus* Jordan and Snyder (USNM 49866, SNHM 12924 and 12925) are not the same as the holotype of *L. erebennus*, but are of this new species.

The affinity of this species is with *C. oligoporus* from Hawaiian waters, but can be distinguished from it by the following characters: The eye smaller, and more vertebrae and more pores in lateral line (see tables 2, 3, 5).

I am unable to distinguish the two specimens from Port Alfred, South Africa, from *C. jordani*, but they are doubtfully included with this species because its geographical distribution is broken considerably from that of *C. jordani.* The origins of dorsal fin of the two African specimens are more anterior in position than in *C. jordani.* The counts and proportional measurements of the two specimens are given below (one specimen had a mutilated head so some of the characters are not given): total length 409 and approximately 635 mm.; pores in lateral line 40; pectoral rays 17 and 16; vertebrae 144 (X-ray); compressed teeth in upper jaw 42 and 55, in lower jaw 40 and 56; one row of teeth in jaws; a few scattered teeth in inner row; preoperculo-mandibular pores 9; supratemporal pore 1; dorsal rays 282; anal rays 228; origin of dorsal fin 24.25 percent behind posterior tip of pectoral fin; preorbital bone bridged over sensory canal; length of head 134 and 144; tip of snout to origin of dorsal fin 176; tip of snout to anus 374 and 386; snout length 32 and 40; diameter of eye 16 and 21; interorbital 21; length of upper jaw to rictus 45; length of pectoral fin 40; premaxillary tooth-patch wider than long.

Some preserved specimens of *C. myriaster* that lose their white markings around the sensory pores are difficult to distinguish from *C. jordani.* To separate these specimens see remarks for *C. myriaster.*

The new species is named for David Starr Jordan, who pioneered in studies of Japanese fishes.

Conger oligoporus, new species

PLATES 1,B, 3,B

Conger wilsoni Fowler, 1923b, p. 375 (Honolulu); 1928, p, 38, pl. 1,c.

HOLOTYPE: USNM 162512, 237 mm. in total length, collected Dec. 22, 1951, 5–20 feet in depth at poison station, 200 yards west of Diamond Head Light House, edge of cut in reef, Oahu Island, Hawaii, by Gosline and class.

PARATYPES: USNM 163567 (3 specimens), 194, 226, and 245 mm. in total length, taken with the holotype.

George Vanderbilt Equatorial Expedition Stations 15 and 26, 2 specimens, Laysan Island and Maro Reef, Territory of Hawaii, 1951.

DIAGNOSIS: Teeth in one row in jaws, pores in lateral line 35 to 36, vertebrae 137 to 139, diameter of eye 24 to 30.

Description: The description is based on the holotype and five paratypes. The counts recorded first are for the holotype; those in parentheses are for the paratypes. Pores in lateral line 35 and 36 (35 to 36); pectoral rays 15 (16); vertebrae (X-ray) 137 (139); teeth in upper jaw in one row; compressed teeth in upper jaw 40 (30 to 46), in lower jaw 39 (42 to 45), vomerine teeth 13 (12 to 17), premaxillary teeth 16 (12 to 21); preoperculo-mandibular pores 9 (9); supratemporal pore 1(1). Gill opening near middle of pectoral base, rictus of jaws extends posteriorly to rear margin of pupil or about two-thirds of eye; origin of dorsal fin from 2.63 to 28 percent of pectoral fin length behind posterior tip of pectoral fin. See table 7 for various measurements expressed in thousandths of total length for the holotype and paratypes.

Geographical range: Known only from the Hawaiian Islands.

Remarks: Fowler (1923b, p. 375) recognized two species from the Hawaiian Islands and thought one of his species was the same as Waite's *C. wilsoni* (=*verreauxi*); however, it differs from *verreauxi* in number of lateral line pores and number of vertebrae. Its affinity is with *C. jordani*, but differs from it in that the eye is larger and the number of vertebrae is fewer.

This new species can be distinguished from the two species of *Conger* in the Hawaiian Islands by the characters given in the key (p. 230).

The name of this new species is in reference to its possession of few lateral line pores.

Table 7.—*Measurements of* Conger oligoporus *expressed in thousandths of total length*

Characters	Holotype	Paratypes				
	USNM 162512	USNM 163567	USNM 163567	USNM 163567	GVF 15	GVF 26
Total length (in mm.)	237	226	194	245	227	110
Head length	143	153	157	145	145	141
Snout to dorsal origin	203	208	219	200	197	200
Snout to anus	346	356	379	353	352	341
Snout length	37	36	36	37	35	34
Diameter of eye	27	30	28	28	25	24
Length of upper jaw to rictus	51	53	54	48	57	45
Pectoral fin length	53	52	59	51	49	45
Depth of body	49	50	55	43	46	49
Length of gill opening	15	16	17	16	15	14

Conger esculentus Poey

Figures 2, 3; Plate 1,f

Conger esculentus Poey, 1858, p. 346 (type locality, Cuba); 1867, p. 246; 1868, p. 424; 1876, p. 151.—Stahl, 1883, p. 80.—Rivero, 1938, p. 173.

Conger niger Bean and Dressel, 1884, p. 169 (Jamaica).

[?] *Conger vulgaris* Günther, 1870, p. 39, item "w," (St. Helena).—Metzalaar, 1919, p. 14 (Curaçao).

[?] *Conger vulgaris* var. *niger* Günther 1869, p. 239 (St. Helena).—Melliss, 1875, p. 110.

Specimens studied: Three specimens, from 970 to 1030 mm. in total length, from the following localities: Cuba, MCZ 9328 (holotype), 9330; Jamaica, USNM 32091.

Diagnosis: Two rows of teeth in jaws; pectoral rays 18 to 19; length of head 170 to 183.

Description; Tip of snout to origin of dorsal fin 222 to 236; upper jaw 62; length of pectorals 59 to 70; number of compressed teeth in upper jaw 53 to 63; lower jaw 54 to 58; vomerine teeth 45 and in a triangular patch; premaxillary teeth 36; tooth-patch wider than long; vertebrae 46 precaudal, and 86 caudal; teeth in jaws in two rows; supratemporal pore 1; preoperculo-mandibular pores 9; preorbital bone without ossification bridging across the sensory canal, pl. 1,f. Additional counts and measurements are recorded in tables 1 to 6, and fig. 2. (All counts and measurements of the holotype were made by William C. Schroeder of the Museum of Comparative Zoology at Harvard.)

Geographical range: Cuba, Jamaica, and possibly to Curaçao and St. Helena.

Remarks: This species is related to *C. erebennus* from Japan and *C. macrocephalus* from the Philippines. The differences distinguishing these species are given in the key (p. 230).

Günther (1870, p. 39, item "w") lists under *Conger vulgaris* an adult from St. Helena. Dr. Marshall of the British Museum kindly furnished the following data for this specimen: Total length 1027 mm.; head length 169 mm.; tip of snout to anus 428; tip of snout to origin of dorsal fin 259; snout length 41; eye 21; pectoral length 68; lateral line pores 37; supratemporal pore 1; and pectoral rays 16. The lateral line pore count of 37 for this specimen is much fewer than the usual 44 to 47 for the species *C. conger* from European waters (table 2). The pore counts and proportional measurements are closest to *C. esculentus* from Cuba. For comparison of the two forms see tables 1, 2, 5, 6. The only difference between the two forms seems to be in the number of pectoral rays—18 to 19 for *C. esculentus* and 16 for the St. Helena specimen. The number of vertebrae and the number of teeth in jaws may show some difference. Until more specimens can be examined I am placing this specimen with *C. esculentus.*

Posada Arango (1909, p. 305) lists *Conger vulgaris* from the Columbian Caribbean; however, this specimen is not a *Conger* since it is described with tentacles and barbels. Metzalaar (1919) lists *Conger vulgaris* from Curaçao. I am unable to verify this specimen as *C. esculentus,* but I am placing it here until it can be verified.

***Conger macrocephalus*, new species**

PLATE 1,M

? *Conger vulgaris* Bleeker, 1864, p. 26, Java, Celebes and Letti.
? *Conger conger* Weber and de Beaufort, 1916, p. 259.

HOLOTYPE: USNM 164334, total length 803 mm., Philippines, Verde Island passage, lat. 13°34′37″ N., long. 121°07′30″ E., Feb. 22, 1909, collected by the *Albatross,* at a depth of 180 fathoms.

DIAGNOSIS: Teeth in upper jaws in two rows laterally; pores in lateral line 35; pectoral rays 17; length of head 199.

DESCRIPTION: Length of head 199; tip of snout to origin of dorsal fin 247; tip of snout to anus 416; snout length 50; diameter of eye 24 length of upper jaw 66; length of pectorals 51; compressed teeth in upper jaw 66; two rows of teeth in jaws, inner row two-thirds the length of outer row; dorsal rays 288; anal rays 214; premaxillary tooth-patch wider than long; origin of dorsal fin 10.41 percent behind pectoral tip; preorbital bone without ossification bridging across sensory canal; supraorbital pore 1; preoperculo-mandibular pores 9; vertebrae 137 (X-ray). Additional counts and proportional measurements are recorded in tables 1, 2, 3, 5, 6.

GEOGRAPHICAL RANGE: Philippines and East Indies.

REMARKS: This species is closely related to *C. esculentus* from the West Indies; however, it differs from it by having fewer pectoral rays and more compressed teeth in upper jaws (table 4). This species is named in reference to its long head.

***Conger erebennus* (Jordan and Snyder)**

PLATES 1,J, 4,B

Leptocephalus erebennus Jordan and Snyder, 1901, p. 849 (in part), fig. 3 (type locality, Misaki, Japan).
Leptocephalus kiusiuanus Jordan and Snyder, 1901, p. 851 (Hakata, Kiushu, Japan).
Conger japonicus Jordan and Hubbs, 1925, p. 194 (in part).

SPECIMENS STUDIED: Six specimens, ranging in length from 429 to 776 mm., from the following localities: JAPAN: Misaki SNHM 6466 (holotype of *erebennus*); Hakata, Kiushu SNHM 6467 (type of *kiusiuanus*); Idzu USNM 22563; Tokyo market USNM 49440; Suruga Gulf USNM 163468. KOREA: Fusan USNM 143410.

Diagnosis: Two rows of teeth in jaws; pectoral rays 19 to 21; origin of dorsal fin from 10 percent behind pectoral tip to 40 percent anterior to pectoral tip; length of head 163 to 184; ossification not bridging across sensory canal of preorbital bone.

Description: Tip of snout to origin of dorsal fin 199 to 222; length of pectoral fins 48 to 60; upper jaw (to rictus) 52 to 59; dorsal rays 288 and 300, anal rays 217 and 229 in two specimens; vertebrae 137 to 147 (50 precaudal and 87 caudal in one specimen); two rows of teeth in jaws laterally, inner row from one-half to whole length of outer row; 39 to 53 compressed teeth in upper jaw, 40 to 52 in lower jaw; premaxillary tooth-patch wider than long; one supratemporal pore; upper edge of gill opening near midpoint of pectoral base, slightly closer to upper edge than lower; rictus of jaw below middle of eye; length of head into trunk 1.10 to 1.39, head and trunk into tail 1.48 to 1.60; ossification not bridging over sensory canal of preorbital bone. Additional counts and proportional measurements are recorded in tables 1 to 6. (Counts and measurements of the types were made by Dr. J. Böhlke at Stanford Museum.)

Geographical range: From Sagami Bay southward to Hakata, Kiushu, Japan, to Fusan, Korea.

Remarks: Jordan and Snyder (1901, p. 849) had two other species mixed with the type series of *Leptocephalus erebennus*: one specimen of *Conger myriaster* and three of *C. jordani.* Jordan and Snyder recognized the differences in the head and trunk proportions in their key; however, in their description the proportional measurements were mixed.

This species is closely related to *C. esculentus* from the West Indies. For differences see key (p. 231).

The number of pectoral rays distinguishes this species from the others found in Japanese waters. It differs further from *C. myriaster* by having a longer head and without white areas around sensory pores and pits. It differs further from *C. jordani* by having two rows of teeth in jaws, the origin of dorsal fin situated more anteriorly, and ossification not bridging over sensory canal of the preorbital bone.

Conger philippinus, new species

Plate 1,k

[?] *Conger vulgaris* Günther, 1870, p. 39 (in part), item "l" (East Indian Archipelago).

[?] *Conger multidens* Pohl, 1884, p. 40 (fide Fowler, 1931, p. 316, Viti Levu).—Whitley, 1927, p. 4.

[?] *Conger orbignyanus* Fowler, 1931, p. 316.

Conger conger Herre, 1934, p. 16 (Cebu, Dumaguete, and Oriental Negros in the Philippines).

Holotype: USNM 134969, 234 mm. in total length, collected at a market in Cebu, Philippines, Mar. 22, 1909, *Albatross.*

Paratypes: SNHM 27116, 223 mm., from Cebu, Philippines, Aug. 27, 1931, Herre; SNHM 26848 (2), 212 and 278 mm., Dumaguete, Philippines, June 18, 1931, Herre's Philippine Expedition.

Diagnosis: Two rows of teeth laterally, pores in lateral line 37 to 38; vertebrae 127 to 135; pectoral rays 15 to 16.

Description: The counts recorded first are for the holotype; those in parentheses are for the paratypes. Length of head 124 (126 to 144); tip of snout to origin of dorsal fin 201 (202 to 224); tip of snout to anus 359 (363 to 401); snout length 27 (27 to 34); diameter of eye 20 (22 to 26); length of pectoral fins 46 (47 to 50); upper jaw (to rictus) 39 (41 to 50); supratemporal pore 1; pores in lateral line 38 (37 to 38); preoperculo-mandibular pores 9; vertebrae 130 (127 to 135); pectoral rays 16 (15 to 16); compressed teeth in upper jaw 38 to 45; two rows of teeth laterally in jaw; premaxillary tooth-patch wider than long; origin of dorsal fin 75 percent of pectoral fin length behind posterior tip of pectoral fin (71.43 percent to 85.00 percent); preorbital bone without ossification bridging across sensory canal at 278 mm. in total length.

Geographical range: Philippine Islands, East Indies, and possibly Fiji Islands.

Remarks: This species is related to *C. wilsoni* from Australian waters; however, it differs from it by having fewer lateral line pores, pectoral rays and vertebrae.

Pohl (1884, p. 40, fide Fowler, 1931, p. 316) records a specimen of *Conger multidens* from the Fiji Islands with origin of dorsal fin about a pectoral fin length behind posterior tip of pectoral fin; however, until a specimen can be examined from that area I am referring it to this species.

Dr. Marshall of the British Museum has measured and made counts on a specimen listed under *Conger vulgaris* by Günther (1870, p. 39, item "l".) The counts and measurements compare closely with *philippinus.*

***Conger wilsoni* (Bloch and Schneider)**

Figure 2,w; Plate 1,h

Gymnothorax wilsoni Bloch and Schneider, 1801, p. 529 (type locality, New Holland).

Conger wilsoni Castelnau, 1872, p. 193 (Hobart, Tasmania, and Hobson's Bay, Victoria).—Waite, 1923, p. 72, fig. 54.

Leptocephalus monganius Phillipps, 1932, p. 230 (Mongoniu, Doubtless Bay).

Leptocephalus labiatus Griffen, 1936, p. 15.

Leptocephalus wilsoni hesperius Whitley, 1944, p. 25, fig. 1, (Leighton Beach, near Fremantle, Western Australia).

Specimens studied: Four specimens, ranging in length from 289 to 1012 mm., from the following localities in Australia: Port Jackson, New South Wales, USNM 47765, 47830, and 47764; Strickland Bay, Rottnest Island, Western Australia, USNM 164518.

Diagnosis: Two rows of teeth in jaws, lateral line pores 38 to 40, pectoral rays 17 to 18, vertebrae 146 to 147.

Description: Tip of snout to origin of dorsal fin 185 to 194; length of head 119 to 139; tip of snout to anus 349 to 379; diameter of eye 15 to 23; length of snout 26 to 34; length of upper jaw (to rictus) 40 to 46; length of pectoral fin 42 to 47; supratemporal pore 1; preoperculomandibular pores 9; vertebrae 146 to 147 (50 to 51 precaudal plus 95 to 96 caudal); vomerine teeth 25 to 46; premaxillary teeth 12 to 36; two rows of teeth in jaws laterally; premaxillary tooth-patch wider than long; preorbital bone has ossification developed across sensory canal (pl. 1,h); origin of dorsal fin from 26 percent to 71.5 percent of pectoral fin behind posterior tip of pectoral fin. Additional counts and proportional measurements are recorded in tables 1–6.

Geographical range: From Moreton Bay, Queensland, southward to Tasmania and New Zealand, and westward to Fremantle, Western Australia.

Remarks: This species is related to *C. oceanicus* but differs in the origin of dorsal fin being more posterior in position and by having a greater number of compressed teeth in upper jaw (fig. 2).

Griffen (1936) in his revision of the eels of New Zealand, lists 2 species from that area and distinguishes the 2 species by the origin of dorsal fin and the thickness of the body.

Conger verreauxi **Kaup**

Conger verreauxi Kaup, 1856a, p. 72 (type locality Australia).
Conger vulgaris Günther, 1870, p. 39, items "x" and "y," (Tasmania).
[?] *Conger labiata* Castelnau, 1879, p. 396 (Port Jackson, New South Wales).
Leptocephalus conger Waite, 1911, p. 164 (between Timaru and Porangahan Bay on east cost of New Zealand).
Leptocephalus labiatus Phillipps, 1932, p. 229, fig. 3.
Leptocephalus verreauxi Griffen, 1936, p. 15.
Conger wilsoni Waite, 1921, p. 49, fig. 74; 1923, p. 72, fig. 54.

Specimens studied: A specimen in the British Museum, examined by Dr. Marshall, and Kaup's type from the original description.

Diagnosis: Two rows of teeth in jaws; vertebrae 152 to 156; origin of dorsal fin about over the posterior tip of pectoral fin; diameter of eye small.

Description: Length of head 131 to 143; tip of snout to origin of dorsal fin 202; tip of snout to anus 377 to 412; snout length 39; diameter of eye 11; length of pectorals 39 to 59; origin of dorsal fin 9.43 percent of pectoral fin behind posterior tip of pectoral fin forward; two rows of teeth in jaws laterally, 54 to 55 precaudal and 97 to 102 caudal vertebrae. Additional counts and proportional measurements are recorded in tables 1–3, 5, 6.

Geographical range: From southern Queensland southward to Tasmania and New Zealand.

Remarks: In the English translation, Kaup's (1856b, p. 115) locality of the type specimen of *Conger verreauxi* was omitted. Kaup's description (1856b, p. 73) states "nach meinen verehrten Freunde Julius Verreaux genannt, welcher ihn in Australien sammelte." Whitley (*in* Griffen, 1936, p. 15) thinks that the type probably came from Tasmania, where Verreaux collected.

Castelnau (1879, p. 396) and Phillipps (1932, p. 229) mention a small tentacle on each side of the snout; if this is so, *C. verreauxi* is the only species in the genus that has such tentacles.

There are two species of *Conger* in Australian waters. The main difference between them appears to be in the number of vertebrae and the origin of the dorsal fin, which is in a more anterior position in *C. verreauxi*.

Conger oceanicus Mitchell

Figures 2, 3; Plate 1,c

Anguilla conger Mitchell, 1814, p. 360.

Anguilla oceanica Mitchell, 1818, p. 407 (type locality, off New York, near Bloch Island).—Storer, 1846, p. 234.

Conger occidentalis De Kay, 1842, p. 314, pl. 53, fig. 172.

Isognatha oceanica Gill, 1861, p. 56.

Echelus conger Jordan, 1888, p. 90.

Leptocephalus conger Jordan and Davis, 1892, p. 664 (in part).—Jordan and Evermann, 1896, p. 354 (in part), pl. 57, fig. 148.—Smith, 1907, p. 111, fig. 35.—Fowler, 1912, p. 9 (in part).

Conger conger Bigelow and Welsh, 1925, p. 86, fig. 36.—Hildebrand and Schroeder, 1928, p. 116.—Jordan, Evermann and Clark, 1930, p. 79 (in part).

Conger oceanica Bigelow and Schroeder, 1953, p. 154, fig. 70.

Specimens studied: 48 specimens, ranging in total length from 152 to 1052 mm., from the following localities: Massachusetts, USNM 16961, 49682, 126121, 148152 (2) MCZ 35806; Connecticut, USNM 16027, 43098, 14053 (2); Rhode Island, USNM 20745; New York, USNM 48941; New Jersey, USNM 6827, 28717, 28765, 33053, 36908, 118205 thru 118210 (7); Virginia, USNM 32796–7–8, 90395; Chesapeake Bay, USNM 127218; North Carolina, USNM 131327, 134184, CNHM 39999, 40000, 40331, AMNH 4369 (3), SNHM 1880; South Carolina, USNM 7418, 25352, 25358, SNHM 10314; Florida (New Smyrna), USNM 62652; Mississippi, USNM 164239 (4); Atlantic Coast of United States, USNM 44341.

Diagnosis: Pores in lateral line 39 to 44; pectoral rays 16 to 18; vertebrae 140 to 147; diameter of eye 17 to 28.

Description: Tip of snout to origin of dorsal fin 185 to 230; length of pectoral fins 37 to 62; supratemporal pore 1; preoperculo-mandibular pores 9; vertebrae 85 to 96 caudal and 50 to 51 precaudal; in one specimen dorsal rays 273; anal rays 187; compressed teeth in upper jaw 27 to 65, in lower jaw 28 to 59; two rows of teeth in jaws, inner row conical; premaxillary tooth-patch wider than long; upper edge of gill opening near midpoint of pectoral fin base; rictus of jaw below middle of eye. Additional counts and proportional measurements are recorded in tables 1–3, 5, 6, and in figure 2.

Distribution: On eastern Atlantic coast from Massachusetts to Florida, and Gulf of Mexico to Pascagoula, Miss. Bigelow and Schroeder (1953, p. 156) record adults from North Truro, Cape Cod, and near Provincetown in Cape Cod Bay, Mass. The *Oregon* collected four specimens just south of Pascagoula, Miss., at a depth of 260 fathoms in an 80-foot balloon trawl.

Remarks: There is a clinal difference in the length of head and snout from north to south. The forms from New England have a shorter head and snout than those of Carolinas and Florida; those from the Gulf of Mexico have the longest.

Area	Length of head in thousandths of total length										
	130	135	140	145	150	155	160	165	170	175	180
New England States	1	1	3	1	2	3	1	----	----	----	----
New Jersey–Virginia	----	1	3	5	2	3	1	3	----	----	----
North Carolina southward	----	----	----	2	1	3	3	3	5	1	----
Gulf of Mexico	----	----	----	----	----	1	----	1	1	----	1

Area	Length of snout in thousandths of total length								
	27.5–29.9	*30.0–32.4*	*32.5–34.9*	*35.0–37.4*	*37.5–39.9*	*40.0–42.4*	*42.5–44.9*	*45.0–47.4*	*47.5–49.9*
New England States	2	3	1	3	1	1	-----	-----	-----
New Jersey–Virginia	1	4	4	2	4	4	-----	-----	-----
North Carolina southward	-----	1	2	1	4	3	3	-----	-----
Gulf of Mexico	-----	-----	-----	-----	-----	2	-----	-----	2

This species is related to *C. wilsoni* from Australia, but differs from it by having the origin of dorsal fin more anterior in position and a fewer number of compressed teeth in the upper jaw (fig. 2).

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THREE NORTH AMERICAN CRETACEOUS FISHES

By David H. Dunkle

I. Remarks on *Helmintholepis vermiculatus* Cockerell

Plate 1

The North American Cretaceous fish *Helmintholepis vermiculatus* Cockerell (1919) is based on a single disassociated scale (USNM 8677). The specimen was collected in 1914 by T. E. Willard, of the U. S. Geological Survey, 1¼ miles northeast of Milliken, sec. 13, T. 5 N., R. 67 W., Weld County, Colo., in exposures of the Fox Hills sandstone (Maestrichtian).

The scale, presumably deriving from the left flank of a fish, is comparatively large and, although composed of successive fine lamellae, is of remarkable over-all thinness. The major portion of the apical margin is missing. The outline of that part impressed in the matrix, however, indicates a roughly 5-sided form for the scale. Of these edges the broadly rounded apical margin has the greatest length. The dorsal and ventral borders converge slightly toward each other, anteriorly, to distinct but obtuse basal angles. The basal margin is divided into upper and lower segments by a low, forwardly convex, median lobe. The greatest length of the scale (21.4 mm.) passes along a longitudinal axis a little nearer the dorsal border than to the ventral one, and the perpendicular of maximum depth (20.9 mm.) is situated far posteriorly in the vertical plane of the dorsal and ventral apical angles.

The nucleus is a concentrated locus on the longitudinal axis of the element, somewhat basal of the middle length of the scale. Surrounding this area in concentric fashion, relatively fine circuli (about 34 in 1 mm.) cover the dorsal, ventral, and basal quadrants of the external surface. No basal radii are evidenced, but suggestive of such structures are a series of sinuous folds in the courses of the circuli, arranged in an anteroposterior line across the median basal field. The circuli terminate, posterodorsally, along a diagonal extending from the nucleus to the middle point of the dorsal border and, posteroventrally, along a more acutely oblique diagonal extending from the nucleus to a point near the ventral apical corner of the scale. The apical quadrant is, thus, a triangular field with a nuclear angle of approximately 120°. The preserved portion of this part is ornamented with short vermiculate markings which in the center of the field are directed more or less longitudinally and on either side of this median area in zones adjacent to the apical diagonals, vertically. Peripherally the anterior terminations of generally longitudinal apical radii, spaced 4.5 to 5 in 1 mm., may be observed. From the comparisons discussed below, it seems feasible to postulate the passage of these radii posteriorly across a missing marginal and hyaline zone to end in notches along the dentate apical margin of the scale.

The scale of *Helmintholepis vermiculatus* cannot be distinguished from anterior flank scales of the upper Cretaceous Pierre shale fishes *Pelycorapis berycinus* Cope (1877) and *Paleoclupea dakotaensis* Dante (1942). From well-preserved specimens in the U. S. National Museum, the skulls, as well as the scales of the latter two genera, are identical. It must be concluded, therefore, that *Helmintholepis vermiculatus* and *Paleoclupea dakotaensis* are synonyms of *Pelycorapis berycinus.* Unfortunately, the generic term *Pelycorapis* does not appear available for the *berycinus* species. Examination was recently made in the American Museum of Natural History of the genotypic specimen, *Pelycorapis varius,* defined by Cope (1874) on the basis of a fragmentary fish from an undetermined horizon in the "Benton" of Kansas. There can be little doubt of at least close relationship, if not even conspecific identity, between *P. varius* and the North American elopid fish *Thrissopater intestinalis* Moodie (1911).

Woodward (1901, pp. 353, 354, 616) early advocated affinity, at least at the family level, between the two species assigned to the generic name *Pelycorapis* (Cope, 1874, 1877), *Syllaemus* (Cope, 1875), *Apsopelix* (Cope, 1871), and *Leptichthys* (Stewart, 1899). *Apsopelix* from the "Benton" of Kansas is apparently known only by the fragmentary type specimen. No differences can be observed between the scales and vertebrae of this specimen and the corresponding parts of *Syllaemus* and *Leptichthys.* Most authorities (for example, Hay, 1929; Romer, 1945) continue to treat *Syllaemus* and *Leptichthys* as distinct genera, but in addition to their similarity of scale and vertebral structure, no major variation has been detected as yet among available skulls of the two genera. Certainly the North American materials which have been variously referred to either *Apsopelix, Syllaemus,* or *Leptichthys* constitute a basically homogeneous group peculiar to a number of marine strata exposed in the Western Interior, which in geologic range seem restricted to the interval between either the late Cenomanian or early Turonian and the Santonian stages of the upper Cretaceous.

Relationship between the *Apsopelix-Syllaemus-Leptichthys* complex of forms and the late upper Cretaceous *berycinus* species is denoted by the common possession of distinctive modifications of the bone pattern of the skull, and by general over-all similarities in body habit, including the structure and relative position of fins. As might be anticipated, on the other hand, certain regularly occurring variations are to be observed. Of these, the proportions of the parts of the visceral skeleton differ and these features may account for the curious apposition of the mandibles commonly displayed by specimens of *Syllaemus* and *Leptichthys.* Further, the scales of the latter two genera have a large and diffuse nuclear field mainly devoid of any ornamentation and, depending on body position, with the apical quadrant covered proximally, either with complete and entirely vertical circuli or with a median hyaline zone. Such comparisons prompt, in at least tentative solution of the problem, allocation of the *berycinus* species to the oldest generic name unquestionably associated with this group, *Apsopelix.*

To be demonstrated shortly in another connection, the compact assemblage of fishes under consideration is of elopine stock. The members, thus, display interesting specializations of the most primitive teleostean stage of morphologic organization. They comprise a distinctive component of upper Cretaceous marine faunas and would seem best interpreted as a line of pelagic plankton feeders.

Sincere thanks are extended to Drs. Bobb Schaeffer, American Museum of Natural History, and Robert W. Wilson, Kansas University Museum of Paleontology, for courtesies in making pertinent materials available. The photograph was made by Jack Scott of the Department of Geology, U. S. National Museum.

II. Reassignment of *Petalolepis? fibrillatus* Cockerell

PLATE 2

The generic name *Petalolepis* first appeared in an unpublished catalog of fish remains from the upper Cretaceous Pläner formation of Saxony, Germany, compiled by Prof. Moritz Steinla. Subsequently in formal description, Geinitz (1868) considered *Petalolepis* a synonym of the elopid genus *Osmeroides* (Agassiz, 1844) and proposed the name *O. divaricatus* for the identical Steinla specimens. Cockerell (1919, p. 173) interpreted the same scales as those of an albulid fish, and finding the name *Petalolepis* available for the reception of the hence reassigned *divaricatus* species, provisionally referred a new American species, *fibrillatus*, to the generic term. Heretofore known only by the one holotypic specimen (USNM 8662), two additional scales of *Petalolepis? fibrillatus* were recently recognized among the national collections of fossil fishes.

The variety and individuality of fish scales have been amply demonstrated through the work of many investigations in all parts of the world. However, when attempts have been made to arrange these exoskeletal elements in developmental series, the resultant trends of structural variation, either parallel, convergent or divergent, appear to cross phylogenetic lines. In direct consequence, serious doubts are entertained by many ichthyologists not only of the ability but also of the use for identifying and naming fragmentary remains of such parataxial nature. Although disassociated fish scales probably never can constitute a completely satisfactory base for precise studies of broad scope, the future clarification of group relationships and corresponding refinement of fish classification, coupled with accumulated factual data concerning development at all ontogenetic and phylogenetic levels, will correct many of the difficulties surrounding the use of scales. Within restricted limits, on the other hand, scales have been proved effective tools. In the present case a new definition of *Petalolepis? fibrillatus* seems justified. The fossil specimens are entirely distinctive in fundamental structural characteristics and are not to be identified with the genotypic *Petalolepis divaricatus* (Geinitz) from Germany. Equally important, they are of potential stratigraphic utility as representative of practically unknown marine faunas from near shore and lagoonal environments for a seemingly short interval of the late upper Cretaceous in North America.

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Family GADIDAE

Paractichthys,[1] new genus

DIAGNOSIS: A fossil genus distinguished from living anacanthine fishes by the following combination of scale characteristics: proportionately large, subquadrangular form with central oblong nuclear field and single longitudinal median basal sulcus; peripheral basal circuli more or less longitudinal from apical diagonals to basal scale margin; more proximal basal circuli crescentic, paralleling the basal border and rather sharply recurved or acutely angulated on approaching the median sulcus; and short, sinuous apical circuli diverging slightly to the apical scale border from a faint median longitudinal axis.

TYPE SPECIES: *Paractichythys fibrillatus* (Cockerell) (=*Petalolepis fibrillatus* Cockerell, 1919).

Paractichthys fibrillatus (Cockerell)

DIAGNOSIS: The same as for the genus (the only species).

TYPE: USNM 8662; one disassociated scale.

GEOLOGIC AND GEOGRAPHIC OCCURRENCE: Upper Cretaceous Blair formation (middle Campanian, following Cobban and Reeside, 1952) in the NW¼NE¼ sec. 26, T. 21 N., R. 104 W., Sweetwater County, Wyo.

REFERRED SPECIMENS: USNM 14517 from the topotypic horizon and locality in Wyoming; and USNM 21898 from the upper Cretaceous Fox Hills sandstone (Maestrichtian), near Milliken, in sec. 23, T. 4 N., R. 67 W., Weld County, Colo.

DESCRIPTION: Scales generally of moderate size and ranging from examples with equal dimensions to ones longer than deep (measurements, in millimeters: 10–17 long by 9–12 deep). In outline, the elements are subquadrangular, although the apical portion was evidently weak and the posterior border of the scale is usually preserved with an evenly rounded profile. As here interpreted, the dorsal margin displays a lower convexity than does the ventral one. Anteriorly these edges diverge slightly from each other to obtuse basal angles. The basal border is of low forward convexity but displays a prominent notched median lobe. The longitudinal axis is situated nearer the dorsal border than to the ventral, and the perpendicular of maximum depth lies anteriorly near the vertical plane of the basal angles.

The oblong nucleus occurs adapical to the middle scale length, along the main longitudinal axis. Neither basal nor apical radii are present, although a median longitudinal sulcus extending between the

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[1] Derived from the Greek *para*, near; *akte*, shore; and *ichthys*, fish; referring to the inferred near-shore habitat occupied by the fish.

basal margin and the nucleus is a prominent structural feature of all known specimens. Circuli are relatively coarse (about 19 in 1 mm.). On the covered portion of the scale the central ones are crescentic, and paralleling the basal border are either sharply recurved or acutely angulated as their courses approach the median sulcus. Peripherally the circuli are more nearly longitudinal in their arrangement and intersect in very acute angles the basal scale margin after only slight median flexure. The exposed apical quadrant has a nuclear angle of from 75° to 80° and is covered with short, sinuous circuli, which are directed backward and slightly away from a faint median longitudinal axis.

Remarks: The scale characteristics of *Paractichthys* are more comparable to those of anacanthine fishes than to any other living group (David, 1956). While very probably not closely related to any extant member, all features exist in one or another genus of the Gadidae. It is upon this basis that the family assignment has been made. Heretofore, the codfishes and their allies have been recognized only from marine sediments of Tertiary age. *Paractichthys*, thus, extends the known geologic range of the gadid fishes into the upper Cretaceous, and the genus may prove, on recovery of more complete remains, a key to the establishment of the complete phyletic history of this distinctive assemblage of fishes.

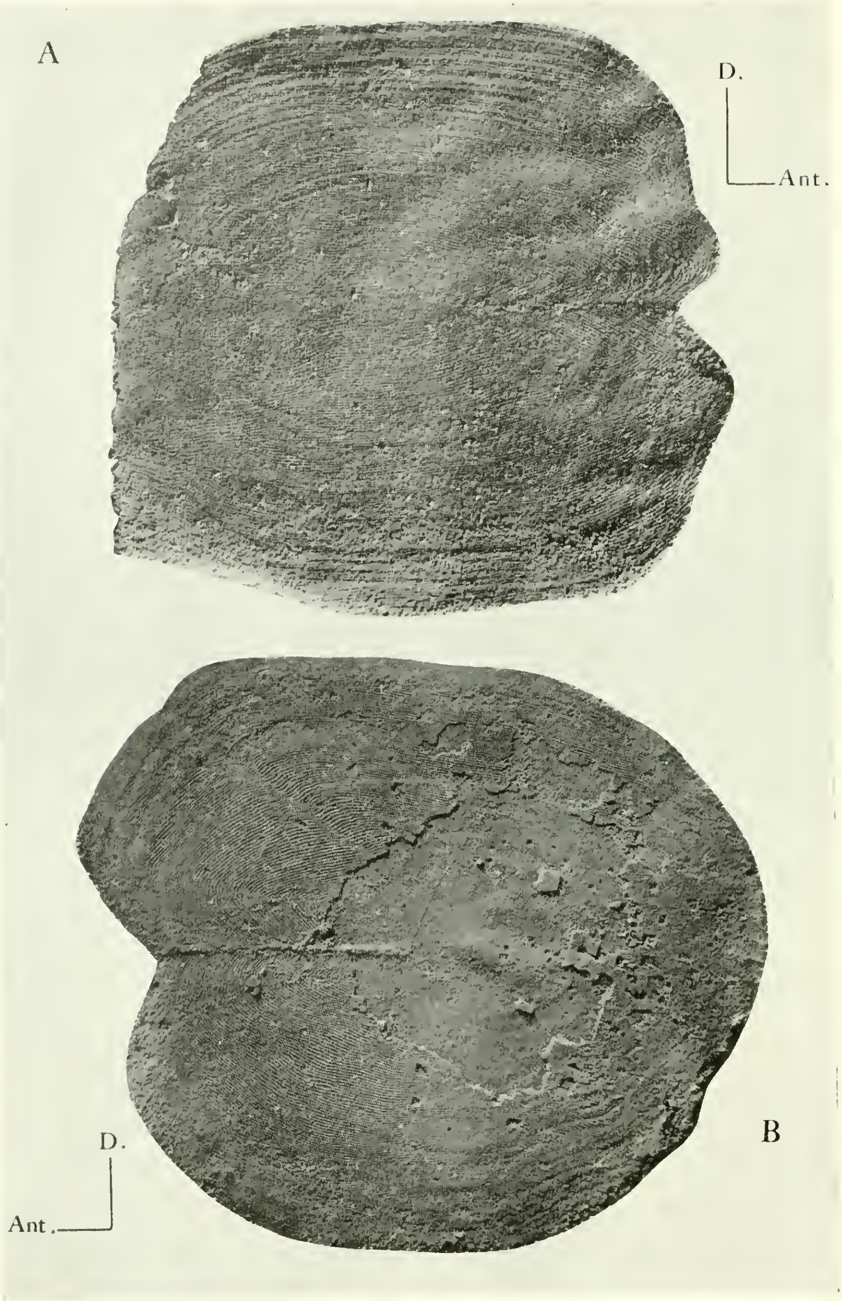
III. Comments on the Status of *Cyclolepis stenodinus* Cockerell

Plate 3

The genus *Cyclolepis* was named and described by Geinitz (1868). The genotypic species, *C. agassizi*, is based on unassociated scales from the Pläner formation (Cenomanian and Turonian) of Saxony, which display a subcircular or ovate outline with nearly central nucleus, concentric circuli, and an absence of either radii or ctenoid structures. Although various opinions have been held regarding the affinities of the form, most current classification outlines list *Cyclolepis* with the salmonoid fishes (Romer, 1945; David, 1946).

In 1919, Cockerell described an isolated scale from the upper Maestrichtian (Fox Hills sandstone) of Colorado under the name *Cyclolepis stenodinus*. The Cockerell type (USNM 8703) is exposed in internal aspect, displaying prominent annular growth rings, and as thus observed would appear to compare closely with the characterization of *Cyclolepis* Geinitz. However, recent examination under highly refractive liquids and the binocular microscope has revealed previously unreported features of the embedded external surface of the scale. The new information creates serious doubt as to the correctness of the generic reference and even as to the validity of the Colorado species.

Photograph of type scale *Helmintholepis vermiculatus* Cockerell (1919), herein reassigned to *Apsopelix berycinnus* (Cope), with missing margins restored. Reproduction approximately × 4. Explanation of abbreviations: Ant, anterior; and D, dorsal.



Paractichthys fibrillatus (Cockerell). Scales (A, USNM 8662 type; B, USNM 14517) from the upper Cretaceous Blair formation in Sweetwater County, Wyo. Reproduction approximately × 10. Explanation of abbreviations: Ant, anterior; D, dorsal.

Holotypic scale of *Cyclolepis stenodinus* Cockerell (USNM 8703). Specimen, presumably from right flank of fish, drawn with anterior basal edge oriented to the right; external surface ornamentation somewhat diagrammatized, and small vertical striae between circuli omitted. (Magnification × 9.)

The original description of *Cyclolepis stenodinus* now may be expanded. A relatively thin scale of moderate size (measurements, in millimeters: 12.4 long by 9.7 deep). In outline, subcircular with broadly rounded and confluent dorsal, apical, and ventral margins; obtuse but distinct basal angles; and a centrally lobed basal edge. Perpendicular of maximum depth adjacent to the basal angles and thus situated far anteriorly. Nucleus a concentrated focus both internally and externally, slightly apicad of central. No basal or apical radii, but suggestive of the former are several (three or more) indistinct folds or undulations in the courses of the circuli across the central part of the basal field, arranged in lines convergent posteriorly toward the nucleus. Circuli on anterior inserted portion of scale coarse (18 in 1 mm. centrally and 12 in 1 mm. peripherally above and below, and in their posterior zone of termination along the apical diagonals); essentially vertical in arrangement although slightly curved in an anterior direction around the nucleus and bent posteriorly both along the ventral basal diagonal and in an upper peripheral zone so that the dorsal ends of the lines intersect the scale margin at more acute angles than do the ventral ends. Interspaces between the more widely separated circuli of the dorsal and ventral quadrants marked by short, fine, parallel striae (10 to 12 in 0.1 mm.), directed at acute angles to the circuli and generally perpendicular to the anteroposterior axis of the scale. Apical field triangular with a nuclear angle of about 101°; ornamented with fine circuli (34–36 in 1 mm.) arranged in parallel but slightly undulating crescentic courses to meet the terminations of the basal circuli along the apical diagonals in angles of approximately 90°. Internal surface of scale distinctly marked by sparsely tuberculous and concentric annular growth rings which are in places so closely set they resemble concentric circuli.

No materials of the genotypic *Cyclolepis agassizi* are available for comparison. Notwithstanding, the characteristics of the scale of *Cyclolepis stenodinus* are not those either commonly or easily associated with the scales of salmonoid fishes. Rather, scales of its type with essentially vertical circuli which are coarser in the basal portion than in the apical one and with nearly central nuclei are better recognized as pertaining to the Synentognathi, Scombroidea and Carangoidea. During search among these latter groups for more closely comparable materials, striking and fundamental similarities were observed between *C. stenodinus* and *Hemilampronites hesperius* Cockerell (1919). In fact, only minor differences of shape, absolute size, and slight details of sculpture exist between the two species and these are well within the range of variation to be expected between scales from different parts of the body of one fish. Interestingly also, the holotype of *H. hesperius* (USNM 8713) and that of *C. stenodinus* were both collected by T. E. Willard of the U. S. Geological Survey on Sept. 14, 1914, from the same exposure of Fox Hills sandstone in sec. 23, T. 4 N., R. 67 W., southwest of Milliken, Weld County, Colo. It is concluded that *Cyclolepis stenodinus* is a synonym of *Hemilampronites hesperius*.

Cockerell (1919) referred *Hemilampronites hesperius* to the Hemiramphidae. Such a relationship is indeed supported by the centrally lobate basal border and the marked angle of meeting of the apical and basal circuli displayed by the scales. As remarked by David (1946) in another case, however, the proportionately long, broadly rounded outline and lack of discrete basal radii suggest relationship also with either or both the Scomberesocidae and Exocoetidae, among other Synentognathi. This distinctive combination of structural features, which serves adequately to separate the Cretaceous species from the Tertiary and living members of the order, may well indicate a primitive ancestral type. Unfortunately, the fossil record of the flying fishes and their allies is meager. Until available information permits reconstruction of the evolution of the order, no precise designation of the relationships of *H. hesperius* seems feasible.

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TAXONOMY AND NOMENCLATURE OF THREE SPECIES OF LONCHURA (AVES: ESTRILDINAE)

By Kenneth C. Parkes [1]

In August and September 1956 I collected birds for a virus research project in central Luzon, Philippine Islands. The museum skins and skeletons prepared as a by-product of this project are now in Carnegie Museum, and represent the first modern collection of Asiatic birds in that institution. Virtually all of the work, therefore, of identifying these Philippine specimens has been done at the American Museum of Natural History (AMNH) and the U. S. National Museum (USNM). In connection with these more-or-less routine identifications, a certain amount of revisionary work proved to be necessary for certain species, several with ranges extending far beyond the Philippines. It has been thought desirable to publish such findings separately rather than include them in the final report of the 1956 collection, where they would be more-or-less irrelevant. The present paper treats the three species of the large estrildine genus *Lonchura* whose ranges include the Philippines.

The field work was carried out as part of a project of the Graduate School of Public Health, University of Pittsburgh, under the sponsorship of the Commission on Viral Infections, Armed Forces Epidemiological Board, and supported in part by the Office of the Surgeon General, U. S. Department of the Army. Specimens were collected and prepared with the invaluable assistance of Mr. Telesforo Oane and the generous counsel of Dr. Canuto G. Manuel, both of the

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[1] Carnegie Museum, Pittsburgh, Pa.

National Museum of the Philippines. Much of the taxonomic work was carried out at the American Museum of Natural History, where I received many courtesies from Drs. Dean Amadon and Charles Vaurie, and at the U. S. National Museum, with the help of Mr. H. G. Deignan. Additional specimens were borrowed through the kindness of Dr. Raymond A. Paynter, Jr., of the Museum of Comparative Zoology, Dr. Austin L. Rand of the Chicago Natural History Museum, Dr. S. Dillon Ripley, Jr., of the Yale Peabody Museum, and Dr. Dwain W. Warner of the Minnesota Museum of Natural History.

Lonchura leucogastra (Blyth)

Three subspecies of the white-breasted mannikin are currently recognized: *Lonchura leucogastra leucogastra* (Blyth) of Siam, the Malay Peninsula, and Sumatra; *L. l. everetti* (Tweeddale) of the Philippines and northern Borneo; and *L. l. castanonota* Mayr of southern Borneo. Delacour (1943, p. 82) has shown that *Lonchura leucogastroides* (Horsfield and Moore) of Sumatra, Java, Bali, and Lombok, formerly considered to be a subspecies of *L. leucogastra*, is not closely related to the latter species.

Tweeddale described the Philippine *everetti* (type locality Monte Alban, Luzon) in 1877, and later (1878, p. 622) commented that specimens from Palawan appeared to be intermediate between *everetti* and *leucogastra.* He assigned them to the former, working under a strictly binomial system. After having examined over 60 Philippine specimens (this species is by far the least common Philippine *Lonchura*), I have come to the conclusion that the name *everetti* should be confined to the birds of Luzon and a few adjacent islands. The remainder of the range hitherto ascribed to *everetti* is occupied by a form which, although intermediate in many respects between *everetti* and *leucogastra,* occupies such an extensive range that I feel it merits recognition as an additional subspecies, which may be called

Lonchura leucogastra manueli, new subspecies

Type: USNM 201273; adult male; "near Isabella" [=Isabela], Basilan Island, Philippine Islands; Jan. 26, 1906; E. A. Mearns, collector (original No. 13903).

Diagnosis: Similar to *L. l. everetti* and *L. l. leucogastra,* but, in general, more deeply colored than the former, less deeply colored than the latter (details below); bill (except for Palawan birds; see measurements) averaging larger than that of either subspecies; wing averaging longer than that of *leucogastra.* Although in some characters *manueli* displays a condition intermediate between *everetti* and *leucogastra,* in others it presents a combination of characters typical of one subspecies or the other with a remarkable constancy considering the size of its range. In detail, then, the features distinguishing the three races under consideration are as follows.

The anterior underparts of *everetti* are chocolate brown, becoming deeper and richer on the chin and throat. In *manueli* this deep, rich color prevails, deepening almost to black on the chin and throat. Finally, in *leucogastra* the whole anterior underparts are virtually black. Dorsally there is a corresponding but less striking deepening of the general brown color of crown and back.

In *everetti* and *manueli* the border between the dark breast and white abdomen includes many dark-tipped white feathers, giving this border area a distinctly spotted appearance. Such feathers are lacking in *leucogastra,* in which the border is more clear-cut.

In *everetti* the upper tail coverts are plain brown, somewhat darker than the rest of the upperparts. In *manueli* the upper tail coverts are decidedly blackish, contrasting quite sharply with the rest of the back. Finally, in *leucogastra* the upper tail coverts are black and this dark area has advanced to include the rump as well. The under tail coverts and thighs show a corresponding progression from brown to blackish brown to black in the three subspecies. The white shaft-streaks of the dorsal surface are best developed in *everetti,* somewhat reduced in *manueli,* and decidedly reduced in *leucogastra,* particularly on the head.

The tiny feathers along the metacarpal edge of the wing are predominantly white in *everetti,* predominantly dark brown or black in *manueli* and *leucogastra.* This is a matter of shifting proportions of white and pigmented feathers rather than a progressive intensification of pigmentation as in other color characters cited.

The yellow of the edges of the central rectrices, while variable, is a warmer, more golden color in *leucogastra* than in either *manueli* or *everetti.*

RANGE: Southern half of Philippine Archipelago (see list of specimens for specific islands) and highlands of northern Borneo. The Tutong River specimen mentioned by Mayr (1938, p. 45) has been examined and belongs with *manueli* as might be expected. Six other Borneo specimens examined also belong here; one from Laham, eastern Borneo, and five from Sarawak (Poeh Mountain, Kelabit Plateau, headwaters of Baram River). In the diagnosis above, no comparisons have been made with the rather isolated *L. l. castanonota* Mayr of southern Borneo; this is a distinctive race with much richer coloring, being deep rufous chestnut above and jet black below.

REMARKS: The only islands of the Philippines from which I have examined specimens which were not immediately referable to either *L. l. everetti* or *L. l. manueli* are Sibuyan and Culion; birds from these islands are almost exactly intermediate. It is possible that such intermediate populations may also be found on others of the central islands.

Although, as mentioned above, *manueli* is quite constant in its characters for a bird whose range encompasses so many islands, there is a certain amount of intraracial variation present. The most noticeable of these variations is a tendency for Palawan specimens to have smaller bills than those of the other islands within the range of *manueli* as here defined. The two specimens examined from the Sulu Archipelago are also small-billed. That this does not represent a stage in a cline toward the small-billed *leucogastra* is shown by the fact that the Borneo specimens have bills fully as large as those of typical *manueli*.

This subspecies is named for Dr. Canuto G. Manuel, chief of the zoology division of the National Museum of the Philippines, whose assistance and hospitality added immeasurably to the success of our expedition.

A series of specimens of *Lonchura leucogastra* from Kuching, Sarawak, sent to the U. S. National Museum for identification by B. E. Smythies of the Sarawak Museum, shows that a race is found in that vicinity which differs remarkably from other Borneo birds; no less than three races of this species are thus found in Borneo. The birds of the highlands of northern and eastern Borneo are *L. l. manueli;* those of southern Borneo, *L. l. castanonota.* The Kuching birds are actually closest in appearance to the geographically distant *L. l. everetti* of the northern Philippines. Mr. H. G. Deignan, who had suspected that the Kuching series differed from *everetti* as previously understood, has generously permitted me to include a description of this race in the present paper. I am happy to use the name which had been selected by Mr. Deignan, and designate this subspecies

***Lonchura leucogastra smythiesi*, new subspecies**

Type: USNM 461688; adult male; Tabuan, Kuching, Sarawak; Dec. 9, 1938; collected for Sarawak Museum.

Diagnosis: Nearest to the geographically distant *L. l. everetti* of the northern Philippines, but white shaft-streaks of dorsal surface reduced, practically absent on crown; upper tail coverts virtually concolorous with back instead of a darker brown; anterior underparts deeper brown. The neighboring *L. l. manueli* of the highlands of northern Borneo has blacker anterior underparts and the upper tail coverts decidedly blackish, as mentioned above. The wing of *L. l. smythiesi* averages shorter than that of typical *manueli*, but matches that of the slightly smaller Palawan population assigned to the latter race.

RANGE: Known only from the vicinity of Kuching, Sarawak, Island of Borneo.

SPECIMENS EXAMINED (adults only):

L. l. everetti: Luzon, 5; Catanduanes, 2; Polillo, 5; Mindoro, 1.
L. l. everetti x *manueli* intermediates: Sibuyan, 6; Culion, 2.
L. l. manueli: Negros, 8; Cebu, 4; Bohol, 3; Siquijor, 1; Mindanao, 4; Basilan, 5; Palawan, 12; Tawi-tawi, 2; northern Borneo, 7.
L. l. smythiesi: vicinity of Kuching, Sarawak, 11.
L. l. castanonota: southern Borneo, 5.
L. l. leucogastra: Siam, 3; Malay Peninsula, 6; Sumatra, 2.

MEASUREMENTS: All measurements were taken to the nearest half-millimeter. The wing was pressed flat against the ruler. The "bill index" is the sum of the culmen length and the greatest width of the bill. This index is an attempt to indicate the general "largeness" of the bill rather than merely the customary length figure. Perhaps the most obvious difference in dimension between large-billed and small-billed birds is that of depth at the base, but no satisfactory comparable measurements could be made of this because of the great variation in degree of bill closure effected by preparators. The plus sign (+) indicates that the wing or tail was worn, and that the true measurement would be perhaps a millimeter or so longer. Measurements of excessively worn wings or tails were not taken.

L. l. everetti
LUZON: Wing, 51, 52, 52, 52, 53. Tail, 36, 37, 38, 39. Bill Index (B. I.), 19, 19.5, 20, 20, 20.
CATANDUANES: Wing, 50, 51. Tail, 36, 38. B. I., 20, 20.
POLILLO: Wing, 50, 50, 51, 51+, 52. Tail, 35+, 35+, 36, 37. B. I., 19.5 19.5, 20, 20, 20.5.
MINDORO: Wing, 52.5. Tail, 39. B. I., 19.5.
L. l. everetti x *manueli* intergrades
SIBUYAN: Wing, 51, 51.5, 52, 52, 52, 52.5. Tail, 36.5, 37, 37, 37.5, 38+, 39.5. B. I., 19, 19.5, 19.5, 21, 21, 21.
CULION: Wing, 51, 51.5. Tail, 35.5, 37.5+. B. I., 20, 20.
L. l. manueli
NEGROS: Wing, 50.5, 51.5, 52, 52, 52.5, 52.5, 52.5+, 53. Tail, 36+, 38, 40, 41. B. I., 20.5, 20.5, 20.5, 20.5, 21, 21.
CEBU: Wing, 52, 53.5, 53.5, 55. Tail, 39+, 40. B. I., 20.5, 21, 22.5, 22.5.
SIQUIJOR: Wing, 52. Tail, 37. B. I., 20.
BOHOL: Wing, 52.5, 55, 55. Tail, 37.5, 41. B. I., 20.5, 21.5, 22.
MINDANAO: Wing, 52.5, 53, 54. Tail, 37, 37.5+, 38.5+. B. I., 20.5, 21, 21.5, 22.
BASILAN: Wing, 51, 51.5, 52.5, 53, 53.5. Tail, 35+, 36+, 36.5, 38+, 39. B. I., 19.5, 20.5, 21, 21.5, 22.
PALAWAN: Wing, 49, 50, 50.5+, 51, 51, 51, 51, 51.5, 51.5, 52, 53, 53. Tail, 34+, 34+, 36, 37+, 37.5, 37.5+, 38. B. I., 19, 19, 19, 19, 19.5, 19.5, 19.5, 19.5, 19.5, 20, 20, 20.5.
TAWI-TAWI: Wing, 50.5, 52.5. Tail, 36+, 37+. B. I., 19, 19.5.
BORNEO: Wing, 50.5+, 51, 54. Tail, 34+, 36.5. B. I., 20, 20, 21.

L. l. smythiesi

Sarawak: Wing, 50, 50, 50.5, 50.5, 50.5, 51, 51, 52, 52, 52, 52. Tail, 35, 36, 37, 37, 37.5, 38. B. I., 19, 20, 20, 20.5, 20.5, 20.5, 21, 21.

L. l. leucogastra

Siam: Wing, 49, 49, 49.5. Tail, 33.5, 34, 37. B. I., 17.5, 17.5, 17.5.

Malay Peninsula: Wing, 48.5, 50, 50, 50.5, 50.5, 50.5. Tail, 34.5, 35, 35+, 35.5, 35.5, 36.5. B. I., 17, 17.5, 18, 18, 18.

Sumatra: Wing, 49.5, 52.5. Tail, 35.5, 37. B. I., 17.5, 17.5.

Lonchura punctulata (Linnaeus)

Linnaeus (1758, p. 173) originally described the nutmeg mannikin as *Loxia punctulata,* listing its range simply as "Asia." His description was based entirely on the description and plate of Edwards (1743, p. 40). In the 12th edition of the "Systema Naturae" (1766), Linnaeus added a reference to Brisson, who specifically mentioned Java. Kloss (1931, p. 364) considered that Linnaeus thus acted as his own "first reviser," and that the type locality of *Loxia punctulata* should be restricted to Java. Hellmayr (1914, p. 60) had earlier come to the same conclusion. This is at variance with the treatment of Baker (1926, p. 91; 1930, p. 223) and other authors who have used the Linnaean name for the Indian rather than the Javanese race.

The identification of Linnaeus' name *punctulata* with a particular population of the nutmeg mannikin must rest entirely on Edwards' description and plate, since this was the sole reference in the 10th edition of the "Systema Naturae." If this description and plate are identifiable as one of the subspecies of *Lonchura punctulata,* any subsequent restriction by Linnaeus or anybody else is superfluous. Examination of Edwards' plate and accompanying description make it evident that it cannot possibly apply to the Javanese form, but must be that of India, as advocated by Baker. The evidence is as follows:

1. "The bill is of the shape and bigness of our Green-finch's bill . . ." The plate clearly shows a large-billed form of *L. punctulata;* the Indian bird is large-billed, the Javanese small-billed. Culmen length of *Chloris chloris* (England), 13 mm.; Indian *Lonchura punctulata,* 11.5 mm.; Javanese *L. punctulata,* 10 mm.

2. Although too much reliance should not be placed in Edwards' statement that the bird is figured in its natural size, still the wing-length of the figure matches Indian specimens exactly, and is far larger than Javanese specimens.

3. "Head, neck, beginning of the breast, back, wings and tail, are of a dark reddish brown . . ." True of all except the tail of the Indian race; the Javanese bird has the dorsal surface dull grayish brown, not dark reddish brown.

4. As for the tail, which is described and figured as "dark reddish brown," this does not match *any* form of the species, and is certainly not the Javanese bird in which the tail is distinctly ashy gray. The shape of the tail in the plate is also inaccurate, *unless* the specimen portrayed lacked the long pointed central rectrices, which are yellow in the Indian bird. A specimen of the Indian race in which the bright yellow, pointed central rectrices were missing, and in which

the remaining rectrices were worn (as they appear to be in Edwards' figure) would appear to have a brownish tail.

5. "The forepart of the neck has something of a purplish cast"; true of the Indian race, not of the Javanese.

6. "The rump is of a lighter greenish brown." The rump of the Indian bird is decidedly yellowish or greenish, with faintly indicated darker markings as shown on Edwards' plate. The rump of the Javanese bird is heavily barred with dark gray and white, with no trace of yellowish or greenish.

7. The edges of the white abdominal feathers are described and figured as black; in the Javanese form these edges are dark brown, not black.

8. "The middle of the belly, thighs, lower belly and covert-feathers under the tail, are light brown, or dirty white." Exactly true of the Indian race; the thighs and under tail coverts of the Javanese race are white, heavily barred with dark gray.

The name of the Javanese race thus reverts to *Lonchura punctulata nisoria* (Temminck), while the Indian form is *L. p. punctulata* (Linnaeus). Stuart Baker gives the restricted type locality as Calcutta. Hodgson's *L. p. lineoventer* from Nepal, used for the Indian race by Kloss (1931), Stanford and Ticehurst (1938, p. 611), and others, is a synonym of *punctulata*.

L. p. topela (Swinhoe), with type locality Amoy, has customarily been considered the form which occurs in the mountains of Yunnan and northeastern Burma, although its status in the latter area has been questioned (Smythies, 1953, p. 231). La Touche (1927, p. 295), under *topela*, states: "In eastern Yunnan it is represented by another race, probably more closely akin to the Indian forms." All of the literature on Yunnan birds I have been able to find, however, lists the resident race as *topela*. The form found in most of Burma except the northeastern section is *L. p. subundulata* (Godwin-Austin).

In any case, the Yunnan-northeastern Burma bird does differ from *topela*, as might be anticipated on geographic grounds. The latter race is found in Taiwan and Hainan, and in eastern China and northeastern Indochina. It is the second-palest of the races of *L. punctulata*, being exceeded in this respect only by the Philippine race *L. p. cabanisi*.

The Yunnan bird may be described as follows:

Lonchura punctulata yunnanensis, new subspecies

TYPE: AMNH 720698; adult female; "hills around Tengyueh" [=Tengchung], western Yunnan, alt. 6,000 feet; June 1924; George Forrest, collector (original No. 5027).

DIAGNOSIS: Similar to *L. p. topela* (Swinhoe), but coloration markedly richer; pencilling of ventral feathers darker and coarser; dark throat-patch warmer, more reddish brown; dorsal coloration in general browner, less gray, with, in many specimens, a greater contrast between the whitish shaft streaks and the ground color of the feathers. The yellow of the upper tail coverts and central rectrices averages deeper, less greenish. In juvenal plumage, *L. p. yunnanensis* is everywhere brighter, less grayish in color than *topela*. There is no significant difference in size between *yunnanensis* and *topela*. Measurements of type: wing (flat), 54 mm.; tail, 39 mm.; culmen, 11 mm.; tarsus, 13 mm.

Differs from *L. p. subundulata* (Godwin-Austin) of Assam and southern Burma in having more conspicuous light shaft streaks on the dorsum, a browner (less blackish) tone ventrally, and ventral markings of quite a different shape; the breast and flanks of *subundulata* have a spotted appearance, while those of *yunnanensis* are pencilled like those of *topela*. The posterior border of the brown throat of *subundulata* is more sharply defined than that of *yunnanensis*. Actually the population which is currently known as *subundulata* is a variable series of intermediates between the well-defined *punctulata* to the west and the *yunnanensis-topela* group to the east.

Range: Mountains of Yunnan and northeastern Burma (for localities, see list of specimens examined).

Remarks: Four specimens from Mengtz, in southeastern Yunnan, appear to be somewhat intermediate between *L. p. topela* and *L. p. yunnanensis*, although closer to the latter. Three of the four, however, are in such worn plumage as to make color comparisons almost valueless.

Smythies (1953, p. 231) writes: "The status of *topela* [in Burma] is uncertain; a single specimen obtained by the Vernay-Hopwood expedition at Singhaling Hkamti may have been a winter visitor, whereas birds seen at 5,000 feet or more in the Sadon hills and in the Ngawchang valley and not collected may have been resident *topela;* Stuart Baker claims that it occurs in the Shan States."

The Vernay-Hopwood specimen, taken on Mar. 4, 1935, is in the middle of the post-juvenal molt. A specimen (AMNH 720672) taken at Sinlumkaba, east of Bhamo, on Apr. 19, 1908, has almost completed the post-juvenal molt. Both are referable to *yunnanensis*. That this subspecies does, indeed, breed in northeastern Burma is suggested by a specimen (USNM 377788) taken 6 miles north of Myitkina on May 24, 1945, and one (AMNH 347218) taken at Myitkina on June 25, 1945. The specimen from Washaung (near Myitkina) mentioned by Stanford and Mayr (1941, 355) is, of course, *yunnanensis* rather than *subundulata*. It was taken on Apr. 12, 1939, and is in about the same stage of the post-juvenal molt as the Singhaling Hkamti specimen.

Baker (1930, 223) lists *Munia inglisi* Hume in the synonymy of *L. p. topela;* however, *inglisi* was named from Cachar, and birds from this region are referable to *L. p. subundulata*.

L. p. catervaria Koelz (1954, p. 19), described from the Khasia Hills, represents a population intermediate between *punctulata* and *subundulata*, and is best placed in the synonymy of the latter. It will be remembered that *subundulata* itself represents a rather variable intermediate population.

SPECIMENS EXAMINED:

L. p. yunnanensis: YUNNAN: Vicinity of Tengyueh, 23; Nantien, 1; Shweli-Salaween Divide, 6. BURMA: Myitkina, 1; 6 miles north of Myitkina, 1; Singhaling Hkamti, 1; Washaung, 1; Sinlumkaba, 1.

L. p. yunnanensis x *topela* intermediates: YUNNAN: Mengtz, 4.

L. p. topela: Taiwan, 40; Hainan, 23; Fukien, 6; Kwangtung, 1; Tonkin, 5; Annam, 2.

L. p. topela x *subundulata* intermediates: BURMA: Pegu, 2.

L. p. subundulata: Assam, 5; Khasia Hills ("*catervaria*"), 10.

Also series of other races in USNM and AMNH.

Lonchura malacca (Linnaeus)

Delacour (1943, p. 83) united three groups of forms which had often been considered separate species: *L. malacca*, *L. ferruginosa*, and *L. atricapilla.* He used the name *ferruginosa* for the combined species, overlooking the fact that *Loxia malacca* Linnaeus, 1766, antedates *Loxia ferruginosa* Sparrmann, 1789. The desirability of merging the three groups has been questioned by some authors, but I am not prepared to go into this question here. The present paper is concerned only with that portion of the combined species formerly known as *Lonchura atricapilla*, all forms of which lack white on the head and underparts.

It is tempting to consider *L. grandis* of New Guinea as part of this species, since the adults closely resemble the *atricapilla* group. Delacour (1943: p. 83) considered *grandis* and *ferruginosa* (=*malacca*) to comprise a superspecies, giving the large bill and extensively black underparts of *grandis* as specific characters. Even more important, in my opinion, is the pattern of the juvenal plumage, in which *grandis* differs markedly from all races of *malacca* in being streaked on the throat.

Salomonsen (1953, p. 265) pointed out that a revision of this species was badly needed, and he reviewed it briefly himself. The large area ascribed by Salomonsen and other authors to the race *atricapilla* involves a number of well-marked clines, which can be divided into several subspecies and intergrades. Salomonsen's treatment of the Philippine populations is critically discussed (p. 290) after a review of the mainland forms.

The distribution of *L. m. sinensis* is substantially as given by Salomonsen (1953, p. 266), namely Malay States, southern Siam, and lowlands of Sumatra. The diagnostic characters can, how-

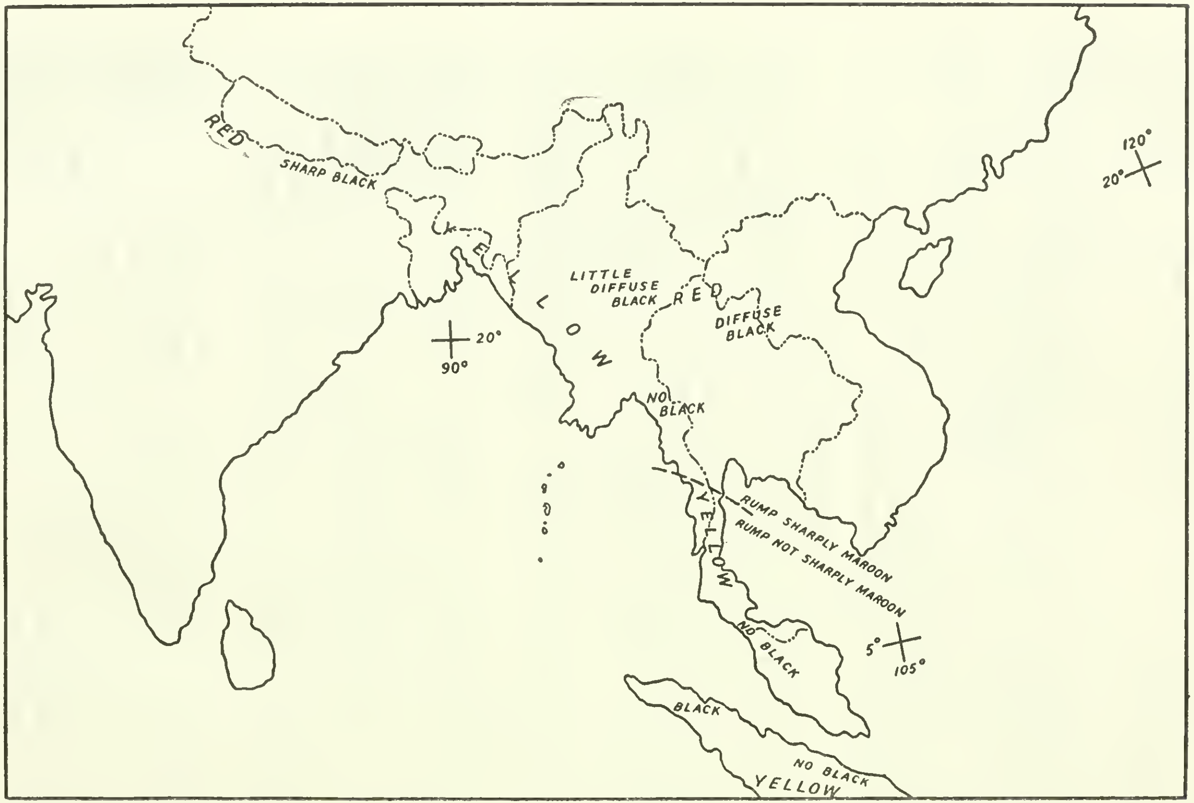

Figure 1.—Trends in geographic variation in *Lonchura malacca*. "Red" and "Yellow" refer to the color of upper tail coverts and edges of rectrices. In smaller lettering is shown the relative size and distinctness of the black abdominal patch, when present. The line across the upper Malay Peninsula divides the populations with a maroon rump sharply defined from the back color and those in which the rump is virtually concolorous with the rest of the back. All localities are approximate.

ever, be expanded. The black abdominal patch is absent. The back is paler (particularly noticeable in fresh plumage) than that of adjacent populations to the north and west. The rump is darker and more reddish than the back, but this color is much paler and more diffuse than in any of the races to the north. The upper tail coverts and central rectrices are yellow. The race *L. m. batakana* (Chasen and Kloss) from the mountains of northern Sumatra is similar in dorsal color (including rump and tail), but smaller, and with a well-defined black abdominal patch.

Toward the northwest, *sinensis* intergrades with *atricapilla*, as suggested by Chasen and Kloss (1929, p. 23). A specimen from Pegu is precisely like *sinensis* above and below, except that the rump is a deeper maroon and quite sharply defined. Another Pegu specimen is similar dorsally, but blackish on the lower abdomen and under tail coverts. Specimens from northern Burma and northwestern Yunnan resemble *atricapilla* in having the tail and coverts yellow, and a well-defined maroon rump patch; the Yunnan specimens are paler than those of Burma. Ventrally these birds are rather variable, but all have a more-or-less diffused blackish area in the lower abdomen.

In Assam and Bengal occurs true *atricapilla*, which has a well-defined black abdominal patch, deep maroon rump, and yellow tail and coverts.

Salomonsen (1953, p. 266), Smythies (1953, p. 229), and others have synonymized *Munia rubro-nigra* Hodgson (Nepal) with *atricapilla* of Bengal. This is understandable in view of the distributions and distinguishing characters for the two claimed by Stuart Baker (1926, pp. 80–81). Both are incorrect. As pointed out by Vaurie (1949, p. 38) and others, *rubro-nigra* does not differ from *atricapilla* in wing length or color of underparts. Judging from a limited amount of material, however, the name *rubro-nigra* is available for a well-marked race of Nepal and adjacent India. It occurs at least as far east as Jainagar, on the Nepal-Bihar border (specimen, Yale Peabody Mus. 26520, slightly intermediate toward *atricapilla*), and as far west as Dehra Dun. It resembles *atricapilla* in having a well-defined black abdominal patch and sharply defined maroon rump, but the long, dissected upper tail coverts are a rich maroon red, little different from the rump, whereas in *atricapilla* these feathers are golden yellow to orange. The rectrices themselves are washed with yellow in *atricapilla*, deep reddish brown in *rubro-nigra*. The latter race is also slightly paler dorsally. The four *rubro-nigra* seen have quite large and heavy bills, but accurately sexed material is insufficient to determine whether there is any actual difference between the two races in this respect.

The population of Chieng Rai, northernmost Thailand, mentioned by Deignan (1945, p. 559), is somewhat variable, but cannot be satisfactorily assigned to either a known race or an intergrade between races. Rather than to try to stretch the limits of well-defined subspecies to include these birds, it would seem advisable to recognize them as a subspecific entity, for which an appropriate name is

Lonchura malacca deignani, new subspecies

Type: USNM 350467; adult male; Chieng Rai, northern Thailand (1,214 feet); May 8, 1936; H. G. Deignan, collector (original No. 1297).

Diagnosis: Differs from all other subspecies of the mainland, glossy black-headed group except *rubro-nigra* in that the long upper tail coverts and central rectrices in most (not all) specimens are deep orange-red rather than some shade of yellow. In a minority of individuals these feathers are rich yellow-orange, not unlike (but somewhat more intensely colored than) those of *atricapilla*. All individuals of *deignani*, however, may be distinguished from *rubro-nigra* or *atricapilla* by their more diffuse and generally less blackish abdominal patch, and by having dark brown rather than black under tail coverts. The general color of both dorsal and ventral surfaces is also a paler reddish brown in *rubro-nigra* than in *deignani*.

Range: Chieng Rai Province, northern Thailand, and probably Indo-China. A single specimen from Hue, Annam, is referable to *deignani*. A series of specimens from Hainan in the American Museum of Natural History consists of cage birds, as shown by the condition of the claws; the species is not known to occur in Hainan in a wild state. However, these specimens may well have originated on the Indo-China mainland across from Hainan, since they agree in every respect with *deignani*.

Specimens examined (mainland and Sumatra races):

L. m. rubro-nigra: Nepal, 1; Nepal-Bihar border, 1; United Provinces, 2.
L. m. atricapilla: Assam, 5.
L. m. atricapilla x *sinensis* intermediates: northern Yunnan, 5; northern Burma, 2; central Burma, 2; southern Burma, 2.
L. m. sinensis: Malay Peninsula, 2; Sumatra, 1.
L. m. batakana: Sumatra, 2.
L. m. deignani: northern Thailand, 6; Annam, 1; "Hainan" (cage birds), 8.

Leaving the glossy black-headed birds of the mainland, we turn now to the eastern populations inhabiting Taiwan, the Philippines, Celebes, and Borneo. There is a general cline in the direction of increased saturation of the pigment of head and breast running from north to south, from grayish brown in Taiwan to rich black in Borneo and northern Celebes; then, surprisingly, back to brown again in southern Celebes (*L. m. brunneiceps*). The pale northern extreme is *L. m. formosana* (Swinhoe). Salomonsen (1952, p. 354) has shown that specimens from northernmost Luzon are inseparable from Taiwan examples of *formosana*. The rest of the birds from central Luzon to Borneo have until lately been considered to be *L. m. jagori* (Martens), type locality restricted by Salomonsen (1953, p. 267) to Manila. As represented in the Philippines, *jagori* is actually a tremendously variable series of intermediates between *formosana* and the almost consistently black-headed Borneo population. Salomonsen endeavored to express this by describing the black-headed birds as *L. m. gregalis*, with type locality Opol, Mindanao. This merely complicated matters, however, because birds from the range ascribed by Salomonsen to his "*gregalis*" are *not* consistent in having dull black rather than dark brown heads, as he claims. Three Sulu birds in the American Museum of Natural History, for instance, have distinctly brownish crowns, and even some of the Borneo specimens (cf. AMNH 720576, Labuan) tend to have rather brownish heads. In a series of 18 specimens from Basilan, which should be "*gregalis*" (University of Michigan Museum of Zoology), there is much variation; although mostly black-headed, several are distinctly brown on the crown and nape. Some of my own Luzon series (which is quite variable *inter se*) are as dark as any Borneo specimens seen. Peters (1940, p. 209) could detect no significant difference between Borneo and Philippine specimens of this species, calling both *jagori*. De Schauensee (1957, p. 11), on the other hand, upheld "*gregalis*," calling it "a very distinct race," on the basis of comparing *one* adult male and two immature females from Mindanao with three Luzon specimens!

Ideally we should probably use two names, one for the Taiwan-northern Luzon bird and one for the birds of Borneo and northern Celebes, with the rest of the Philippine birds considered as a variable intergrading cline. Unfortunately the name *jagori* was based on the highly variable population of central Luzon. In view of the fact that variability in this species is so high in this part of the world, so that few specimens could be named if their localities were unknown, it appears best to continue to use *jagori* in its traditional sense, considering *gregalis* Salomonsen as a synonym. The subspecies *jagori* thus includes both brown-headed and black-headed birds, with a preponderance of the latter toward the south, but no reasonable geographic line can possibly be drawn between them.

There seems to be no consistent geographic variation in *Lonchura malacca* within the Island of Borneo; this, of course, is in striking contrast to the situation in *L. leucogastra*.

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RHIZOCEPHALA OF THE FAMILY PELTOGASTRIDAE PARASITIC ON WEST INDIAN SPECIES OF GALATHEIDAE

By Edward G. Reinhard [1]

Of the 12 genera of Rhizocephala that make up the family Peltogastridae as currently understood, only *Galatheascus* and *Tortugaster* contain species that parasitize anomuran Crustacea of the family Galatheidae. Members of the other genera occur on Paguridae.

In a collection of parasitized galatheids belonging to the Museum of Comparative Zoology (MCZ), Harvard University, that the author, through the courtesy of Dr. Elisabeth Deichmann, had the privilege of studying, some remarkable new representatives of Peltogastridae were encountered. The specimens, obtained off the north coast of Cuba by the *Atlantis* expeditions to the West Indies in 1938 and 1939, comprise two new species of a new genus that are described in this paper. The *Atlantis* material also includes *Galatheascus minutus* Boschma, hitherto unreported from American waters, and *Tortugaster fistulatus* Reinhard.

An inspection of some of the Galatheidae in the U. S. National Museum brought to light additional examples of one of the new species and of *Galatheascus minutus*. Moreover, two parasitized specimens

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[1] A posthumous paper. At the time of his death, Jan. 29, 1958, Dr. Reinhard was with the Department of Biology, The Catholic University of America, Washington, D. C.

of *Munida irrasa* A. Milne Edwards from North Carolina and Florida, which had been collected by the U. S. Fish Commission many years ago, also had peltogastrids present that proved to be new. Descriptions of this new genus and new species also are given here.

The two new genera are gregarious in their habit of growth, but they differ markedly from the other gregarious forms in external appearance and in various aspects of their internal anatomy. One of their most distinctive features is the peculiar orientation of the mesentery in relation to the stalk.

Family PELTOGASTRIDAE

***Cyphosaccus*, new genus**

GENOTYPE: *Cyphosaccus chacei*, new species.

DIAGNOSIS: Gregarious; body elongate, V- or U-shaped; stalk on the left side. Mantle aperture a blind canal which eventually opens to form a birth pore. Testes saccular, small, situated near posterior end. Vasa deferentia directed posteriorly. Colleteric glands in the vicinity of the stalk. On Galatheidae.

When the animal is viewed with the anterior arm to the left and directed upward, the side facing the observer is the mesenterial or dorsal surface. The curvature of the sac is therefore in a lateral direction, with the stalk originating on the left side.

***Cyphosaccus chacei*, new species**

FIGURE 1; PLATE 1, FIGURE 1

SYNTYPES: Off Cayo Coco, Cuba, *Atlantis* Station 3397, lat. 22°34′30″ N., long. 78°16′ W., 180 fathoms, Apr. 28, 1939; 18 specimens on one *Munida irrasa* A. Milne Edwards. Harvard-Havana Expedition, *Atlantis*. MCZ 11431.

ADDITIONAL SPECIMENS: Off Cayo Coco, Cuba, *Atlantis* Station 3399, lat. 22°35′ N., long. 78°2′ W., 180 fathoms, Apr. 28, 1939; 10 specimens on one *Munida irrasa* A. Milne Edwards. Harvard-Havana Expedition, *Atlantis*. MCZ 11432.

Off Havana, Cuba, *Albatross* Station 2337, lat. 23°10′38″ N., long. 82°20′21″ W., 199 fathoms, Jan. 19, 1885, 15 specimens on one *Munida irrasa* A. Milne Edwards. *Albatross* coll. USNM 100943.

Off Pelican Island, Barbados, Station 7, 80 fathoms, Mar. 16, 1918; 1 specimen on *Munida irrasa* A. Milne Edwards. Barbados-Antigua Expedition. USNM 57962.

DIAGNOSIS: Body slender and V-shaped, with the stalk at the vertex of the angle. Length of anterior arm equal or nearly equal to

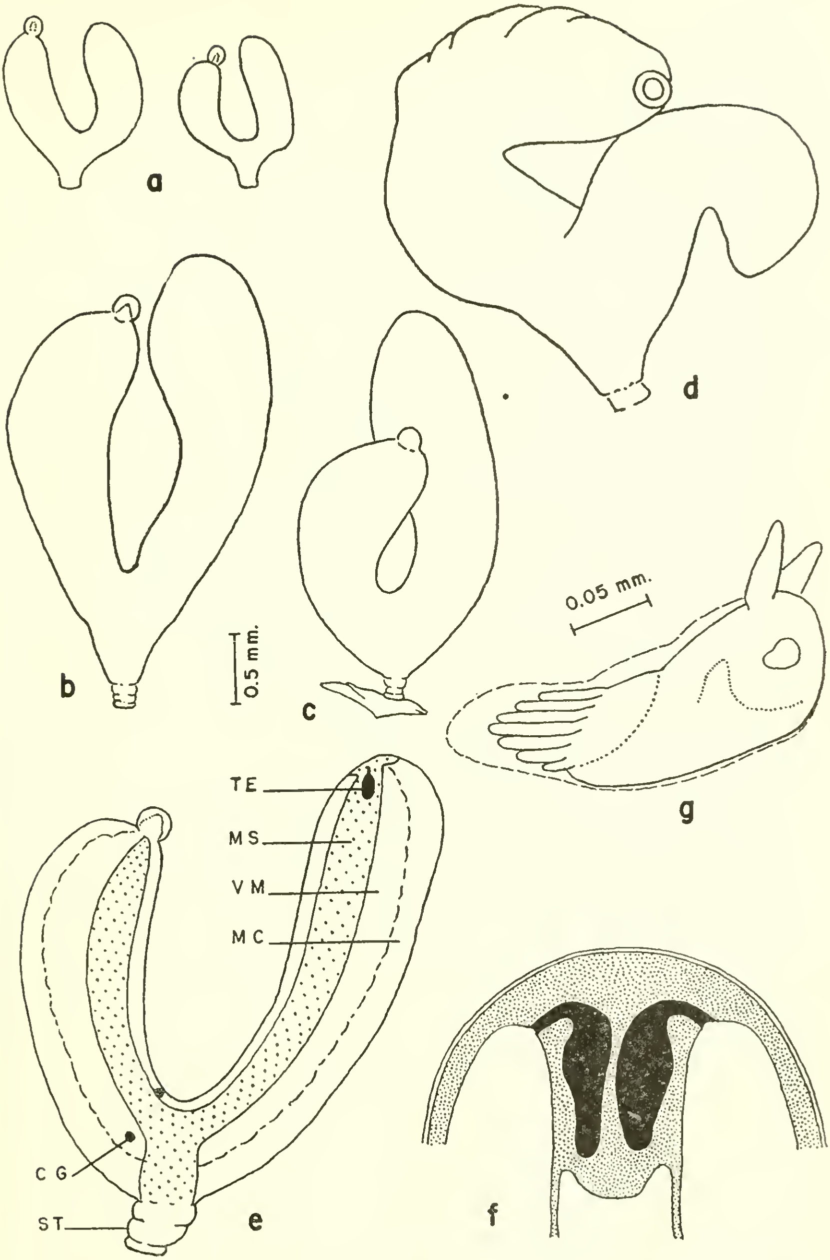


Figure 1.—*Cyphosaccus chacei,* new species: *a,* Young specimens (USNM 100943); *b, c,* two of the syntype specimens (MCZ 11431); *d,* older specimen (USNM 57962); *e,* diagram of internal anatomy; *f,* diagram of testes and vasa deferentia; *g,* cypris larva from mantle cavity of syntypes. The scale appearing alongside *b* refers to *a–d,* which are drawn to the same magnification. Abbreviations: *cg,* colleteric gland; *mc,* mantle cavity; *ms,* mesentery; *st,* stalk; *te,* testis; *vm,* visceral mass.

the posterior one. Testes separate, vas deferens short and recurved. Larvae hatch in the cypris stage.

Description: The parasites are attached to the ventral surface of the host's abdomen; in the case of the syntypes, on segments 3–6. The snytype specimens have a length of approximately 5 mm., while the additional examples from the same locality measure 6 mm. Those from the *Albatross* collection are only 2 mm. long and are very immature. The specimens from any one host individual are all fairly uniform in size.

The curious shape of the sacs can best be explained by reference to the figures. In general, the parasites have the appearance of a 2-pronged fork, with the posterior arm equal to or usually a little longer than the anterior one. Each arm is rather slender at its point of origin and becomes broader toward the tip. In the mature specimens the lesser diameter is 0.5 to 0.75 mm. and the greater diameter about 1 mm. The anterior arm terminates in a nipple-like prominence, covered by a bulbous sheath which is a continuation of the external cuticle. The stalk of the mature specimens is marked by three circular grooves.

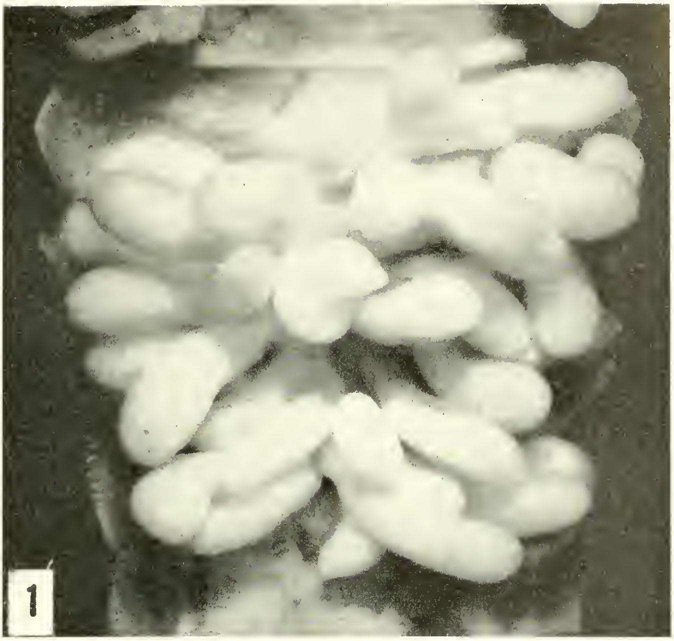
The external surface is covered by a thin cuticle which has the appearance of being finely striated. This, however, is due to the innumerable muscle fibers, chiefly circular, that lie beneath it.

The rather narrow mesentery proceeds from the stalk towards the concave surface of the sac where it passes into both arms and continues to their extremities. At the anterior end its termination is somewhat acute but at the posterior end it flares out to form a thin plate.

In the immature animals from the *Albatross* collection one can see a compact ovarian mass running the entire length of the animal and filling up the cavity of the sac. In the other specimens the visceral mass is collapsed and completely empty but the mantle cavity is filled with larvae in the cypris stage. This feature is rather uncommon, since the great majority of Rhizocephala hatch in the nauplius stage of development.

Although the colleteric glands could not be found with certainty in the large animals because of the degenerated condition of the visceral mass, they were evident in the immature specimens. They occur alongside the stalk at the base of the anterior arm and are of very simple construction, consisting of several layers of epithelium surrounding a single unbranched canal.

The testes are two small elongated pouches situated near the tip of the posterior arm with their blind ends directed towards the stalk. The outer wall of the organ is made up of a well-defined structureless membrane. Each gives rise to a short vas deferens that soon reverses



1. *Cyphosaccus chacei*, new species; 15 specimens attached to abdomen of *Munida irrasa*. 2, *Cyphosaccus cornutus*, new species; three specimens attached to abdomen of *Munidopsis erinacea*. (Photographs by Henry F. Mengoli.)

its course to open alongside the testes at the junction of the mesentery with the mantle.

The single specimen from the Barbados (fig. 1,*d*) was not sectioned. It appears to be an animal that is undergoing degeneration after the release of its brood. The mantle cavity is empty and the anterior end of the sac has a conspicuous round orifice, presumably the birth pore. The host also bears the scar of a companion parasite no longer present.

REMARKS: Dr. Fenner A. Chace, Jr., curator of marine invertebrates, U. S. National Museum, for whom this species is named, recorded the presence of abdominal parasites on three examples of *Munida irrasa* A. Milne Edwards obtained by the *Atlantis* off Cayo Coco, Cuba (Chace, 1942, p. 46). Two of these were loaned to the author through the courtesy of the Museum of Comparative Zoology. They provided part of the material described here.

***Cyphosaccus cornutus*, new species**

FIGURE 2; PLATE 1, FIGURE 2

SYNTYPES: Off Playa Baracoa, Havana, Cuba, *Atlantis* Station 3305, lat. 23°05′30″ N., long. 82°35′ W., 330 fathoms, Mar. 23, 1939, three specimens on one *Munidopsis erinacea* (A. Milne Edwards), Harvard-Havana Expedition, *Atlantis*. MCZ 11721.

DIAGNOSIS: Body broadly U-shaped, comparatively stout, uniform in thickness, with the stalk in the midregion. Testes fused.

DESCRIPTION: The parasites are attached to the sternites of the third and fourth abdominal segments. Two are oriented with the anterior arm towards the left side of the host; the other is turned in the opposite direction. All three are of approximately the same size, 8 mm. in length and about 1 mm. in thickness.

The shape of the sac resembles an ox-bow, although the anterior arm is misshapen. The tip of this arm bears a nozzle-like prominence enclosing a blind canal. The smooth external surface of the sac is covered with a thin cuticle through which an underlying meshwork of delicate longitudinal and circular muscle fibers belonging to the mantle can be seen. The longitudinal fibers are more widely spaced than the circular ones.

When the animal is examined with the anterior arm to the observer's left, as in the drawings, the mesenterial surface lies uppermost. The mesentery, which extends along the entire length of the sac, supports a well-developed visceral mass. In the animals that were sectioned, segmenting eggs are also present in the mantle cavity. Whether they hatch as nauplii or as cypris larvae is not known.

The testes occur near the posterior end of the mesentery. These elongated sacs are fused for approximately one-third of their length in one specimen, and completely fused in the other. Each gives rise to a vas deferens shaped like an inverted J, which runs in a posterior direction, then curves in the opposite direction shortly before it terminates. The vasa deferentia are about as long as the testes.

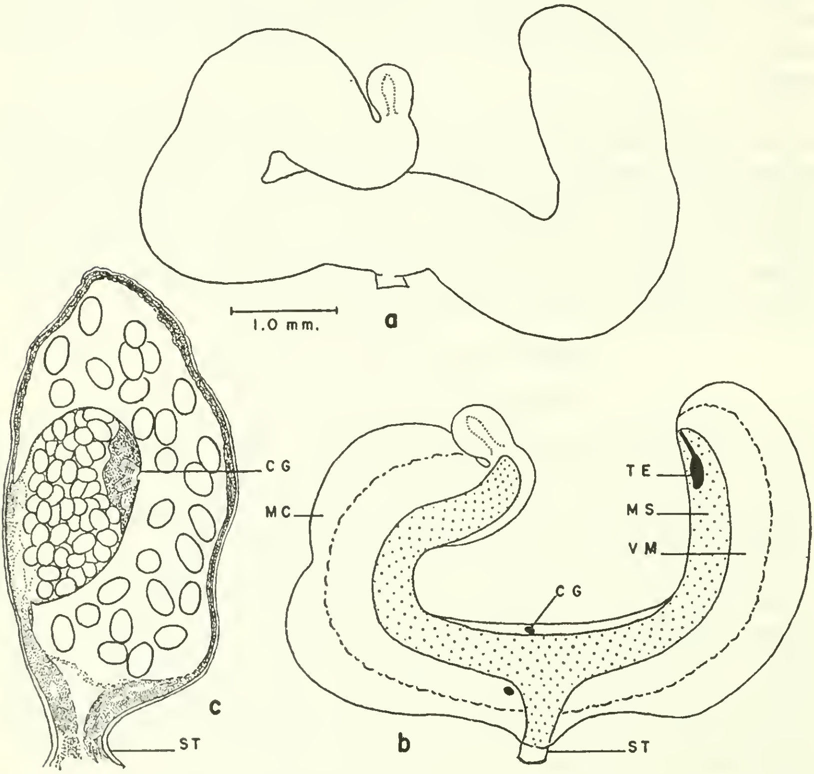


Figure 2.—*Cyphosaccus cornutus*, new species: *a*, Syntype, external appearance (MCZ 11721); *b*, diagram of internal anatomy; *c*, section through region of stalk. The scale refers to *a* and *b*. Abbreviations as in figure 1.

The colleteric glands are located in the region of the stalk. They are of simple design, with no more than two or three narrow channels leading to the opening into the mantle cavity.

Remarks: Chace (1942, p. 90) mentioned the presence of "abdominal parasites" on a female of *Munidopsis erinacea* (A. Milne Edwards) from Playa Baracoa, Cuba. This is the parasitized specimen that provided the material for the present study.

Boschmaia, new genus

Genotype: *Boschmaia munidicola*, new species.

Diagnosis: Gregarious; body elongate, bifurcate, with arms of unequal length. Mantle aperture covered. Stalk on right side; testes adjacent to stalk. On Galatheidae.

The orientation of the mesentery with respect to the stalk is a distinguishing feature of this genus. In the previously known members of the family Peltogastridae the stalk arises from the dorsal or mesenterial surface, but in *Cyphosaccus* and *Boschmaia* it is placed in a lateral position. Whereas in *Cyphosaccus* the mesentery lies uppermost when the animal is viewed in an upright position with the anterior arm to the observer's left, in *Boschmaia* the opposite is true. Here the mesentery lies on the far side of the animal when the sac is viewed in the same manner as above. Since the mesentery in Rhizocephala marks the dorsal surface of the animal, the stalk in this genus arises on the right side.

The generic name *Boschmaia* is given in honor of Prof. H. Boschma, director of the Rijksmuseum van Natuurlijke Historie, Leiden, Holland, the author of more than 80 papers dealing with the Rhizocephala and the foremost authority on this group of animals.

Boschmaia munidicola, new species

Figure 3

Diagnosis: Anterior arm much longer than posterior one. Testes minute, vasa deferentia long and straight; colleteric glands near anterior end.

Syntypes: Off Cape Lookout, N. C., *Fish Hawk* Station 7302, U. S. Fish Commission, 7½ fathoms, July 24, 1902, 9 specimens on one *Munida irrasa* A. Milne Edwards. USNM 100945.

Additional specimens: Off Key West, Fla., *Fish Hawk* Station 7279, U. S. Fish Commission, lat. 24°21′55″ N., long. 81°58′25″ W., 98 fathoms, Feb. 14, 1902, 14 specimens on one *Munida irrasa* A. Milne Edwards. USNM 100946.

Description: The parasites are attached by means of a short, thin stalk to the third and fourth abdominal segments of the host. They have a somewhat hook-shaped appearance. Each sac is strongly bent, with one arm, which is the anterior part of the animal, nearly twice as long as the other. The basal portion of the sac tapers in the direction of the stalk. At the summit of the anterior arm there is a knob-like prominence formed by the mantle opening. The aperture, however, does not communicate with the exterior since it is covered by the external cuticle.

The syntype specimens are mature animals measuring about 6 mm. in length and 1 to 1.5 mm. in thickness. They contain developing nauplii. Those from Key West are younger specimens, more slender in form, without eggs or embryos in the mantle cavity but with a visceral mass that fills up most of the space. They measure about 5 mm. in length and 0.5 to 0.75 mm. in thickness. There is relatively little difference in size between the various sacs found on the same host individual.

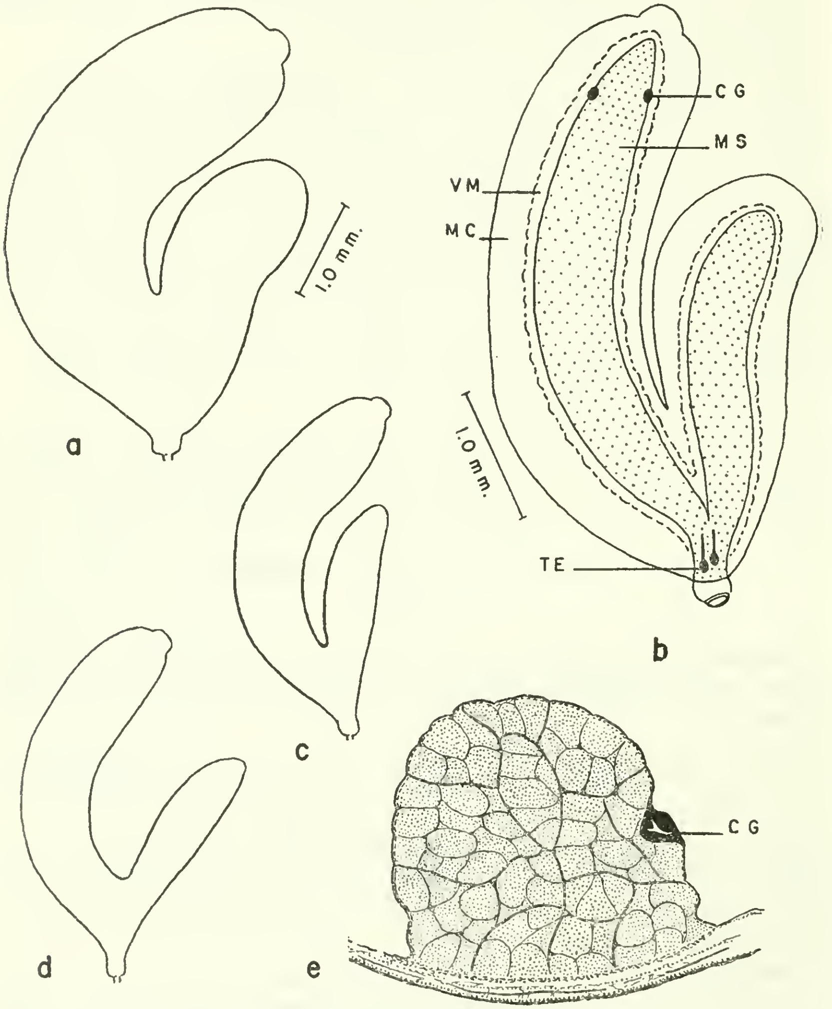


Figure 3.—*Boschmaia munidicola*, new species: *a*, Syntype, external appearance (USNM 100945); *b*, diagram of internal anatomy; *c*, *d*, younger specimens (USNM 100946); *e*, visceral mass and colleteric gland in transverse section. The scale appearing alongside figure *a* refers to *a*, *c* and *d*. Abbreviations as in figure 1.

The mantle and visceral mass, in general structure, are like those of *Peltogaster paguri* and exhibit no unusual features. The mesentery is broad, about equal in width to the visceral mass, and extends from one end of the sac to the other. At the base where the two arms meet there is an extension of the mesentery towards the right to connect with the stalk. The visceral mass accompanies the mesentery to its termination.

The testes are exceedingly small, rounded bodies set close to the stalk. They measure only 35 to 40 microns in diameter. The straight and comparatively long vasa deferentia pursue an upward course away from the stalk along the surface of the basal extension of the visceral mass. Their length is about 250 microns.

The colleteric glands are located near the anterior end of the sac, with the left gland slightly in advance of the right. In a cross section of the animal the gland appears as an elliptical mass comprising a single canal surrounded by several layers of cells. Its depth is 60 to 80 microns and its extent in a dorsoventral direction is about 150 microns.

Genus *Tortugaster* Reinhard

Tortugaster fistulatus Reinhard

Figure 4,*e*

Tortugaster fistulatus Reinhard, 1948, pp. 33–37, fig. 1 (external appearance, internal structures), fig. 2 (transverse section), fig. 3 (vas deferens).

Material examined: South of Cay Sal Bank, north coast of Cuba, *Atlantis* Station 2987, lat. 23°22′ N., long 79°53′ W., 280–300 fathoms, Mar. 13, 1938; one specimen on *Munidopsis spinifer* (A. Milne Edwards). Harvard-Havana Expedition. MCZ 11755.

East of St. Augustine, Fla., *Atlantis* Station 3780, lat. 30°27′ N., long. 79°52′ W., 250–265 fathoms, Feb. 24, 1940; one specimen on *Munidopsis bahamensis* Benedict. MCZ 11734.

These are new locality and new host records for a species that has previously been known only from the type specimens found on *Munidopsis robusta* A. Milne Edwards, off Tortugas, Fla. In their attachment and orientation with respect to the host and in their external appearance these examples of *T. fistulatus* agree with the type. The specimen on *Munidopsis spinifer* measures 6 mm. in length and 3 mm. in width and is a mature animal with eggs present in the mantle cavity. The parasite on *Munidopsis bahamensis* is also fully developed and differs from the other only in size. Its length is 8 mm. and width 4.5 mm. Because of their poor state of preservation these animals were not sectioned. They are the specimens ("abdominal parasites") mentioned by Chace (1942, pp. 89, 91) in his report on the Galatheidae obtained by the *Atlantis* expeditions to the West Indies.

Genus *Galatheascus* Boschma

Galatheascus minutus Boschma

FIGURE 4,*a–d*

Galatheascus minutus Boschma 1933, pp. 476–478, fig. 1 (external appearance), figs. 2, 3 (transverse sections); 1947, pp. 2–4, fig. 1 (attached to host).

Type specimen on *Galathea nexa* Embleton, from Oban, Scotland.

MATERIAL EXAMINED: Off Cayo Coco, north coast of Cuba, 180 fathoms, 1939; two specimens on one *Munida stimpsoni* A. Milne Edwards. *Atlantis* Coll. MCZ 11344.

Gulf of Mexico, *Blake* Station 45, lat. 25°33′ N., long 84°21′ W., 101 fathoms, 1877–78; one specimen on *Munidopsis barbarae* (Boone). *Blake* Coll. MCZ 11719. (Chace, 1942, p. 81, mentions this specimen. The host is an intersex.)

Off Cape Lookout, N. C., *Fish Hawk* Station 7302, U. S. Fish Commission, 7½ fathoms, July 24, 1902; one specimen on *Munida irrasa* A. Milne Edwards. USNM 100944.

Off Fort Pierce, Fla., *Combat* Station 235, lat. 27°27′ N., long. 78°58′ W., 180 fathoms, Feb. 2, 1957; one specimen on *Munida schroederi* Chace. USNM 100947.

All five specimens are oriented with their long axis perpendicular to the main axis of the host and with the anterior end directed towards the right. The site of attachment is on the second or third abdominal segment. The largest parasite, found on *Munida schroederi*, measures 7 mm. in length, 4 mm. in width, and 3 mm. in thickness; the smallest, found on *Munidopsis barbarae*, measures 3 by 2 by 1.5 mm. All have developing embryos in the mantle cavity and are therefore mature animals.

The mantle opening in three of the specimens is small, indistinct, and narrow, but in the parasites of *Munidopsis barbarae* and *Munida schroederi* it is wider and surrounded by an elevated rim. The short, thin stalk, which is oval in cross section, arises in the median dorsal part of the body. The smooth external cuticle is only about 4 microns thick except where it forms an inconspicuous shield around the base of the stalk.

In order to study the internal cuticle, one of the specimens occurring on *M. stimpsoni* was macerated in KOH. Retinacula were found on the cuticle covering the visceral mass but not on the lining of the mantle. They consist of one to three spindles having a length of 7 to 10 microns and a width of 2 to 3 microns. The retinacula of *Galatheascus striatus*, which they resemble in all respects except size, are 20 to 25 microns long.

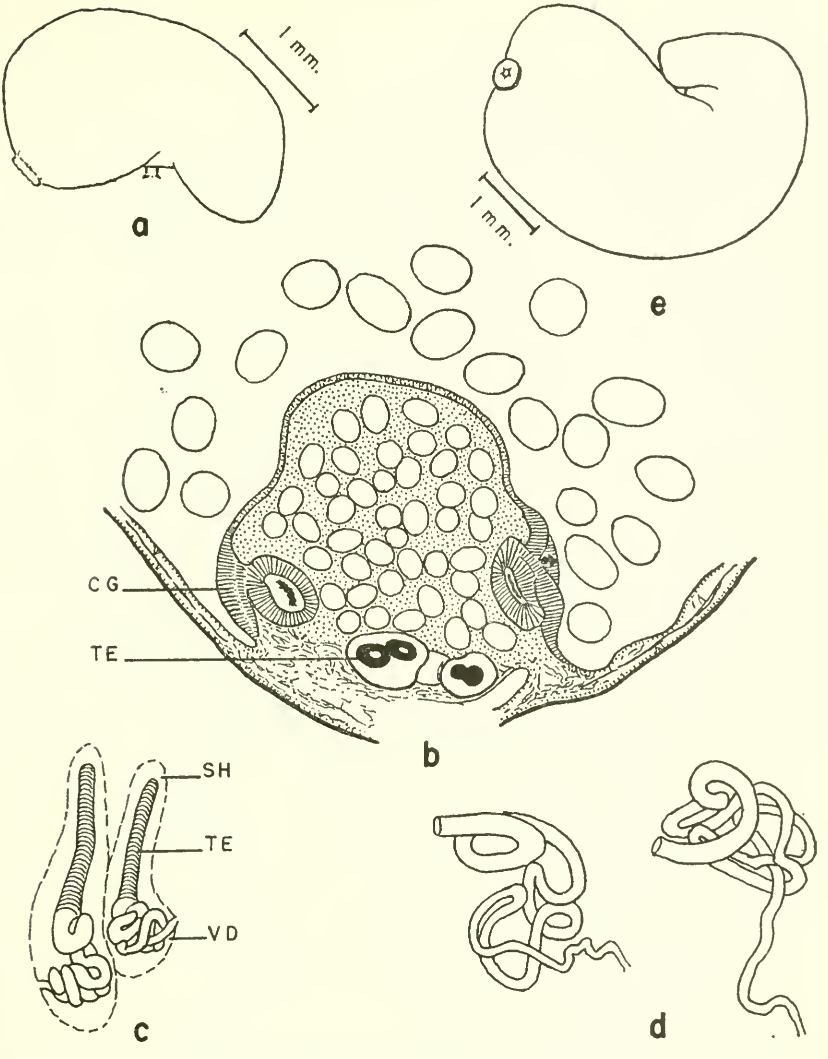


FIGURE 4.—*a–d*, *Galatheascus minutus* Boschma: *a*, external appearance of specimen on *Munidopsis barbarae; b*, transverse section of the same specimen; *c*, testes and vasa deferentia of specimen on *Munida stimpsoni; d*, chitinous linings of vasa deferentia revealed by maceration of another specimen on *Munida stimpsoni; e*, *Tortugaster fistulatus* Reinhard, external appearance of specimen on *Munidopsis spinifer*. Abbreviations: *sh*, sheath; *vd*, vas deferens; others as in figure 1.

Serial sections of the other parasite occurring on *M. stimpsoni* and of the *Blake* specimen were prepared. No differences were observable in the details of their internal anatomy.

The mesentery begins just behind the mantle opening and gradually increases in width as it passes backwards. It reaches its maximum breadth in the region of the stalk, then tapers off and ends about half way between the terminations of the male genital organs and the posterior end of the sac.

The testes are located in the region of the stalk. They consist of a fairly long, straight portion followed by a slightly coiled portion. The vasa deferentia are long and highly tortuous tubes, nearly as wide as the testes at their beginnings, but gradually diminishing in thickness. Each of the male genital systems is enclosed in a loose sheath or bag. In the sections one sees a noticeable space between the testis or vas and the envelope that surrounds it.

The colleteric glands, located anterior to the stalk, occur in the same sections of the animal as those which include the testes. They lie in the dorsal half of the visceral mass, rather close to the mesentery, and, although simple in construction, are not indistinct. The base of the gland forms a cavity which contains a coagulum. A short duct reaches from this cavity to the surface of the visceral mass, and its wall, as well as that of the cavity, consists of a layer of tall columnar epithelial cells. The gland reaches to a depth of about 140 microns below the surface of the visceral mass and extends in a dorsoventral direction for a distance of about 180 microns.

The specimens identified here as *Galatheascus minutus* agree with the description of the type material in size, position of the stalk, nature of the external cuticle, structure and position of the colleteric glands, and in the general morphology and location of the male genital organs. The fact that the mesentery of *G. minutus* is described as extending from the anterior to the posterior end, while in our specimens it is only about three-fourths as long as the sac, is not considered to be a significant difference. Boschma (1933, p. 478) stated that the testes of *minutus* have their closed ends directed "towards the posterior extremity" of the body, but the word "posterior" in this connection was a mistake (Boschma, personal communication). In our material and in the type specimens of *minutus* the blind ends of the testes point in an anterior direction. This is likewise the condition in *G. striatus* (Boschma, 1929). Although the sac that surrounds each of the male reproductive systems is not mentioned in the description of the type, Boschma's figures of transverse sections of *striatus* and *minutus* both show this feature.

The list of Peltogastridae occurring on the Galatheidae is now as follows: *Galatheascus striatus*, *G. minutus*, *Tortugaster fistulatus*, *Cyphosaccus chacei*, *C. cornutus*, and *Boschmaia munidicola*. A comparison of the morphology of these animals fails to reveal any distinctive feature that sets this group apart from the other Peltogastridae, although in all except *Galatheascus* there is a pronounced tendency toward asymmetry.

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ADVANCES IN OUR KNOWLEDGE OF THE HONEY-GUIDES

By Herbert Friedmann

In the following pages I have brought together new information on various aspects of the biology of the honey-guides that has come to attention since the publication of my book in 1955. Together with these additional data, I have made such comments as seem necessary, either for their proper evaluation or for their allocation with respect to earlier knowledge. Only two phases of honey-guide studies are not included: Purely systematic data, and my continuing investigations on wax digestion, the results of which will be presented separately.

In addition to such notes as have appeared in print and which are here collated, I am indebted to the following for unpublished observations: J. P. Chapin, W. R. Ingram, C. H. Jerome, D. W. Lamm, H. M. Miles, B. Neuby-Varty, R. H. Stevenson, V. G. L. van Someren, and J. M. Winterbottom.

Additional Data on Eggs and Egg-Laying

Because of the difficulties attached to study of ovulation in parasitic birds, one must always be alert for incidental data bearing on this topic. The new information is as follows:

1. Greater honey-guide, *Indicator indicator*

One observation bearing on the time of day of ovulation comes to me from J. M. Winterbottom. On Sept. 16, 1943, in the northwestern corner of the Livingstone District, Northern Rhodesia, he caught a female greater honey-guide on the nest of a hoopoe in a hole in an ant hill. The bird had already laid its egg. He watched it go to the nest, and walked up at once, so it was only a matter of seconds, half a minute at the most, that the bird was on the nest. In answer to my query, Winterbottom informs me that this took place during the hot part of the day, between 11 a. m. and 2 p. m.

A female collected April 28 at Enugu, eastern Nigeria, by Serle (1957, p. 415) had two large yolked ova in the ovary and two ruptured egg follicles, indicating that at least four eggs would have been laid. It may be recalled that earlier data of the same type (Friedmann, 1955, p. 136) suggested, in one case at least, that eight eggs would have been laid by one bird. We still do not know what the usual number may be.

Recently, H. A. Roberts (1956, p. 114) has stated that, when about to lay in a barbet's nest, the hen honey-guide goes there accompanied by the male, and that the latter acts as a lure to draw away the potential hosts from their nest, thereby giving the hen the chance to enter it and deposit an egg. Roberts writes that the female barbet rushes out of the nest hole as the honey-guides approach, and back into it again as they depart a short distance, this performance "being repeated until she becomes rather exhausted. At this stage the female honey-guide conceals herself nearby, and as soon as both barbets pursue the increasingly bold male honey-guide, the female honey-guide makes a dash for the hole. Usually a short lull among the contestants now follows which enables the female honey-guide to deposit her egg. Should the barbets try and return too soon, the male honey-guide at once takes action to lure them away . . . ." This account is comparable to one by Millar which I have previously described (Friedmann 1955, pp. 136–137), and as I wrote then, it is "difficult to believe that the male accompanies the female to the nests of the potential hosts, as there are no data suggesting anything comparable to mating in these parasites. That the male should act as a foil, to draw off the barbets on guard while the female deposits her egg, seems like too good a story not to have entered into the recording of whatever may have actually transpired." In the case described above by Winterbottom, no male honey-guide was noted. However, we still have so few direct observations of the act of egg deposition that it is advisable to keep an open mind on this matter, even though it seems rather unlikely that the males attend the laying females.

2. Sharp-billed honey-guide, *Prodotiscus regulus*

Serle (1957, pp. 416–417) collected a female at Enugu, eastern Nigeria, on September 27 that had an egg in membrane in the oviduct and three large yolked ova and two ruptured follicles in the ovary, indicating that at least five eggs could have been laid.

Additional Host Records

Our knowledge of the life histories of all the honey-guides is still so imperfect that it is to be expected that additions to the lists of known victims will be made for a long time to come. Besides these new host species, further data on previously poorly documented ones have also come to attention in the past three years. The total supplementary data, presented here under the various species of honey-guides, do not change the present picture materially but merely add to the total recorded information and help to orient more properly some of the earlier information.

1. Scaly-throated honey-guide, *Indicator variegatus*

One additional host has been recorded for this still infrequently observed honey-guide. The case is of sufficient interest to quote the original account in some detail.

Jackson's tinker-bird, *Pogoniulus bilineatus jacksoni* (Sharp)

Van Someren (1956, p. 220) writes that

> . . . at another nest I knew to hold young, I noted fresh chippings on the ground and thought perhaps another hole was being started, but there was no such cavity. Sitting down in cover, I heard dull tapping coming from the nest hole, then noticed chippings coming out . . . . With a sharp knife, I cut a circular opening . . . and exposed the nest. The chamber and tunnel had been considerably enlarged and within was a three-quarters grown variegated honey-guide. It was remarkable that the hen honey-guide had been able to force her way in and lay her egg in the original small chamber, and moreover, how did the barbets come to appreciate that the chamber was too small to accommodate the chick! Yet, here they were, enlarging the chamber to ensure the comfort of their foster child! I replaced the circle of wood and sealed it in. The young honey-guide was seen in the forest two weeks later, attended by the foster parents . . .

It is fortunate that, in this case, the young parasite was feathered sufficiently to make its identification certain. In my book (1955, p. 105) I listed one record for the Uganda race of this tinker-bird, *Pogoniulus bilineatus nyansae* (Neumann), and echoed Jackson's (1938, p. 734) doubts that either *Indicator variegatus* or *I. indicator* could possibly get inside the small nest opening to lay there, or that the young parasite, when ready to leave, could get out through it. It now appears that our doubts were needless. Van Someren (1956, p. 221) writes that he has seen a "variegated honey-guide struggling into a hole scarcely large enough for her to enter."

2. Greater honey-guide, *Indicator indicator*

The new data on this, the best known of the honey-guides, whose recorded hosts now number 32 species, or, including subspecies, 38 forms, are as follows:

Striped kingfisher, *Halcyon chelicuti chelicuti* (Stanley)

Previously known from a single instance near Marandellas, Southern Rhodesia, this kingfisher is listed as a host by Smithers, Irwin, and Paterson (1957, p. 89), possibly on the basis of the same record. Neuby-Varty, the discoverer of the first case, has recently written me of what may be a second case. Early in December 1955, near Marandellas, he watched a striped kingfisher at a nest hole about 20 feet up in a tree. Suddenly, a freshly dead kingfisher nestling, about 4 or 5 days old, fell out of the opening and to the ground. He picked it up and noted tiny punctures anterior to the wings that looked very much like the bill hook wounds of a nestling honey-guide. Unfortunately, he was not able to get to the nest and so could not prove that there was a honey-guide chick present. It may be recalled that in the case of nestling ejection by the young honey-guide in a nest of the crested barbet (Friedmann, 1955, pp. 147–148) the young barbets were ejected alive and unharmed, possibly because the nest stump had been broken off and there was little depth left to the nest cavity, thereby making ejection easier. In the present instance, it may be that the depth was greater and the parasite did not attempt eviction until after it had immobilized its nest mate.

Cinnamon-breasted bee-eater, *Melittophagus lafresnayii oreobates* (Sharpe)

In his recent book, van Someren (1956, p. 190) writes that he has taken eggs of the greater honey-guide from nests of this species in Kenya Colony, but does not give any indication of how many such cases he found. In addition, W. R. Ingram informs me (in litt.) that he once found a nest of this bee-eater, also in Kenya Colony, containing one egg of *Indicator indicator* as well as some pecked eggs of the host. This bee-eater was not known to be parasitized prior to these observations.

Crested barbet, *Trachyphonus vaillantii vaillantii* Ranzani

To the two records given in my book (1955, pp. 147–148) may be added two more, both of parasitized nests found in Southern Rhodesia by C. T. Fisher, and mentioned to me by Mr. H. M. Miles (in litt.)

Banded sand martin, *Riparia cincta cincta* (Boddaert)

One record for this hitherto unrecorded host, but the identification of the species of honey-guide involved is only inferential. Captain R. H. Stevenson informs me that a honey-guide's egg was found in a nest of this swallow in the Selukwe Reserve, Southern Rhodesia, about the end of November or the first days of December 1955. It is possible that either *Indicator indicator* or *I. minor* might be involved. In the absence of details, such as notes on the status of the two in that locality, dimensions of the egg, etc., it is not possible to allocate the record. It would seem more likely to be *I. indicator* because that species makes use of nests in holes in the ground much more frequently than does *I. minor*, but both are known to do so. In their recent book on the birds of Southern Rhodesia, Smithers, Irwin, and Paterson (1957, p. 89) list this swallow as a host of the greater honey-guide. I do not know if this is based on Captain Stevenson's record or if it is still another case.

Kenya anteater-chat, *Myrmecocichla aethiops cryptoleuca* (Sharpe)

Previously only two records were known to me, to which two more may now be added, indicating more definitely something of the regularity, if not frequency, with which this species is parasitized. W. R. Ingram informs me that he has found two nests of this bird, each containing a single egg of the greater honey-guide in addition to several pecked eggs of the host.

Red-shouldered glossy starling, *Lamprocolius nitens* (Linnaeus)

To the single host record recorded in my book (1955, p. 152) may be added another, unfortunately without exact data. Mr. C. H. Jerome informs me that he has been told of a second such occurrence, but did not have any explicit information about it.

Blue-eared glossy starling, *Lamprocolius chalybeus chalybeus* (Hemprich and Ehrenberg)

The southern subspecies of this starling, *L. c. sycobius* Hartlaub, was previously known to be parasitized by the greater honey-guide in the northern Transvaal. We may now note the same for the nominate race. Mr. W. R. Ingram writes me that at Serere, Teso District, Uganda, on Mar. 22, 1956, he found a nest of this bird containing a single egg of the greater honey-guide, together with some pecked eggs of the starling.

3. Lesser honey-guide, *Indicator minor*

Recent data of interest involve three species of hosts, one of them previously unrecorded in this capacity.

Striped kingfisher, *Halcyon chelicuti chelicuti* (Stanley)

Previously (Friedmann, 1955, p. 193) I knew of two records, both in South Africa. To these may be added a third, somewhat indefinite one from Kenya Colony, where van Someren (1956 p. 221) found an egg attributed to the lesser honey-guide in a nest of this little kingfisher.

Cinnamon-breasted bee-eater, *Melittophagus lafresnayii oreobates* (Sharpe)

Van Someren (1956, p. 190) has found this bee-eater to be parasitized by the lesser as well as by the greater honey-guide in Kenya Colony. This is an addition to the known victims.

Pied barbet, *Tricholaema leucomelan* (Boddaert)

Previously known as a frequent victim in South Africa, this barbet is now recorded in this capacity in Southern Rhodesia as well, where, according to H. M. Miles (in litt.), Irwin found a nest containing a young lesser honey-guide as the sole occupant.

Although only of suggestive interest, mention may be made of the fact that in Ghana, between Accra and Kumasi, early in June, Donald W. Lamm (in litt.) watched a colony of brown barbets, *Gymnobucco calvus*, ready to begin breeding. At least four lesser honey-guides (*Indicator minor ussheri*) were present. They were very quiet, perching on the heavier branches of the trees, and showed no attempts to enter any of the nest holes. Two of them, a male and a female, were collected, both with well-developed gonads. This observation suggests that this species of barbet, as well as *Gymnobucco bonapartei* (already so recorded by Friedmann, 1955, p. 193), may be a host of the lesser honey-guide.

4. Slender-billed honey-guide, *Prodotiscus insignis*

To the little known information about the hosts of this honey-guide previously compiled by me (1955, pp. 251–252) may be added further details of the cases there described, as well as one additional host species. Like the previous data, the new observations all stem from Dr. van Someren.

Black-throated wattle-eye, *Platysteira peltata peltata* Sundevall.

Of this host all I was able to report previously (Friedmann, 1955, p. 251) was the bare fact that van Someren had once found a parasitized nest. He (van Someren, 1956, pp. 281–283) recently supplied more data, of which the following is a summary. When the nest was found, it contained just the young honey-guide, dark brown with a yellow gape, and quite naked. "The chick grew rapidly and on the fourth day of observation was well feathered on the head and back. It was then that I saw that . . . the plumage being gradually assumed was the olive green of a pigmy honey-guide. . . . The youngster was now receiving quite large moth larvae, imago moths, and dozens of small Diptera." Shortly afterwards some predator robbed the nest and ended the opportunity for further observation.

Kikuyu green white-eye, *Zosterops virens kikuyuensis* (Sharpe)

To the case I previously recorded (Friedmann, 1955, p. 252) merely as having two young slender-billed honey-guides in the nest, van Someren's (1956, pp. 222–223) additional data provide the following details. He found one of the young parasites just out of the nest on the ground near his house. As he was looking to see what nest it may have come from, he saw one of the white-eyes fly with food to a chick in a nest directly above the spot where he had picked up the fledgling. When his son climbed to the nest, the chick in it fluttered to the ground; it was found to be another slender-billed honey-guide. Van Someren put the two young birds in a cage, to which both parent white-eyes came with food for the next two days. The next night it rained very heavily and, as a result, one of the chicks died. The other one continued to be fed by the foster parents and was last seen in a tree nearby with the attendant white-eyes. Van Someren concludes his account by stating that the original white-eyes' eggs had been disposed of and that the honey-guide laid more than one egg in the white-eyes' nest. In view of the relative scarcity of these honey-guides, it does seem more probable that the two eggs in this nest were laid by one hen rather than by two, but this is only an inference. Similarly, we have no knowledge as to whether the host's eggs were removed by the laying honey-guide or ousted by the nestlings. In another place in his book, van Someren (1956, p. 434) does state that the hen honey-guide removes the victim's eggs one at a time when laying her own, but he gives no substantiating evidence for this statement.

Amethyst sunbird, *Chalcomitra amethystina kalckreuthi* (Cabanis)

This sunbird is an addition to the known victims of the slender-billed honey-guide. In November 1956, at Ngong, Kenya Colony, G. R. C. van Someren saw a newly fledged young slender-billed honey-guide being fed by both members of a pair of amethyst sunbirds. He watched them for some time at a distance of less than 10 feet.

Mammalian Symbionts

It is well established that the original foraging symbiont of the greater honey-guide is the ratel or honey-badger, *Mellivora capensis*, and that the human has deliberately become a substitute symbiont in its place. In my earlier account (1955, pp. 41–50) I gave some data to indicate that very occasionally baboons might be involved, and cited one instance of a bird apparently attempting in vain to evoke response from a mongoose, *Myonax cauui*. Verheyen (1951, pp. 91–93; 1957, pp. 105–113), on the other hand, suggested that the honey-guide may attempt to "call" to any or all of the larger mammals, between which he assumed it could not or did not distinguish. I find it difficult to agree with Verheyen in this matter and look upon the mongoose incident as an occasional error on the bird's part. However, the fact that as un-ratel-like a creature as the African human could become accepted as a symbiont shows that there may be a basic symbiont tolerance beyond what normally transpires. In this connection, it is of interest to record the following incident involving a greater honey-guide and a genet, kindly sent me by Bryan Neuby-Varty, who made the observation on his farm near Marandellas, Southern Rhodesia.

One day he was out in the brush when he heard a honey-guide calling and wondered if it was calling to any creature. Moving carefully he got behind a large tree and could see that it was watching a genet (probably *Genetta genetta mossambica*) on the ground at a hole at the base of a tree from which swarms of bees were flying. As long as the bird kept calling, the genet remained motionless, but soon it disappeared up to its shoulders down the hole, apparently not minding the bees. In a short while, it backed out with a small piece of beescomb which it proceeded to eat. Neuby-Varty then moved to a better position on a termite mound about 30 yards from the genet, from which spot he watched it for about half an hour as it repeatedly inserted its paw into the hole, pulled out pieces of comb, and proceeded to eat them. Then the wind changed and the genet must have scented the observer and it slunk off into the tall grass and was gone. Examination of the hole convinced Neuby-Varty that it was not dug by the genet but may have been the work of a jackal or possibly a mongoose or a ratel, although he has never seen the last named animal on his land.

In the above incident, there is no evidence that the bird had guided the genet to the hive, which apparently had been opened previously. It is more likely that the bird was attracted to the spot because of the bees, and its interest was then transferred to the genet that had come there independently and which, by virtue of its feeding there, actually kept the bird from doing the same. After the genet had left, the bird called intermittently for about 10 minutes and Neuby-Varty waited another 20 minutes to see if the beast would return. In those 30 minutes, the bird hopped down to the ground only once and pecked at tiny bits of comb.

We still have too few observations of associations between the greater honey-guide and various mammals, but it does seem that observations such as this one, or the one involving the mongoose, and even the baboon incident recorded earlier (Friedmann, 1955, pp. 45–46), hardly justify looking upon these creatures as definitely proved symbionts of the bird in the sense that ratels and humans are.

The Termination of Guiding Behavior

In my detailed account (Friedmann, 1955, pp. 25–71) I stated that the stimulus which appears to bring to a halt the guiding behavior, released earlier by the bird meeting with a potential foraging symbiont such as a ratel or a human, "is the sight or sound of bees. It is tempting to expand van Uexküll's and Lorenz's fruitful concept of the 'kumpan,' or companion, as the releaser of instinctive actions in birds and apply it to the honey-guides . . . . From this standpoint guiding may be looked upon as the result of the reactions evoked in the bird when the releasing agent is met with in the bird's natural environment, away from the bees' nest, for which it is the 'kumpan,' and the 'guiding' behavior is 'satisfied' or, at least, brought to a stop when the bird brings together the 'bee companion' and the bees." While I still think this statement is as close to the actual picture as present understanding permits, it has seemed to me possibly a little forced in its reasoning. It was, therefore, with considerable interest that I recently came across, in Russell's (1953) description of the drive character of instinctive behavior, some ideas that give further support to the applicability of the "kumpan" concept to guiding activities.

In the current general theory of instinct, we find that usually a chain of actions grouped under one heading as instinctive behavior tends to be divided into two phases, an introductory one of openly seeking, striving, appetitive behavior, and a directly subsequent one of essentially consummatory action, generally of a quasi-mechanical or quite stereotyped nature. The emphasis on the innate drive character of instinctive behavior, developed largely by Lorenz and his colleagues, seems warranted.

These investigators account for the specificity of the drives by hypothesizing what they term "action specific energy," which is said to accumulate and to be discharged with and into highly specific appetitive behavior patterns. Lorenz (1950) further assumes "that some sort of energy, specific to one definite activity, is stored up while this activity remains quiescent and is consumed in its discharge." Russell sees no real need to hypothesize energy when all that seems to be "accumulated" may be described just as readily as "specific tension or unreleased tendency to carry out a certain course of action." Regardless of whether it is a specific energy or a specific tension, the fact remains that we have, in either case, a support for what I implied when I wrote that the guiding behavior was "satisfied" and brought to a halt when both the bees and the bee "kumpan" simultaneously came to be within the sensory range of the bird. The specific energy is discharged, or the specific tension is dispelled, when the guiding bird achieves the unison of the releasing agent, the foraging symbiont, and the thing with which the releaser is associated in the experience of the activated bird, the bees. The mode of termination of guiding is one more example of the increasingly obvious fact that it is the discharge of consummatory action and not the biological or survival value involved that is the goal of innate appetitive behavior as far as the individual bird is concerned.

The Rustling Flight

The rustling flight, recorded for both the greater and the lesser honey-guides (Friedmann, 1955, pp. 130–133, 184), is of interest not only for itself but as the possible root from which evolved the highly specialized performance of the lyre-tailed honey-guide, *Melichneutes robustus*. The evidence is somewhat divided as to whether the rustling sound is produced by the wings or the tail in the greater and lesser honey-guide species, while in the lyre-tail it seems obvious that the sound is made by the highly peculiar outer tail feathers.

Two interesting additional observations have come to me, both having to do with the greater honey-guide. Neuby-Varty writes me that about the end of May, on his farm near Marandellas, Southern Rhodesia, he heard a greater honey-guide giving its *victor* call from the top of dead branches of a tree. Then it flew towards him, and just as the bird came above him, it started to make a rattling noise, apparently with its wings. The tail may have been involved as well, as the bird spread it fanwise while making the noise. Neuby-Varty timed the performance and found the noise (written down as *feet-up*) was given 10 times, with an interval of about a second between the sounds.

W. R. Ingram, at Serere, Uganda, informs me that he has found the rustling or drumming flight to be given only towards evening and always in the early dry season. He thinks it has no connection with courtship, as there are no suitable hosts nesting at the time of the year. He first heard it in December 1955, at about 7 p. m. and almost dark; the noise "was most eerie and seemed to come from different parts of the sky almost at once, showing that whoever or whatever was making the noise was moving very fast indeed." Ingram describes the sound made by suggesting that if one blows out the word *whukooo* with a great expulsion of air on the first syllable and with strong emphasis on the *K*, and then emptying one's lungs on the *ooo*, a similar sound can be produced. He goes on to say that "the noise was heard occasionally at dusk during the whole dry season (December–March) and again in 1956, but the author was never discovered." It was not until 1957 that he succeeded in seeing as well as hearing the performing bird. Early in December of that year, at about 6 p. m., he saw the bird

> . . . traveling at a very high speed in a circling, dipping flight. It careened around the sky for about 30 seconds and then dived into a large tree . . . . Immediately, three or four *victor* notes came from this very tree . . . . I knew this tree to be a popular stud-post, all the year round, but still I could not connect the bird in the sky with the honey-guide.
>
> However, I did not have to wait very many evenings before I got a repeat performance. I managed to pick up the bird in flight with the binoculars during its drumming flight, follow it round and into the same stud-post. At the moment it darted into the tree, if fanned its tail and the outer white feathers were very conspicuous; this is the only time it opened its tail in flight, so I assume the noise is done with the wings. It landed on a prominent perch and I got close enough for a positive determination . . . .

This account indicates a similarity in habit to the aerial evolutions of the lyre-tail even more definitely than did our previous data. It also supports the observations of Ranger, Neuby-Varty, and myself that the sound is produced by the wings and not by the tail.

Feeding Habits

That fair numbers of honey-guides may occasionally gather to eat at a single bees' nest is shown by an observation sent me by H. F. Stoneham, who heard noises coming from one of his domestic beehives. Thinking that a rat or some other creature was raiding the nest, he went to it, and was surprised to see eight honey-guides fly out in rapid succession, six greaters and two lessers.

Kettlewell (1955, pp. 45–47) describes a nest of wild bees built in an abandoned wrecked automobile, the metal of which became hot from the sun and caused the honey inside to ferment. This apparently had intoxicated a greater honey-guide, which Kettlewell pulled out of the automobile.

An addition to the known diet of the lesser honey-guide is reported by van Someren (1956, p. 221), who saw one taking the young larvae and pupae from the paper nest of an aculeate wasp. This recalls the old observation of Butler, Feilden, and Reid (1882, p. 208) who reported the greater honey-guide pecking at the comb of a wasp's nest that had fallen to the ground.

Chapin has recently sent me some observations on the feeding habits of the least honey-guide, *Indicator exilis*, in the eastern Belgian Congo. He opened an old bees' nest in which he found considerable quantities of comb, practically empty of honey. The next day a least honey-guide came to it, and again two days later he saw one there. He placed a piece of the comb in a branch of a tall bush where he could watch it, and the bird came there and ate pieces of the comb. The bird was alone in each case, which fact seems to answer Chapin's (1939, p. 540) earlier statement that since this species does not guide humans, it may have some other mammalian symbiont.

Chapin observed not only the least honey-guide feeding at open bees' nests, but also his newly discovered pigmy honey-guide, *Indicator pumilio*. In fact, most of his specimens of the latter were captured with a butterfly net as they emerged from a beehive.

Recently Verheyen (1957) has taken objection to my conclusion that the primary interest of the honey-guides in bees' nests is the wax of the comb rather than the honey, pollen, or bee larvae. It should be pointed out that I have described that the birds do eat the bee larvae and pupae, and, adventitiously, the honey, but it still remains that the wax is the one substance they are most eager to get from the hive, and the one substance they cannot obtain elsewhere. They are constantly catching insects on the wing, and are certainly not primarily wax feeders. As I pointed out, honey-guides grow to full size in their hosts' nests without getting any wax in their food, but once they begin fending for themselves they eat wax avidly, not as a substitute for some other food but as an addition to their diet. By itself, beeswax is not a "total" food as it lacks nitrogen, without which no bird could survive for more than a few weeks or a month.

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THREE NEW SERRANID FISHES, GENUS PIKEA, FROM THE WESTERN ATLANTIC

By Leonard P. Schultz

Several years ago, when studying the serranid fishes related to *Pikea* Steindachner, *Chorististium* Gill, and *Liopropoma* Gill during my preparation of the report on the Marshall Island fishes (U. S. Nat. Mus. Bull. 202, vol. 1, 1953), I observed that USNM 117191 represented an undescribed new species. However, the six specimens in that lot were in poor condition, so I waited until additional specimens became available for further study. This new material contained still another undescribed species with two new subspecies, all of which are described here.

Mrs. Patricia Isham made the drawings for figures 1 and 2.

Genus *Pikea* Steindachner

Pikea Steindachner, Sitzber. Akad. Wiss. Wien, vol. 69, p. 2, 1874 (type species, *Pikea lunulata*=*Grystes lunulatus* Guichenot).

Dr. James Böhlke (Notulae Naturae, Philadelphia, No. 291, pp. 1–7, pl. 1, 1956) pointed out that I overlooked one of the almost embedded dorsal spines in my description of *Ypsigramma lineata* (U. S. Nat. Mus. Bull. 202, vol. 1, p. 375, fig. 59, 1953) and that *Chorististium* *rubrum* (Poey) is scaled over between dorsal fins similar to *Y. lineata.* He concluded that my genus *Ypsigramma* is a synonym of *Chorististium,* with which opinion I fully agree.

Therefore the generic name *Chorististium* must be used for that group of species in which the spiny and soft dorsal fins are separated by several rows of scales. The group of species with continuous dorsal fin and eight dorsal spines then takes the next available generic name, which I find to be *Pikea* Steindachner.

Radiographs made of nearly all the specimens available to me in this relationship show clearly that the vertebrae always are 10+14=24 and that in the genus *Chorististium* there are always eight dorsal spines—the seventh is embedded (occasionally the tip projects slightly) and is separated from the sixth and eighth spines, which project.

The three new forms have the following characters in common. Dorsal fin single, distance from tip of snout to dorsal origin, 2½ times in standard length; posterior edges of scales with ctenii, head scaled forward to front nostrils; basal part of soft dorsal, pectoral, and caudal fin scaled; basal three-fourths of anal fin covered with scales; opercle with two flattish, bluntly rounded spines; preopercle finely serrate; anterior nostril tubular, posterior nasal opening, a pore at front of eye; gill rakers slender with dentigerous rudiments anteriorly; villiform teeth on jaws, vomer and palatines; caudal fin emarginate; pectoral fin elongate, reaching to opposite anal fin origin; first dorsal spine shortest, about one-third length of third dorsal spine; lateral line arched along back below base of dorsal fin then curving downward to midline of caudal peduncle; premaxillary protractile; gill membranes free from isthmus but attached to it far forward; pelvic rays always I,5; branched caudal rays 8+7; vertebrae always 10+14=24; seven branchiostegals; pores in lateral line to base of caudal fin 45 to 49 (rarely 49).

***Pikea cubensis*, new species**

FIGURE 1

HOLOTYPE: USNM 158138, collected by the *Oregon,* northeast of Caibarien, Cuba, lat. 22°50′ N., and long. 79°08′ W., 200 to 225 fathoms, July 16, 1955, standard length 80.3 mm.

PARATYPES: USNM 175254, collected with holotype and bearing same data; 3 specimens, 113, 83, and 58 mm. USNM 185083, Bahama Islands, lat. 25°15′ N., long. 79°13′ W., 200 fathoms, July 23, 1957, *Combat* station 445, 2 specimens, 69 and 79 mm.

DESCRIPTION: Counts made on the types are recorded in table 1.

Precision measurements were made on the holotype and paratypes. These data are recorded in thousandths of the standard length, respectively, 80.3, 113, 83, and 58 mm. Greatest depth of body 293, 327, 283, and 285; length of head 380, 354, 368, and 371; snout 80, 103, 88, and 86; fleshy interorbital space 62, 62, 60, and 60; diameter of eye 108, 88, 96, and 117; postorbital length of head 194, 173, 193, and 190; least width of preorbital 19, 20, 18, and 22; length of maxillaries 166, 173, 181, and 178; least depth of caudal peduncle 139, 149, 139, and 138; distance from base of last anal ray to midbase of caudal fin 217, 251, 245, and 219; length of longest (third) dorsal spine —, —, 133, and 143; of longest soft dorsal ray (third from last) 212, 208, —, and 172; longest anal spine (third) 106, 90, 108, and 98; longest soft anal ray (third from last) 162, 159, 175, and 150; longest pectoral ray 280, 268, 286, and 281; longest pelvic ray 164, 142, 163, and 173; longest caudal fin ray —, 274, —, and —.

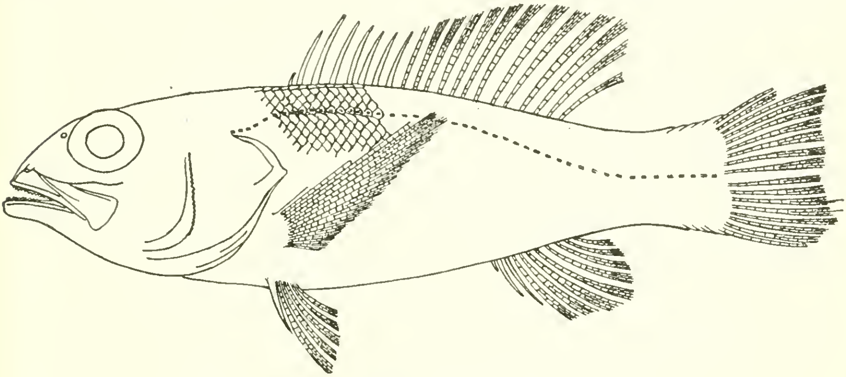

FIGURE 1.—*Pikea cubensis*, new species, from Cuba.

COLOR IN ALCOHOL: Plain straw-colored except tips of outer caudal fin rays are blackish.

REMARKS: This new species is distinguished as indicated in the key on page 327. It differs from *P. mexicanus* in the number of soft dorsal fin rays.

Pikea mexicanus mexicanus, new species and subspecies

FIGURE 2

Liopropoma aberrans (non Poey) Longley and Hildebrand, Carnegie Inst. Washington Publ. No. 535, Papers Tortugas Lab., vol. 34, p. 101, 1941 (USNM 117191 from Tortugas).

HOLOTYPE: USNM 158246, collected Nov. 25, 1950, by the *Oregon* in Gulf of Mexico, southeast of Corpus Christi, Tex., lat. 27°22′ N; long. 96°08′ W., 103 fathoms, standard length 101 mm.

PARATYPES: USNM 117191, collected by Dr. W. H. Longley at Tortugas, Fla., 6 specimens, 46 to 95 mm. USNM 155240, collected July 12, 1952, by the *Oregon* in Gulf of Mexico, southwest of Cape

San Blas, Fla., lat. 29°31′ N., long. 86°26′ W., 100 fathoms, standard length of 2 specimens 91 and 113 mm. USNM 155508, collected by the *Pelican* Feb. 4, 1939, in the Gulf of Mexico, southeast of Corpus Christi, Tex., lat. 29°02′ N., long. 96°40′ W., 48 fathoms, standard length 130 mm. USNM 156706, Gulf of Mexico, south of Panama City, Fla., *Pelican* station 154–2, Mar. 10, 1939, lat. 29°08.5′ N., long. 85°47′ W., 70 fathoms, 1 specimen, standard length 77 mm. USNM 156707, Gulf of Mexico, southeast of Pensacola, Fla., *Pelican* station 143–4, Mar. 5, 1939, lat. 29°44.5′ N., long. 86°34.5′ W., 98 fathoms, 1 specimen, standard length 83 mm. USNM 156708, Gulf of Mexico, southwest of New Orleans, La., *Pelican* station 85–3, July 12, 1938, lat. 28°09′ N., long. 91°27′ W., 50 fathoms, 1 specimen, standard length 79 mm. USNM 156709, Gulf of Mexico, southeast of Corpus Christi, Tex., *Pelican* station 114–4, Feb. 4, 1939, lat. 26°56.5′ N., long. 96°27′ W., 90 fathoms, 1 specimen, standard length 86 mm.

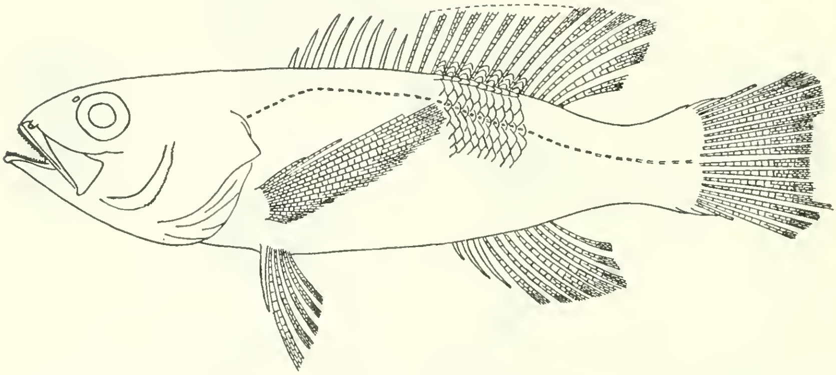

FIGURE 2.—*Pikea mexicanus*, new species, from Gulf of Mexico off Corpus Christi, Tex.

The following paratypes are in the Tulane University collections, New Orleans. All are from the Gulf of Mexico and were collected by the *Oregon:* TU 12985, lat. 29°19′ N., long. 86°04′ W., 82 fathoms, Oct. 31, 1953, 1 specimen, 71 mm. TU 11008, lat. 27°10′ N., long. 96°20′ W., 150 fathoms, June 5, 1954, 1 specimen, 112 mm. TU 14739, lat. 27°40′ N., long. 95°45′ W., 100 fathoms, May 7, 1956, 1 specimen, 106 mm. TU 12972, lat. 28°47′ N., long. 85°19′ W., 64 fathoms, Mar. 7, 1953, 11 specimens, 54 to 76 mm. TU 11004, lat. 27°10′ N., long. 96°20′ W., 150 fathoms, June 5, 1954, 6 specimens, 87 to 104 mm.

DESCRIPTION: Counts made on the types are recorded in table 1.

Precision measurements were made on the holotype and three paratypes. These data are recorded in thousandths of the standard length, 101, 130, 113, and 91 mm., respectively. Greatest depth of body 258, 254, 283, and 291; length of head 371, 354, 363, and 357;

TABLE 1.—*Counts recorded for species referable to the genera* Pikea, Liopropoma, *and* Chorististium

(Letter "x" denotes data recorded from the literature)

Genera and species	Number of fin rays																	Total number of gill rakers on first arch													
	Dorsal							Anal				Pectoral																			
	VI-I-I	VIII	IX	12	13	14	15	III	8	9	10	i,13	ii,10	ii,11	ii,12	ii,13	ii,14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Pikea																															
japonicus		1				1		1			1													1							
aurora		4			4			4		4						8								4							
mexicanus mexicanus		34				33	1	33	33						3	38	1							10	15	3					
mexicanus atlanticus		24				24		20	20							21					1	10	11	1							
cubensis		4			4			4	4							8							1	3							
mowbrayi		1		1				1	1					2				1													
swalesi		2		1				2	2						4																2
lunulata		2		2				2	2						3	1					1	1									
maculata		x		x				x	x						x																
longilepis		1			1			1	1			2											1								
Liopropoma																															
aberrans			x	x				x	x																						
roseus			x			x		x	x																						
Chorististium																															
pallidum	1			1				1	1								2					1									
brocki	2			2				2	2						1	2							1								
lineata	5			5				5	5							7						2	2								
susumi	1			1				1	1							2			1	1											
africanum	x			x				x	x							1				x	x										
rubrum	4			4				4	4				3	2	1					1			1								

snout 89, 88, 84, and 77; fleshy interorbital space 59, 69, 62, and 60; diameter of eye 79, 77, 84, and 86; postorbital length of head 208, 200, 199, and 192; least width of preorbital 25, 32, 26, and 25; length of maxillaries 164, 167, 166, and 176; least depth of caudal peduncle 127, 135, 133 and 137; distance from base of last anal ray to midbase of caudal fin 228, 231, 235, and 242; length of longest (third or fourth) dorsal spine 119; 123, ——, and 116; of longest soft dorsal (third from last) ray 228, 211, 208, and 239; longest anal (third) spine 114, 107, 89, and 102; longest soft anal (third from last) ray 189, 177, ——, and 179; longest pectoral ray 297, 304, 310, and 297; longest pelvic ray 173, 181, 186, and 176; longest caudal fin ray 238, ——, 257, and 231.

COLOR IN ALCOHOL: Plain straw-colored, with traces of black pigment at tips of outer caudal fin rays.

REMARKS: This new species is distinguished from *P. cubensis* by having 14 soft dorsal rays instead of 13. It may be distinguished from the other related species by means of the key.

Pikea mexicanus atlanticus, new subspecies

HOLOTYPE: USNM 185005, collected Nov. 8, 1957, off French Guiana, lat. 7°18′ N., long. 53°32′ W., *Oregon* station 2021, 100 fathoms, standard length 108 mm.

PARATYPES: USNM 185008, taken with holotype and bearing same data, standard length 98 mm. USNM 185007, off Surinam, lat. 7°32′ N., long. 54°12′ W., 100 fathoms, Nov. 8, 1957, *Oregon* station 2014, 5 specimens, 84 to 109 mm. USNM 185006, off Venezuela, lat. 9°53′ N., long. 59°53′ W., 125 fathoms, Nov. 3, 1957, *Oregon* station 1983, 9 specimens, 59 to 107 mm.. USNM 185082, off Surinam, lat. 7°30′ N., long. 54°16′ W., 125 fathoms, Nov. 8, 1957, *Oregon* station 2013, 1 specimen, 56 mm. USNM 185080, off Venezuela, lat. 9°24′ N., long. 59°41′ W., 110 fathoms, Nov. 4, 1957, *Oregon* station 1988, 1 specimen, 77 mm. USNM 185081, off Venezuela, lat. 9°39′ N., long. 59°47′ W., 100 fathoms, Nov. 4, 1957, *Oregon* station 1986, 9 specimens, 59 to 92 mm.

This new subspecies from off the Guianas and Venezuela is essentially the same (in all important characters) as *Pikea mexicanus mexicanus* of the Gulf of Mexico, except for the number of gill rakers on the first gill arch—18 to 21 on *P. m. atlanticus* and 21 to 23 on *P. m. mexicanus*. Because of the slight overlap in counts of gill rakers, I prefer to consider the form from off the coasts of Venezuela and the Guianas as a subspecies.

Key to genera and species related to *Pikea*

1a. Spiny dorsal fin continuous with soft dorsal by a ridge of scales along sides of connecting dorsal spines; no scaled area separating spiny and soft dorsal rays; 2½ to 5½ scales in a row from lateral line to base of last dorsal spine; 16 to 21 predorsal scales to occiput.

2a. Dorsal spines VIII (genus *Pikea*) [1]

3a. Anal rays III,10; dorsal rays VIII,14; pectoral ii,14; pores in lateral line 47; zig-zag scales around caudal preduncle 40 to 42; outer edge, distally, of each caudal lobe white (Japan) . . . . **P. japonicus** (Döderlein) [2]

3b. Anal rays III,9; dorsal rays VIII,13; pectoral ii,13; pores in lateral line 48 to 51, zig-zag scales around caudal peduncle about 45 (Hawaiian Islands) . . . . **P. aurora** Jordan and Evermann [3]

3c. Anal rays III,8.

4a. Pores in lateral line 43 to 49, rarely 49.

5a. Dorsal rays VIII,12.

6a. Pores in lateral line 43; pectoral rays ii,11; gill rakers on first gill arch about 15; tips of outer caudal fin rays black (Bermuda). **P. mowbrayi** (Woods and Kanazawa) [4]

6b. Pores in lateral line 46 or 47; pectoral rays ii,12; predorsal scales to occiput 19 to 21; gill rakers on first gill arch about 28 (Philippines) . . . . **P. swalesi** (Fowler and Bean) [5]

5b. Dorsal rays VIII,13 or 14; pectoral rays ii,13 rarely ii,12 or ii,14; pores in lateral line 46 or 47; tips of outer caudal fin rays usually black in adults.

7a. Dorsal rays VIII,13; gill rakers on first arch 20 or 21 (Cuba). **P. cubensis,** new species

7b. Dorsal rays VIII,14; gill rakers on first arch 21 to 23 (Gulf of Mexico). **P. mexicanus mexicanus,** new species and subspecies

7c. Dorsal rays VIII,14; gill rakers on first arch 18 to 21, rarely 21 (off Venezuela and Guianas). **P. mexicanus atlanticus,** new subspecies

4b. Pores in lateral line 48 to 70; gill rakers on first gill arch about 18 to 20 (unknown for *P. maculata*).

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[1] *Pikea* Steindachner, Sitzber. Akad. Wiss. Wien, vol. 69, p. 2, 1874 (type species, *Pikea lunulata* (=*Grystes lunulatus* Guichenot 1863).

Labracopsis Döderlein *in* Steindachner and Döderlein, Anz. Akad. Wien, vol. 20, p. 49, 1883; Denkschr. Akad. Wien, vol. 47, p. 235, 1883 (type species, *Labracopsis japonicus* Döderlein).

[2] *Labracopsis japonicus* Döderlein *in* Steindachner and Döderlein, Anz. Akad. Wien, vol. 20, p. 49, 1883; Denkschr. Akad. Wien, vol. 47, p. 235, pl. 6, fig. 3, 1883 (Japan).

[3] *Pikea aurora* Jordan and Evermann, Bull. U. S. Bur. Fish. vol. 22, (1902), p. 178, 1903; Ibid., vol. 23 (1903) pt. 1, p. 220, pl. 14, 1905 (Hilo).

[4] *Liopropoma mowbrayi* Woods and Kanazawa, Fieldiana, Zool., vol. 31, No. 53, p. 633, fig. 134, 1951 (Bermuda).

[5] *Chorististium swalesi* Fowler and Bean, U. S. Nat. Mus. Bull. 100, vol. 10, p. 186, 1930 (Gulf of Tomini, Celebes).

8a. Pores in lateral line 48 to 55.

9a. Pectoral rays ii,13 or 14; dorsal rays VIII,12; pores in lateral line 48 to 52; zig-zag scales around caudal peduncle about 40 to 52; body with numerous black spots (Reunion Island and Mauritius) . . . . **P. lunulata** (Guichenot)[6]

9b. Pectoral rays i,13; dorsal VIII,13; pores in lateral line 54 or 55 (Panana) . . . . **P. longilepis** (Garman)[7]

8b. Pores in lateral line about 65 to 70; dorsal rays VIII,12; pectoral ii,13; sides of body spotted (Japan). **P. maculata** Steindachner and Döderlein[8]

2b. Dorsal spines IX (genus *Liopropoma*)[9]

10a. Dorsal rays IX,12; pores in lateral line 45 (Cuba). **L. aberrans** (Poey)[10]

10b. Dorsal rays IX,14; pores in lateral line 58 (my count of drawing is 62 or 63) (Pernambuco, Brazil). . . . . **L. roseus** (Günther)[11]

1b. Spiny dorsal and soft dorsal fins completely separated externally by a scaled area of 5 to 7 rows across back between fins; dorsal rays VI–I–I,11 or 12; the seventh dorsal spine usually embedded below scales; pores in lateral line 45 to 48; 2½ to 5 scales in a row from lateral line to last dorsal spine; zig-zag scales around caudal peduncle 30 to 32; gill rakers 5 to 7+1+11 to 14 on first arch; anal rays III,8 . . . . (genus **Chorististium** Gill)[12]

11a. Coloration plain pale, no stripes or dark pigment marks on sides or on fins; pectoral rays ii,14; predorsal scales 12 to occiput; dorsal rays VI–I–I,i,11 (Christmas Island and Bikini Atoll) . . . . . . **C. pallidum** Fowler[13]

11b. Coloration of alternating dark and pale streaks or dark wavy lines on sides.

12a. Sides of body with brown pigment specks, a few arranged in irregular lines on midsides; an oblique short dark brown streak on pectoral base; predorsal scales 13 to occiput. . . . . . **C. brocki** (Schultz)[14]

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[6] *Grystes lunulatus* Guichenot, Notes sur l'Ile de la Reunion. Faunae Ichthyologique, p. c-4, 1863 (Reunion Island).

Pikea lunulata Steindachner, Sitzber. Akad. Wiss. Wien, vol. 69, p. 2, 1874; Denkschr. Akad. Wiss. Wien, vol. 47, pl. 6, fig. 2, 1883.

Glaucosoma semilunifera Steindachner, *in* Bliss, Trans. Roy. Soc. Mauritius, new ser. vol. 13, p. 47, 1883 (Mauritius).

[7] *Liopropoma longilepis* Garman, Mem. Mus. Comp. Zool., vol. 24, p. 45, 1899 (lat. 7°33′ N.; long. 78°34′20″ W.).

[8] *Pikea maculata* Döderlein and Steindachner, Denkschr. Akad. Wiss. Wien, vol. 47, p. 234, pl. 6, figs. 1, 1a, 1b, 1883 (Japan).

[9] *Liopropoma* Gill, Proc. Acad. Nat. Sci. Philadelphia, p. 52, 1861 (type species, *Perca aberrans* Poey).

Bathyanthias Günther, Rep. Voyage *Challenger*, Zool., vol. 1, No. 6, p. 6, 1880 (type species *Bathyanthias roseus* Günther).

[10] *Perca aberrans* Poey, Memorias, vol. 2, p. 125, pl. 12, fig. 2, 1860 (Cuba).

[11] *Bathyanthias roseus* Günther, Rep. Voyage *Challenger*, Zool., vol. 1, No. 6, p. 6, pl. 1, fig. B, 1880 (Pernambuco, Brazil).

[12] *Chorististium* Gill, Proc. Acad. Nat. Sci. Philadelphia, vol. 14, p. 15, 1862 (type species, *Perca rubre* Poey; misspelled *Chorististum* in heading).

Ypsigramma Schultz, U. S. Nat. Mus. Bull. 202, vol. 1, p. 372, 1953 (type species, *Ypsigramma lineata* Schultz).

[13] *Chorististium pallidum* Fowler, Monogr. Acad. Nat. Sci. Philadelphia, vol. 2, p. 199, fig. 20, 1938 (Christmas Island).

[14] *Ypsigramma brocki* Schultz, U. S. Nat. Mus. Bull. 202, vol. 1, p. 379, fig. 60, 1953 (Marshall and Gilbert Islands).

12b. Coloration not as above.
  13a. Sides of body with 7 or 8 distinct, almost straight lengthwise dark brown streaks.
    14a. Five brown streaks on each side of caudal peduncle; 3½ or 4 scales between lateral line and last doral spine; predorsal scales 12 or 13 to occiput. . . . . **C. lineata** (Schultz)[15]
    14b. Four brown streaks on each side of caudal peduncle; 3 scales between lateral line and second dorsal origin; predorsal scales 10 to occiput. . . . . **C. susumi** Jordan and Seale[16]
  13b. Four or 5 dark streaks on each side of body; 3 dark streaks on each side of caudal peduncle.
    15a. Five dark streaks on each side of body; pectoral rays ii,12; tips of posterior lobes of median fins with black blotches (Cuba; Bahama Islands) . . . . **C. rubrum** (Poey)[17]
    15b. Four dark streaks on each side of body; pectoral rays ii,13 (Zanzibar) . . . . **C. africanum** Smith[18]

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[15] *Ypsigramma lineata* Schultz, U. S. Nat. Mus. Bull. 202, vol. 1, p. 355, fig. 59, 1953 (Marshall and Philippine Islands).

Chorististium susumi (not Jordan and Seale) Smith, J. L. B., Ann. Mag. Nat. Hist., ser. 12, vol. 7, p. 862, pl. 27, fig. c, 1954 (Matemo Island, off East African Coast).

[16] *Chorististium susumi* Jordan and Seale, Bull. U. S. Bur. Fish., vol. 25 (1905), p. 256, fig. 48, 1906 (Apia, Samoa).

[17] *Liopropoma rubre* Poey, Memorias, vol. 2, p. 418, 1861 (Cuba).

[18] *Chorististium africanum* Smith, J. L. B., Ann. Mag. Nat. Hist., ser. 12, vol. 7, p. 866, fig. 1, pl. 27, fig. B, 1954 (Pinda Pembra, Zanzibar and Tekomazi Island).

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THE STATUS OF THE LIZARD CNEMIDOPHORUS PERPLEXUS BAIRD AND GIRARD (TEIIDAE)

By T. Paul Maslin,[1] Richard G. Beidleman,[2]
and Charles H. Lowe, Jr.[3]

Several years ago Burger (1950), in a paper concerned with the systematics of *Cnemidophorus*, stripped the name *Cnemidophorus perplexus* of all specimens previously associated with it except the type. This action followed a period of some 50 years of taxonomic confusion and, as Burger himself pointed out, was a temporary measure until more material was available with definite locality data. Burger, with qualifications, followed Burt (1931) in his designation of the type and type locality. Burt in turn apparently based his designation of the type on indirect statements made by Cope in 1893 and again in 1900 and possibly from examinations of the catalog entries of the U. S. National Museum (USNM). But he based his designation of the type locality on the original description of Baird and Girard in 1852. His selection of the type locality has been accepted by most workers since then, but his action was unjustified. He designated one specimen as the lectotype of *perplexus,* and the habitat of different specimens as the type locality. This discrepancy and the recent description of two new striped species from the Southwest provided

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[1] University of Colorado Museum, Boulder, Colo.

[2] Colorado College, Colorado Springs, Colo.

[3] University of Arizona, Tucson, Ariz.

the original motivation for a reinvestigation of the status of the species, which poses the problem of answering three questions. First, what specimen actually constitutes the type; second, what is the type locality; and third, with what species in this area may the name *perplexus* be associated? These questions while simple are not easily answered Their solutions have been greatly facilitated by the kindness of Dr. Remington Kellogg, director of the U. S. National Museum, in making available to us type material and other specimens; by the cooperation of Dr. Doris M. Cochran in her search of the USNM catalogs; and by the material assistance of the Council on Research and Creative Work of the University of Colorado, whose monetary aid has made possible the acquisition of comparative material.

THE TYPE: Baird and Girard (1852) published descriptions of a series of lizards based largely on material collected by Dr. John H. Clark, under Col. J. D. Graham, head of the Scientific Corps, U. S. and Mexican Boundary Commission; but there were also included specimens collected by others. In this paper the extremely brief description of *Cnemidophorus perplexus* is based on an unstated number of specimens presumably collected by Clark in the valley of the Rio San Pedro of the Rio Grande del Norte (according to Smith and Taylor, 1950, p. 363, this is the Devils River, Val Verde County, Tex.) and specimens collected by Gen. Churchill on the Rio Grande west of San Antonio and by Dr. William Gambel, at no specific locality, on his last journey to California. No holotype is indicated, nor by any clue from the description, title, or introduction does one specimen seem to receive closer attention that any other. This is not too surprising in that the type concept was in its infancy at that time.

As far as we are aware, the first indication that a type existed is Cope's (1893, p. 34) remark that "The type specimen is the largest obtained, and is probably adult." He does not, however, indicate to which specimen he is referring; but this can be determined on the basis of size alone. Cope (1893, pl. 6, figs. 1, A-G; pl. 12, fig. B) also figures the species. In his explanation of plates (p. 51) it is indicated that figure 1 of plate 6 is of "Specimen No. 3060 U. S. National Museum." Cope used these figures again in a later work (Cope, 1900, p. 573, fig. 105), but here they lie above the legend "Cat. No. 3060, U. S. N. M." This suggests, but does not specifically state, that the figures are of the type and that a lectotype, USNM 3060, had been designated. We can find no such designation in the literature and assume that Cope himself selected a type sometime prior to 1893. Frequently Cope (1900) designated the types in the tables of specimens held by the Museum. But in this instance USNM 3060 is not even listed, nor does Yarrow (1882) list this specimen in his catalog. Furthermore, in his extended description of "the type" Cope's (1900, p. 573) first sentence does not agree with the published figure above it. He states: "In the type specimen of this subspecies the interparietal plate is narrower than the parietals, and is twice as long as wide." In the figure it is much broader. Farther on he also states that there are 19 femoral pores on each side in the type; the excellent figures show 25.

These discrepancies suggest that possibly the type is some specimen other than USNM 3060 or, as was frequently done in those days, more than one specimen was cataloged under that number. Through the kindness of Dr. Kellogg we have been able to examine all of the specimens upon which Baird and Girard based their description. The largest of these is now numbered 3060, and it is perfectly obvious that the figure, in spite of the legend beneath it, is not of this specimen. On the other hand Cope's (1900, pp. 573–574) description of the type is a remarkably accurate description of this very same individual. Originally, however, there were, indeed, two specimens cataloged under this number. The smaller of the two was reidentified by Stejneger (Cochran, in lit.) as *gularis* and assigned a new number, USNM 30885. Actually the specimen—judging by its small size, seven light stripes, moderately enlarged hexagonal post-antebrachial scales, enlarged temporal scales, etc.—is a specimen of *C. inornatus*. It is of interest to note that Cope's (1900, p. 588, fig. 112) figure of *Cnemidophorus tesselatus variolosus* Cope is also of a specimen numbered 3060. But this figure, too, is not of the specimen now bearing this number, nor is it a figure of USNM 30885. Cope obviously had been careless in assembling his manuscript, and his figures in this instance are valueless in determining the status of this species. His (1900) figure 105 is not a figure of a specimen of *C. perplexus* at all, but probably of some race of *C. tigris*.

Before assuming that USNM 3060 is the type of *perplexus* as indicated but not specifically stated by Cope, it is essential to know if this specimen is a syntype. The original material upon which Baird and Girard based their description of this species is apparently intact, or nearly so, and in the U. S. National Museum; but the catalog entries of this material do not completely match Baird and Girard's (1852, p. 128) locality notations.

Dr. Doris M. Cochran, curator of herpetology at the U. S. National Museum, has kindly provided us with the catalog entries on this material. The specimens from the "Valley of the Rio San Pedro of the Rio Grande del Norte" are cataloged as having been collected along the "Rio San Pedro to the Rio Grande, Texas" by Col. Graham. However, Baird and Girard (1852) in their introduction specifically state the bulk of the material upon which their paper is based was "collected by John H. Clark, under Col. J. D. Graham." There are now five specimens in this lot cataloged under USNM 3022; originally there were six. The specimens "collected" by Gen. Churchill are two in number and are cataloged under USNM 3050, and designated as having been collected in "Texas." Gambel's contribution is now entered as follows: "Type/*Cnemidophorus perplexus*/'Calif'??/ probably W. Texas/. Dr. W. Gambel/3060/1." Dr. Cochran (in lit.) informs us that at Dr. L. Stejneger's suggestion she added in her own hand the word "type," the two question marks after "Calif" and the notation "probably W. Texas." These entries so closely match the notation of Baird and Girard in their original description of the species that there seems little doubt that they truly represent the specimens in hand when the original description was made, even though at that time the specimens were uncataloged and without numbers. The taxonomic fate of Clark's and Churchill's specimens will be mentioned later; it is Gambel's large specimen that is of importance at the moment.

The catalog entry of USNM 3060 was made on July 20, 1858, probably by Baird himself (Cochran, in lit.). Between that time and 1893 it had presumably been selected by Cope as the type of *perplexus*, for in 1900 he described a specimen which he designated in his description as the type, and this specimen is unquestionably USNM 3060. It is not until Burt (1931) published his studies on the teiid lizards of the genus *Cnemidophorus* that a statement is finally made in the synonymy of *Cnemidophorus sexlineatus perplexus* that the type is USNM 3060.

This action of Burt's constitutes a formal designation of a lectotype, properly selected from the syntypes of Baird and Girard. According to our interpretation of the proceedings of the 12th International Congress of Zoology, Paris, 1948, and the 14th International Congress of Zoology, Copenhagen, 1953, this action is final and the lectotype of *Cnemidophorus perplexus* Baird and Girard is what is now USNM 3060.

THE TYPE LOCALITY: Examination of the Clark material shows that it is not *Cnemidophorus perplexus* but rather *C. sacki gularis*. Hence, the type locality of Rio Pedro of the Rio Grande del Norte is invalid for the former species. As will be seen, Gambel's specimens, including the type, USNM 3060, could not have been collected in "W. Texas" as suggested by Dr. Stejneger inasmuch as Gambel never visited this part of the Southwest. Furthermore, the suggestion by several authors that Gambel made the collections on his second journey to California seems unlikely because of the northerly route followed and certain terminal events associated with that trip. Therefore it is necessary to reevaluate the actual type locality for *Cnemidophorus perplexus*, as evidence permits.

William Gambel was a young Philadelphia protégé of the frontier botanist Thomas Nuttall. After making several eastern collecting excursions with this eminent scientist, Gambel, at 18, was encouraged to attempt a trip to the West, penetrating the only portion of this new country which Nuttall had not himself visited, namely the Southwest.

Today, Gambel is most well known for making the first collections of plants from the Santa Fe, N. Mex., region and for his observations on and collections of birds from this frontier country of the 1840's. However, he also acquired a small collection of reptiles, including the designated type of *Cnemidophorus perplexus* and the following: *Holbrookia texana* (USNM 2787), *Sceloporus graciosus* (USNM 2861), *Phrynosoma modestum* (USNM 176), *Crotaphytus wislizeni* (USNM 2722), *Heterodon nasicus nasicus* (USNM 1277), *Masticophis taeniatus* (USNM 1979), and *Thamnophis elegans vagrans* (USNM 908).

Because Gambel published on the birds and Nuttall published on Gambel's plant collections for the Academy of Natural Sciences of Philadelphia, accurate information is available with respect to localities and dates for these specimens. With respect to the reptiles, however, no study of the material was ever published by Gambel or his immediate colleagues; consequently, collection details are vague. Baird and Girard (1852, p. 128) note that the specimens of *Cnemidophorus perplexus* were collected on Gambel's "last journey to California." In Yarrow's (1882) catalog, Gambel's several species are for the most part designated as having been collected in "Calif." The only specific locality is that given for *Phrynosoma modestum.* Yarrow (1882) cites this specimen (USNM 175) as coming from "Plaenis." No such place can be located in the territories through which Gambel passed and it seems likely that Yarrow misread a label in making this notation. Cope (1900, p. 439) cites the same specimen as coming from the "plains," presumably of eastern New Mexico. In order to reach some decision on the collection locality, especially of *Cnemidophorus perplexus*, it is necessary to scrutinize more closely the two western trips of Gambel.

The first, in 1841, embarked upon undoubtedly at the behest of Thomas Nuttall, followed in general outline the Santa Fe Trail from Independence to Santa Fe and the Old Spanish Trail from that community to California. The second expedition, which culminated in Gambel's death, followed the eastern portion of the Oregon Trail from Independence to Wyoming and the Hudspeth Trail over Hastings Cut-Off through Nevada to California. This latter trip was in 1849.

Despite suggestions to the contrary in the literature, especially Baird and Girard (1852), it is implausible that any of Gambel's extant collections were from the second trip, either from California or en route. Indeed, it is most unlikely that any specimen material Gambel might have collected on this trip was ever returned to the East, due to the circumstances described below.

At the end of this second overland journey, Gambel died of typhoid fever in December 1849 in the northern Sierra Nevadas of California and was buried at Roses Bar above the Feather River. His grave was subsequently destroyed by placer miners. There were friends in California aware of Gambel's death. D. B. Woods of Mountain House wrote an obituary of Gambel which later appeared in a Philadelphia newspaper. Also, on this trip Gambel had apparently been accompanied by a man named Beesley from the Philadelphia area who returned to the East early in March of 1851 (Osborn, 1931, p. 259; letter, John Cassin to Baird, March 12, 1851, ". . . . Beesley who accompanied poor Gambel has returned within a day or two . . . ").

Gambel, on this second trip, had made a journal which was returned to his wife after his death, most probably by Beesley. Later the journal was turned over to the Academy of Natural Sciences and subsequently lost. There is no evidence, however, that anything beyond this journal was returned from the young naturalist's belongings. Nonscientific friends on the scene of Gambel's death would be most unlikely to take sufficient interest and effort to send or bring back from far away California any specimens, especially alcoholics, either by the torturous overland route or around Cape Horn by ship. Also, little among the known accessions of Gambel suggests a collection point close to the more northerly route which apparently was followed in 1849. Therefore, the designation "second journey to California" seems invalid as a time and locality for any of Gambel's collecting, particularly herpetological collecting.

The route of Gambel's first trip west, to Santa Fe and eventually to southern California, has been outlined by several authors but is herein changed somewhat to conform with newly discovered evidence. Gambel left Independence for Santa Fe with a party of 80 men, mostly merchants and their merchandise-loaded wagons, between May 8 and May 10, 1841. This yearly caravan to Santa Fe followed the Santa Fe Trail on to the Arkansas River in Kansas. It now appears evident that this particular caravan did not proceed to Fort Bent near the Colorado Rockies and then south over Raton Pass. Instead, it took the Cimmaron Cut-Off, leaving the Arkansas River in western Kansas, cutting across the panhandle of Oklahoma into northeastern New Mexico, probably encountering the mountains proper near Wagon Mound, passing on to Las Vegas and thence to Santa Fe.

The basis for suggesting this change in route is a letter which was published in Niles' National Register (vol. 61, p. 1575, 1841). This anonymous letter, dated July 1841, was written by a man who joined the annual Santa Fe caravan just before the crossing of the Arkansas River in Kansas. That he and Gambel were members of the same party from that time on is borne out by practically identical descriptions of two Indian encounters in letters of the two men to people in the East. Information in the Niles' National Register letter makes it possible to designate the arrival date at Santa Fe as July 2, 1841.

Gambel was in the vicinity of Santa Fe, along the Rio Grande and in the nearby mountains, for the period from July 2 to about September 1. He made representative collections of plants, especially from the "sandy hills along the borders of the Rio del Norte, Santa Fe (Mexico)." The Rio Grande River lies about 20 miles west of Santa Fe and today is generally inaccessible by highway in this area. During Gambel's visit, however, the main road from the east crossed Santa Fe Creek near the town and continued to the Rio Grande along the south side of this creek, thence turning south towards Albuquerque. It would seem justifiable to assume that Gambel gained access to the Rio Grande collecting localities by means of this road. Thus, specimens from "Rio del Norte, Santa Fe" presumably were collected south of the entrance of Santa Fe Creek into the Rio Grande River, west and southwest of Santa Fe.

None of the plant collections or bird observations warrant suspecting that Gambel went far south of Santa Fe; but one of the species of reptiles he collected suggests that he might have. This species, *Holbrookia texana*, extends up the Rio Grande Valley as far as Valencia County (4 miles north of Sabinal). It might even extend as far north as Albuquerque; but the likelihood of its occurring in Santa Fe is questionable. Although he makes comments about birds at Taos, it seems unlikely that Gambel went that far north. One of his comments concerns wintering juncos, and certainly he was not there during the winter. He probably learned about Taos birds from people in Santa Fe.

On or within a day or so after September 1, Gambel departed from New Mexico, supposedly from Abiquiu, with John Workman's party for California. This party is reported to have traveled northwest from New Mexico across southwestern Colorado, over the Colorado and Green Rivers in eastern Utah in September, into the mountains south of Salt Lake, then southwest across mountains and desert to southern California. There is some variance in arrival dates in California between the Workman party and Gambel, the former arriving in early November and the latter "the last of November being three month's traveling over Rocky Mountains & barren deserts . . . ." The difference in arrival dates may simply mean that Gambel took time out for exploration on his own or with a small detached party somewhere en route.

In considering the most likely localities from which Gambel might have made his collections of reptiles on this first California expedition, the valley of the Rio Grande River southwest of Santa Fe seems the most probable choice, especially with respect to *Cnemidophorus perplexus.* Inasmuch as Gambel's type specimen was a female containing at least one large ovarian egg, the date it was collected probably fell somewhere between July 25 and not much later than August 7. During this period Gambel was collecting a number of plants near the river and, in the course of such collecting, had, like modern-day botanists with herpetological leanings, ample opportunity to collect lizards as well.

Assuming that Gambel did collect *C. perplexus* on the Rio Grande River near Santa Fe, he may or may not have shipped it home before leaving for California. The fall express for Independence left Santa Fe shortly after July 25, on which date Gambel wrote a letter (Pennsylvania Historical Society collection) home to his mother in Philadelphia. Nuttall had urged that Gambel dispatch his plants to George Engelmann of St. Louis, who was to send them through a John H. Barnard on to Nuttall in Philadelphia. Nuttall (letter, Nuttall to Engelmann, Nov. 3, 1841; Missouri Botanical Gardens) received a letter from Gambel at Santa Fe stating that he intended to send to Nuttall via Engelmann "a part of the collections he had made up to that place by another party returning to St. Louis in October." There is nothing, however, among the Engelmann correspondence at the Missouri Botanical Gardens to suggest that Engelmann ever received Gambel's shipments from Santa Fe, either from the annual express or from an October party. If shipments were made, they must eventually have reached Philadelphia and the Academy of Natural Sciences but undoubtedly after Nuttall had departed for England at the end of 1841. Thus they probably would have remained in storage at the Academy. It seems logical that Gambel would ship east anything collected to this point, since the next shipment point would have to be from California, over a thousand miles away across difficult country. But apparently no such shipment was made. Judging from the gravid condition of the type of *Cnemidophorus perplexus* the chances of its having been collected before the fall express left for Independence is very slight. It appears, then, as though Gambel carried all of his collections to California.

How the specimens eventually reached the Smithsonian Institution is as obscure as where they were originally collected. In the Seventh Annual Report of the Smithsonian Institution (1853, p. 55) there is a notation under the section on new 1852 reptile accessions, "A small number of specimens procured by Dr. Gambel, in the same country, has also come into the possession of the Institution." There is, unfortunately, no further information on the accession. The accessions immediately preceding this entry were of specimens from California. It appears from this entry and Baird and Girard's (1852) locality notations that Gambel must have shipped all of his herpetological collections from California and that the original recipient of these collections, whoever he may have been, simply assumed that it was there that they had been collected. The possible ways by which the Smithsonian Institution could have acquired them are many. They might have been donated through Gambel's wife directly or through her brother, might have been sold to someone by Gambel's wife, and subsequently donated, might have been received from the Academy of Natural Sciences, purchased by some Smithsonian agent such as John Kirk Townsend, a friend of Gambel's, etc.

How the other specimens of *C. perplexus* (so identified at that time) got into Baird's hands at the Smithsonian is an easier problem. General Churchill was a close personal friend of the Bairds in Carlisle, Pa., and indeed became Baird's father-in-law. Colonel Graham's collections were actually made for him under orders by John H. Clark, and Clark had been a student of Baird's at Carlisle College. Rowan Kennerly, who also collected one of the early, but not syntypic, USNM specimens of *C. perplexus*, had also been one of Baird's students.

In summary, the type of *Cnemidophorus perplexus* was undoubtedly not collected in "Calif.," in "W. Texas," or during Gambel's "last journey to California"; but was probably collected sometime during the last week of July 1841 during Gambel's first journey to California. The type locality is probably the valley of the Rio Grande in Sandoval County, N. Mex., in the vicinity southwest of Santa Fe.

Description: We are now faced with a paradox, namely the identification of a type. Cope's (1900, p. 573–574) description of the specimen for the most part is accurate. The specimen is in fair condition but rather soft, and as Burt (1931, p. 122) points out the tail is now incomplete. Cope's (*loc. cit.*) measurements, therefore, are probably as accurate as any which can now be made. Our own measurements agree essentially with his.

USNM 3060, mature female, possessing nearly mature ovarian eggs. Total length, 260 mm. (according to Cope); length of head and body, 86 mm.; length of head to posterior edge of auditory meatus, 20.7 mm.; length of head to posterior face of jaw articulation, 20.3 mm.; length of forearm from axilla, 27 mm.; length of hind leg from inguen, 58 mm.; width of head, 11.6 mm. Interparietal twice as long as wide, narrower than parietals; a pair of frontoparietals; third and fourth supraoculars completely separated from frontoparietals by a series of small scales; first and second supraoculars broadly in contact with frontal; five scales in both anterior and posterior occipital rows, anterior nasals 1–1; posterior nasals 1–1; loreals 1–1; preoculars 1–1; suboculars 4–3; frenoculars 0–0; supralabials 6–6, counting first scale in contact with last subocular; infralabials 7–6; chinshields 5–5, first pair in contact throughout their length; chinshields separated posteriorly from infralabials by 4–4 scales, these preceded by a few smaller granules. Scales of central intermandibular area slightly larger than adjacent scales, intermandibular scales gradually decreasing in size posteriorly; anterior gular scales about half diameter of lateral intermandibular scales; gular fold with medial, anteriorly directed open notch; fold bordered by small scales, medially small scales form a triangle, apex forward, anterior to notch, this triangle separating two patches of enlarged scales; these enlarged gular scales smaller than enlarged median intermandibular scales. Anterodorsal brachial scutes in four rows; anterodorsal antebrachial scutes in three rows; post-antebrachial scales small with central strip of very slightly enlarged scales; anterodorsal femoral scutes in seven rows; anterodorsal tibial scutes in three rows. Three enlarged anal plates consisting of a pair separated from cloaca by four rows of small scales and preceded by an enlarged median scale. Femoral pores 19–19, median two separated by four scales. There are 178 vertebral scales counting from but not including enlarged occipitals to first row of enlarged scales at base of tail; 73 scale rows at region of greatest girth excluding ventral plates; 25 scales around base of tail.

Color pattern. Median vertebral light stripe as distinct and as wide as paravertebral light stripes, commencing as a pair of light spots on occipital scales, extending posteriorly to first row of enlarged scales of tail, posterior three-fifths of line undulant or wavy; width of vertebral light stripe, paravertebral dark and light stripes about equal; paravertebral light stripes separated by 12 rows of scales (average of 10 counts) at midbody; paravertebral (first) dark stripes or fields darker than remaining ones; toward center of body vague indication of one or two light spots in these dark fields; second, third and fourth dark stripes successively wider, fourth stripe more than twice as wide as any light stripe which are all subequal in width. Second and third dark stripes each with a very vague indistinct median row of large light spots, somewhat confluent, difficult to count, approximately 12 or 13 spots in each field. Fourth dark stripes with one or two extremely vague, large, diffuse, light spots. Ventrum immaculate white.

COMPARISONS: With this description in mind the type can now be compared with the species of *Cnemidophorus* that Gambel might have encountered from Missouri to California. These species are as follows: *tesselatus*, *tigris*, *sexlineatus*, *inornatus*, *neomexicanus*, *velox*, *sacki*, and *hyperythrus*. The tesselated forms *tesselatus* and *tigris* may be dropped from the list immediately on the basis of color pattern alone. The species *hyperythrus* occasionally has a median light stripe but it has only a single frontoparietal scale and its distribution is such that it is the least likely to have been encountered by Gambel.

Of the remaining forms *sexlineatus* can also be removed from the list on several counts. In this species there is never a median light line as bright or as narrow as the lateral light lines; the third and fourth supraocular scales are in contact with the frontoparietal; the posterior antebrachial scales are definitely though not abruptly enlarged; there are seldom more than 15-15 femoral pores; the intermandibular scales are larger and abruptly demarked by a sudden decrease in size from the small anterior gular scales; the gular fold is not notched, nor are the enlarged gular fold scales interrupted medially by a patch of smaller scales; the enlarged gular fold scales are larger than the median intermandibular scales. Furthermore, the species does not occur in the vicinity of Santa Fe, N. Mex. There is no question of doubt that *sexlineatus* and *perplexus* are not the same.

The remaining species all occur in the vicinity of Santa Fe, and it is these species which must be examined most critically. Of these four species *perplexus* resembles *sacki* the least. In this latter form there is no conspicuous median light stripe; the post-antebrachial scales are abruptly and greatly enlarged; the intermandibular scales are larger and abruptly demarked from the smaller anterior gular scales along a transverse line; the gular fold is unnotched and bordered by a row of enlarged, scutelike scales much larger than the median intermandibular scales and uninterrupted by a triangular patch of smaller scales. The paravertebral light stripes are separated by only about five scales; the second and, particularly, third dark bands are spotted by numerous light spots alternating from side to side of each band; the fourth and lowest band also contains numerous light spots.

C. inornatus of New Mexico and Arizona differs from *perplexus* in that it lacks spots in the dark fields; has about eight scales between the paravertebral light stripes; is much smaller than the type; has larger post-antebrachial scales; the intermandibular scales are much larger, relatively few in number, and abruptly differentiated from the smaller anterior gular scales by one or two transverse rows of still smaller, granular, median scales; the gular fold is unnotched and the enlarged scales of the fold are larger than the median intermandibular scales; there is no patch of smaller scales interrupting the row of enlarged gular fold scales; temporal scales larger and fewer in number; femoral pores fewer.

In spite of the conspicuous differences in scale counts and size, *C. inornatus* in the northwestern part of its range and *C. velox* resemble each more than they resemble any other species of *Cnemidophorus*. Lowe (1955) has discussed the relationship of these two species in a study demonstrating the validity of *C. velox*. While he did not emphasize the fact that *velox* and *inornatus* are nowhere known to be sympatric, he pointed out that they exhibit a marked difference in habitat and geographic distribution. Moreover, both species are relatively rare in those areas where their ranges approach one another. It is possible that *C. velox* is a direct derivative of *C. inornatus.* As far as we are aware, no definitely identified specimens of *velox* have been reported from Santa Fe, but the species has been collected in New Mexico at Taos, Taos County; 5 miles south of Youngsville, Rio Arriba County, a site some 50 miles northwest of Santa Fe; and 2 miles west of Sands, San Miguel County, some 30 miles southeast of Santa Fe. That the species will ultimately be collected near Santa Fe seems inevitable, for it is a member of similar pinyon-juniper communities not far distant and has been taken both to the north and south of this locality.

C. velox differs from *perplexus* in that the median stripe if present and complete is indistinct, lighter in color and narrower than the paravertebral light stripes and never undulant; the paravertebral light stripes are separated by about eight scales; there are no spots in the dark fields; the post-antebrachial scales are larger than those of *perplexus* but not as large as those of *inornatus*; the intermandibular scales are larger and abruptly demarked from the anterior gular scales along a transverse line (in an occasional specimen this is not marked); the largest scales on the gular fold are usually larger but often equal in size to the largest median intermandibular scales; the gular fold is unnotched and the enlarged scales along it are not interrupted medially by a patch of smaller scales; the temporal scales are slightly larger; the third supraoculars are in broad contact with the frontoparietals.

C. neomexicanus has not yet been taken as near to Santa Fe as has *velox.* The nearest known locality for *neomexicanus* is 6 miles south of Bernalillo, Sandoval County, near the Rio Grande and about 50 miles southwest of Santa Fe. However, this locality more closely approaches the probable type locality for *perplexus* than does any in the presently known distribution of *velox.*

C. neomexicanus differs from *perplexus* in only a few characters, but these differences are for the most part concerned with variable characters and fall within the range of variation described by Lowe and Zweifel (1952). The chief and most important difference lies in the fact that in most specimens of *neomexicanus* the fourth, third, and often the second supraoculars are separated from the median head plates by small scales (circumorbitals). In the type of *perplexus* only the fourth supraocular and three-fourths of the third are so bordered. Another marked difference is in size. Of the 48 specimens available to Lowe and Zweifel (1952), all from Socorro County, N. Mex., the largest is a female measuring 76.4 mm. from snout to vent. The type of *perplexus,* also a female, measures 86 mm. In all other characters the two forms are strikingly similar.

The color patterns and the arrangement and size of the brachial, antebrachial, and post-antebrachial scales are identical; *neomexicanus* usually has a peculiar, anteriorly directed open notch on the gular fold as does *perplexus*; the scales of the gular fold are only moderately and gradually enlarged anteriorly as they are in *perplexus* and their maximum size is less than or equal to the largest median intermandibular scales. The enlarged gular scales are occasionally interrupted medially, as in the type of *neomexicanus*, by a patch of small scales. This condition closely approximates the condition of the type of *perplexus*. The intermandibular scales are larger than the anterior gular scales as they are in *perplexus* and usually are not sharply demarked from them; however, on either side a few small scales, arranged in a short transverse row, often separate the two areas laterally in *neomexicanus*, but not medially. The arrangement and size of the temporal scales are as similar in the two forms as this type of scalation can be. The number of scales from the occipital region to the rump in the type of *perplexus* is 178, this is within six scales of the average given by Lowe and Zweifel (1952) for *neomexicanus*, namely 184.3 ± 1.2; and the number of circumabdominal scales exclusive of the ventral plates is 73, two scales less than the mean of *neomexicanus* which is 74.9 ± 0.62. In spite of the differences in body size and the extent of the anterior extension of the circumorbital semicircles we are convinced at this time that *neomexicanus* and *perplexus* are one and the same.

It is appropriate to point out that this finding—the first proper allocation of the old name *Cnemidophorus perplexus* to a definitely known population—has been made possible through the detailed study of variation by Lowe and Zweifel (1952), where for the first time the body scale counts were determined and analyzed statistically in a study of variation in the genus *Cnemidophorus*.

The remaining specimens upon which the description of *perplexus* was based have been examined and may be identified as follows. The five specimens (USNM 3022) collected by John H. Clark in the valley of the Rio San Pedro of the Rio Grande del Norte are all *Cnemidophorus sacki gularis* Baird and Girard. The two specimens of USNM 3050, "collected" by General Churchill on the Rio Grande west of San Antonio, are both *Cnemidophorus inornatus* Baird. The second specimen, collected by Gambel and originally bearing the same number as the type (USNM 3060), is now numbered USNM 30885. This is also a specimen of *Cnemidophorus inornatus*.

For the most part descriptions of specimens of *perplexus* in the literature are so brief as to make identification virtually impossible. Furthermore, so many lined whiptails have been confused with each other that all of the earlier, more extended accounts of these forms, when based on series, almost inevitably are based on more than one species. The synonomy given below is, then, tentative, and includes only those references which seem very likely to pertain to:

Cnemidophorus perplexus Baird and Girard

Cnemidophorus perplexus Baird and Girard, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 128, 1852; Appendix F, Reptiles, *in* Exploration of the Red River of Louisiana, in . . . 1852, p. 239, 1853 (reference to 1852 description).—Cope, U. S. Nat. Mus. Bull. 1, p. 46, 1875 (listed).—Gadow, Proc. Zool. Soc. London, p. 368, 1906 (Bernalillo County, N. Mex.; brief description).—Van Denburgh, Proc. California Acad. Sci., ser. 4, vol. 13, p. 211, 1924 (record from Santa Fe (San Ildefonso), N. Mex.; possible).—Burger, Chicago Acad. Sci., Nat. Hist. Misc., No. 65, p. 3, 1950 (diagnosis based on type).

Cnemidophorus octolineatus, Yarrow, Report upon the collections of batrachians and reptiles, *in* Geographical and geological explorations and surveys west of the 100th meridian, vol. 5, chap. 4, p. 558, 1875 (San Ildefonso, N. Mex.; possible).

Cnemidophorus tesselatus perplexus, Cope, Amer. Nat., vol. 26, pl. 18, fig. B, 1892 (dorsal color pattern, possibly of type of *perplexus*); Trans. Amer. Philos. Soc., vol. 17, pp. 34–35, 1893 (redescribes type specimen; pl. 6, figs. A–G not of *perplexus;* p. 12, fig. B, possibly of *perplexus*); *in* Ann. Rep. U. S. Nat. Mus. 1898, pp. 573–575, 1900 (figure 105 not of *perplexus;* redescription of type).

Cnemidophorus sexlineatus perplexus, Burt, U. S. Nat. Mus. Bull. 154, pp. 122, 125, 1931 (designates lectotype, gives description).

Cnemidophorus sexlineatus, Smith and Taylor, U. S. Nat. Mus. Bull. 199, p. 185, 1950 (cites *perplexus* as synonym; specifies type, type locality unknown).

Cnemidophorus perplexus perplexus, Smith and Taylor, Univ. Kansas Sci. Bull. 33, p. 363, 1950 (lists species as valid, identifies Rio San Pedro as Devils River).

Cnemidophorus neomexicanus Lowe and Zweifel, Bull. Chicago Acad. Sci., vol. 9, pp. 230–247, fig. 1*c*, pl. 1, fig. *a*, 1952 (type, Mus. Vert. Zool. Univ. California No. 55807, McDonald Ranch Headquarters, 4,800 ft., 8.7 miles west and 22.8 miles south of New Bingham Post Office, Socorro County, N. Mex., Charles H. Lowe, Jr., collector; detailed description, comparisons, and ecology).

LECTOTYPE: USNM 3060, adult female, type designation by Burt (1931, p. 122).

TYPE LOCALITY: Herewith restricted to valley of the Rio Grande in Sandoval County, N. Mex., in the vicinity southwest of Santa Fe. Type collected by Dr. William Gambel on his first journey to California, near the end of July 1841.

Summary

The type of *Cnemidophorus perplexus* was selected by Cope but not clearly designated as such. Burt (1931) followed the procedures recommended by the 13th and 14th International Congresses of Zoology and properly designated USNM 3060 as the lectotype of this species. The specimen was collected by William Gambel, probably on his first journey to California near the end of July 1841. The type

locality is probably the valley of the Rio Grande in Sandoval County, N. Mex., in the vicinity southwest of Santa Fe. As this locality is geographically and ecologically apart from the area formerly recorded as being occupied by this species, extensive comparisons of *C. perplexus* with all the species living in the region of Santa Fe had not been made. Of the various species that are now known to occur here it is evident that one of them, *C. neomexicanus* Lowe and Zweifel, is conspecific with *C. perplexus*. This name, therefore, must be considered as a synonym of *Cnemidophorus perplexus*.

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SYNOPSIS OF THE SPECIES OF AGROMYZID LEAF MINERS DESCRIBED FROM NORTH AMERICA[1]

By Kenneth E. Frick[2]

Introduction

A total of 206 described North American species are dealt with in this paper. All are separated by illustrated keys and briefly characterized in short descriptions that include the known larval host plants and distributions. Although I am aware of some undescribed species in each of the large genera, I have attempted to define and illustrate each of the previously described species so that new species can be recognized as distinct. The objective of this paper is to lay a firm foundation upon which students of the agromyzid leaf miners may build.

Originally only Nearctic species were to be considered. However, the types of the described West Indian and Central American species are in North American museums except for a few deposited in the British Museum (Natural History). Therefore, it was considered desirable to include the Neotropical area of North America not only because the types were available but because of the number of requests received by U. S. National Museum (USNM) personnel for identifications of leaf miners from the southern extremities of North America.

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[2] Irrigation Experiment Station, Prosser, Wash.

The North American species are distributed throughout 15 genera and 11 subgenera. Except for *Xyraeomyia* and possibly *Haplomyza*, all are Holarctic. Several very small genera, mostly monotypic, are not found in North America. These are the Neotropical *Triticomyza* Blanchard and the Palaearctic *Carinagromyza* Sasakawa, *Gymnophytomyza* Hendel, *Ptochomyza* Hering, *Selachops* Wahlberg, and *Xeniomyza* de Meijere. Each genus is redescribed and separated by the use of illustrated keys giving full consideration to the unusual species peculiar to North America. These unusual species are discussed under their respective genera. The similarities and differences between the faunas of North America and the Palaearctic region, the two best collected regions in the world, are also taken up under each genus.

It might be noted here, however, that the northern Neotropical region, poorly collected though it is, has contributed more than its proportionate number of extraordinary species. Among these are the reddish lunule and lower frontal vitta of *Melanagromyza diadema*, the white spot on the halter of *Ophiomyia punctohalterata*, the yellow scutellum of *Phytobia* (*Phytobia*) *picta*, the pictured wing of *P.* (*P.*) *kallima*, the yellow third antennal segment of *P.* (*Calycomyza*) *meridiana*, the distally narrowly yellow femora of *P.* (*C.*) *cassiae*, *P.* (*C.*) *ipomoeae*, and *P.* (*C.*) *lantanae*, the enlarged third antennal segment of males of *Liriomyza commelinae*, and the very large (3.5 to 4 mm. in wing length) South American *L. braziliensis* Frost and *L. ecuadorensis* Frost that have posterolateral setae medially on the midtibia and have larvae that mine the tubers and sometimes the stems of *Solanum tuberosum* Linnaeus.

Two species groups that are all or nearly all Neotropical have representatives in the southern Palaearctic region also. The first of these is the *viridula* group in the genus *Agromyza*. There are four northern Neotropical species and one from eastern United States. There appear to be two Palaearctic species: *Agromyza salicifolii* Collin does not occur north of Israel, and *A. quercus* Sasakawa occurs in Japan. A similar situation is found in *Melanagromyza*. There are five Neotropical representatives in the *pulicaria* group. The two Palaearctic species occur in the southern extremities of that region and one, *M. inaequabilis* Hendel, is not found as far north as Europe while the distribution of *M. pulicaria* Meigen includes Europe.

The morphological characters used in the keys and descriptions were described by Frick (1952). The only change made in that system is the renumbering of the dorsocentral setae. Hendel (1931) numbered from the posterior of the mesonotum forward and Frick (1952) accepted that arrangement. However, in 1953 Frick (1953b) rejected that system and counted from the anterior to the posterior or scutellum. The mesonotum and its setae were later illustrated (Frick, 1956a).

Because complete synonymies have been given previously (Hendel, 1931–1936; Frick, 1952, 1953a, 1956b, 1957a), only North American synonyms for genera, subgenera, and species are listed herein. The most recent paper (Frick, 1957a) gives all but two name changes not previously published so that the correct binomina would be available for this synopsis. The two names not included are *Liriomyza reverberata* (Malloch) and *L. sorosis* (Williston); the changes are discussed in full herein.

The locations of those holotypes not mentioned in the original descriptions or in other papers are given herein. A number of types of Frost's species had been retained in his personal collection and these he recently transferred to the U. S. National Museum.

The references are limited to the original descriptions and to those papers that have illustrations or good redescriptions of previously poorly defined species. The citations are not intended to be complete or to give all nomenclatural changes because those have been previously published (Frick, 1952, 1953a, 1957a). Those papers cited in the text by author and date only are given in full in the list of references cited (p. 445).

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Key to the genera of Agromyzidae found in North America

1. Subcosta developed throughout its length, coalescing with vein R_1 before reaching costa; vein R_1 somewhat broadened at union with the costa (fig. 1) (Agromyzinae) 2
Subcosta becoming a fold distally and ending in costa separately and basad of vein R_1; R_1 not broadened at its union with the costa (fig. 2) (Phytomyzinae) 5
2. Halter usually all black, rarely with a white spot on knob. 3
Halter white or yellowish . . . . **1. Agromyza**
3. Carina between antennae prominent, fusiform or hemispherical, antennae somewhat divergent (fig. 45) 4
Carina absent, flattened between antennae even though bases widely separated; antennae anteriorly directed. . . . . **2. Melanagromyza**
4. Carina fusiform (fig. 45); orbital setulae erect or reclinate (fig. 47). **3. Ophiomyia**
Carina hemispherical; orbital setulae proclinate (fig. 55). . . . **4. Tylomyza**
5. Scutellum with four setae (fig. 99). 6
Scutellum with two setae (fig. 95) . . . . **6. Cerodontha**
6. Orbital setulae erect or reclinate (fig. 133), sometimes weakly developed, or absent 7
Orbital setulae proclinate, well developed (fig. 141). 12
7. Wing with costa reaching to end of vein M_{1+2}, or (*Phytobia*) if only to R_{4+5} then ultimate section of M_{3+4} subequal to the penultimate section (fig. 77) 8
Wing with costa reaching to end of vein R_{4+5}; ultimate section of M_{3+4} at least twice as long as penultimate section when crossvein m-m present (fig. 134) 11
8. Scutellum yellow, at least centrally; vein M_{1+2} ending nearest wing tip (fig. 118) 9
Scutellum usually dark and concolorous with mesonotum, if yellow vein R_{4+5} ending nearest wing tip (fig. 60). . . . . **5. Phytobia**
9. Genovertical plates narrow, usually slightly but not abruptly raised above the plane of the frontal vitta; if abruptly raised then genovertical plates narrow except dorsad of antennae (fig. 104). 10
Genovertical plates broad, about one-third the width of the frons and very abruptly raised above the plane of the frontal vittae (fig. 128). **8. Metopomyza**
10. Mesonotum dull black, heavily gray pollinose; two sparse rows of acrostichal setae; crossvein m-m absent; only one upper-orbital seta, reclinate and outwardly directed (fig. 129). . . . . **9. Haplomyza**

Mesonotum shining black and yellow, or if gray pollinose then either four rows of acrostichals, or crossvein m-m present, or two upper-orbital setae present . . . . 7. **Liriomyza**

11. Crossvein m-m, when present, never basal to crossvein r-m; basal section of M_{3+4} present (fig. 134) . . . . 12. **Phytagromyza**

Crossvein m-m basal to crossvein r-m and appearing to be the basal section of vein M_{3+4}, which is absent (fig. 135). . . . . 13. **Pseudonapomyza**

12. Costa reaching to the end of vein M_{1+2}; halter with a dark spot on knob. . 13

Costa reaching to the end of vein R_{4+5}; halter white or yellowish. 14

13. Wing with axillary lobe and calypter well developed; mesonotum with acrostichal setae present. . . . . 10. **Phytoliriomyza**

Wing with axillary lobe very small and calypter virtually absent; acrostichal setae absent . . . . 11. **Xyraeomyia**

14. Wing with crossvein m-m present . . . . 14. **Napomyza**

Wing with crossvein m-m absent . . . . 15. **Phytomyza**

Systematic Treatment

1. Genus *Agromyza* Fallén

Agromyza Fallén, Specimen entomologicum novam Diptera disponendi methodum exhibens, p. 21 (No. 66), 1810 (Dissertat. Lund.).
Domomyza Rondani, Dipt. Ital. Prodr., vol. 1, p. 121, 1856.

This is a moderately large genus of 22 described species that has the subcosta complete and uniting with vein R_1 at the costa, which is expanded at that point (fig. 1), and the halteres white. The only species that I have seen that has the union of the subcosta and vein R_1 with the costa atypical in some specimens is *Agromyza aristata.* However, most of those examined have the typical costal union (fig. 4). The most diverse types have the subcosta about one-fourth incomplete and R_1 distinctly bent but not expanded near the costa.

There are no diverse species that deviate from the Palaearctic pattern. The great majority of North American species have only two or three well-developed dorsocentrals with none to several small ones. Only four species have the usual arrangement of one strong presutural and three strong postsutural dorsocentrals. In the Palaearctic region there are proportionately more species with the latter arrangement.

As for the species groups, there are representatives in the *rubi* group (couplets 3–5) but none in the *cinerascens* group, which contains three European species. The correlation between shining mesonota and grass mining larvae (*ambigua* group) holds true in North America as in the Palaearctic region. Of the six known North American species (couplet 14), four have larvae that mine the leaves of grasses. The alternative (couplets 7–13) contains eight species that have the mesonotum subshining to dull and larvae that mine in dicotyledons. The host plants are known for four.

One of the more unusual features of the North American fauna is the five species keying out at couplet 10 (*viridula* group). These are large dark species that may have a metallic sheen to the mesonotum and abdomen. Of the five, four are Neotropical, which seems to account for the higher proportion in North America. There are two species in the Palaearctic region. *A. salicifolii* Collin is not found north of Israel and *A. quercus* Sasakawa occurs in Japan.

Key to the described species of *Agromyza*

1. Mesonotum with two or three well-developed postsutural dorsocentrals plu, none to several small postsuturals; a presutural dorcocentral, when presents small and posterior to the presutural seta 2
   Mesonotum with four strong well-developed dorsocentrals, one presutural and three postsutural, the presutural at least slightly anterior to the presutural seta 19
2. Vein M_{1+2} at or nearest the wing tip; midtibia medially without posterolateral setae 3
   Vein R_{4+5} nearest the wing tip; midtibia medially with one or two posterolateral setae 6
3. Mesonotum dull, grayish pollinose; at least three well-developed postsutural dorsocentrals 4
   Mesonotum shining black; two well-developed postsutural dorsocentrals . . . . **varifrons**
4. Femora, tibiae, and tarsi yellow; vein M_{1+2} ending only slightly nearer the wing tip than R_{4+5} (figs. 4, 17) 5
   Femora, tibiae, and tarsi dark brown to black, except for foretibia being yellow distally; vein M_{1+2} ending at wing tip . . . . **rubi**
5. Body with all setae yellowish; dorsal upper-orbital arising from black extending from vertex (fig. 14) . . . . **pallidiseta**
   Body with all setae black; dorsal upper-orbital arising from yellow (fig. 5). **aristata**
6. Mesonotum and scutellum subshining to dull black, somewhat grayish pollinose, with or without a greenish sheen; larvae mine dicotyledons . . 7
   Mesonotum and scutellum shining black; larvae mine grasses 14
7. Thorax and abdomen yellow or light brown; femora mostly yellow . . . 8
   Thorax and abdomen very dark brown or black, with or without a greenish sheen; femora predominately dark brown 9
8. Third antennal segment and maxillary palpus yellow . . . . **diversa**
   Third antennal segment and maxillary palpus brown . . . . . **canadensis**
9. Tibiae and tarsi dark brown or black 10
   Tibiae and tarsi yellowish . . . . **reptans**
10. Mesonotum, scutellum, and abdomen with a greenish sheen 11
    Mesonotum, scutellum, and abdomen without a greenish sheen, subshining or dull brown or black 12
11. Upper-orbital setae subequal in length (fig. 20) . . . . **viridula**
    Upper-orbital setae unequal in length, the ventral about 1.5 times as long as the dorsal (fig. 10) . . . . **inaequalis**
12. Calypter with margin and fringe white 13
    Calypter with margin and fringe yellow . . . . **centrosemae**
13. Anepisternum entirely dark brown or black . . . . **frosti**
    Anepisternum with a narrow yellow dorsal margin . . . . **currani**

14. Costa reaching to the end of vein M_{1+2} 15
    Costa reaching to the end of vein R_{4+5} 16
15. Calypter with fringe light brown; frons longer than wide . . . **parvicornis**
    Calypter with fringe white; frons wider than long . . . . **nigripes**
16. Anterior half of mesonotum with acrostichal setae in six rather regular rows 17
    Anterior half of mesonotum with acrostichals in four rather regular rows. **subnigripes**
17. Gena in height midway between vibrissal and posterior angles about one-third the eye height (fig. 3) 18
    Gena in height midway between vibrissal and posterior angles about one-seventh the eye height (fig. 6) . . . . **barberi**
18. Third antennal segment dorsally flattened, distally with a sharp angle. **niveipennis**
    Third antennal segment rounded (fig. 3) . . . . **ambigua**
19. Calypter with margin and fringe brown 20
    Calypter with margin and fringe white or yellow 21
20. Midtibia medially with two posterolateral setae . . . . **isolata**
    Midtibia medially without posterolateral setae . . . . **spiraeae**
21. Tibiae and tarsi dark brown . . . . **rutiliceps**
    Tibiae and tarsi yellowish . . . . **albitarsis**

Agromyza albitarsis Meigen

Agromyza albitarsis Meigen, Systematische Beschreibung der bekannten europaischen zweiflügeligen Insekten, vol. 6, p. 171, 1830.—Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 100, 1931 (figure of head).

Agromyza cinerascens (Macquart), Melander, Journ. New York Ent. Soc., vol. 21, p. 253, 1913 (3 from Washington: 1 ♂, 1 ♀, Monroe; 1 ♀, Port Gamble).

This Holarctic species belongs with those species having four strong dorsocentral setae, one being presutural. The calypteral fringe is white and the tibiae and tarsi are yellowish. The larvae make blotch mines in the leaves of *Populus* spp. and *Salix lasiandra* Benth. I have studied reared specimens from Washington, California, and Pennsylvania. The species probably is widely distributed.

Agromyza ambigua Fallén

Agromyza ambigua Fallén, Diptera sueciae, vol. 2, No. 37 (Agromyzides), p. 4, 1823.—Hendel, *in* Lindner, Die Fliegen der Palaearktischen Region, fam. 59, p. 103, 1931 (figure of head and wing).

Agromyza kincaidi Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 285, 1913 (figure of wing).—Shewell, Canadian Ent., vol. 85, p. 463, 1953.

The holotype of *A. kincaidi* was compared with two specimens of *A. ambigua* in my collection and with four in the U. S. National Museum, all determined by E. M. Hering. This is a shining black species with three developed dorsocentrals, the costa reaching to the end of vein R_{4+5}, a relatively wide gena, and a rounded third antennal segment (fig. 3). The larvae mine the leaves of some grasses. A Holarctic species, *A. ambigua* is at present known only from Alaska in North America.

Agromyza aristata Malloch

Agromyza aristata Malloch, Canadian Ent., vol. 47, p. 13, 1915.
Agromyza ulmi Frost, Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 54, 1924.—Needham, Frost, and Tothill, Leaf-mining insects, p. 252, 1928 (figure of leaf mine).

A. aristata belongs to the species group in which there are no medial setae on the midtibia and vein M_{1+2} is at or nearest the wing tip (fig. 4). The head (fig. 5) has the arista and the setae somewhat shortened. The larvae mine in the leaves of *Ulmus americana* L. and probably *Celtis occidentalis* Mic. because I have seen a leaf with a mine very similar to that found on elm. Known from Iowa, Illinois, Indiana, Ohio, Pennsylvania, New York, and Virginia.

Agromyza barberi Frick

Agromyza abbreviata Malloch (not Fallén, 1823), Ann. Ent. Soc. Amer., vol. 6, p. 285, 1913 (fig. of wing).
Agromyza barberi Frick, Univ. California Publ. Ent., vol. 8, p. 372, 1952.

This is a shining species with three developed dorsocentrals, the costa ending at vein R_{4+5}, and a very narrow gena (fig. 6). The larvae probably mine the leaves of grasses. Known only from the holotype from New Mexico.

Agromyza canadensis Malloch

Agromyza canadensis Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 299, 1913 (figure of head)—Shewell, Canadian Ent., vol. 85, p. 462, 1953.

This large species (3 mm. in wing length) has the mesonotum dull and bearing about five developed dorsocentrals. It is rather similar to *A. diversa* in that the mesonotum is light brown. However, this species has the third antennal segment and maxillary palpus brown. The head has a very narrow gena (fig. 7). There are only three specimens known, all from Ontario, Canada.

Agromyza centrosemae Frost

Agromyza centrosemae Frost, Ann. Ent. Soc. Amer., vol. 29, p. 301, 1936.

The holotype male is in the U. S. National Museum (No. 62972). It is extremely teneral but the mesonotum lacks a metallic sheen and the calypteral fringe is yellowish. These characteristics separate this species from *A. frosti* and *A. currani*. Known only from the holotype which was reared from *Centrosema pubescens* Benth. in the Panama Canal Zone.

Agromyza currani Frost

Agromyza currani Frost, Ann. Ent. Soc. Amer., vol. 29, p. 305, 1936.

The female holotype is in the American Museum of Natural History and there is a male paratype in the S. W. Frost collection. The head is high and narrow and the arista is plumose (fig. 8). This species is rather distinctive in having the anepisternum and tergites bordered with yellow and the mesonotum heavily dull gray pollinose. The two known specimens are from Barro Colorado Island, Panama Canal Zone.

Agromyza diversa Johnson

Agromyza diversa Johnson, Occ. Pap. Boston Soc. Nat. Hist., vol. 5, p. 26, 1922.—Shewell, Canadian Ent., vol. 85, p. 462, 1953.

This species belongs to *Agromyza* sens. str. even though the body, including the scutellum, is predominately yellow. *A. diversa* differs from the very similar *A. ferruginosa* van der Wulp of Europe in having the head mostly brown. I have seen specimens from Iowa, Illinois, Massachusetts, Vermont, and Ontario.

Agromyza frosti Frick

Agromyza schmidti Frost (not Aldrich, 1929), Ann. Ent. Soc. Amer., vol. 29, p. 302, 1936.

Agromyza frosti Frick, Univ. California Publ. Ent., vol. 8, p. 373, 1952.

The male holotype is in the U. S. National Museum (No. 62966). There are three paratypes in the S. W. Frost collection. The head has the antenna placed well below the middle of the head and the eye is ovoid (fig. 9). This is a species of moderate size (2 mm. in wing length) that has two developed dorsocentrals, the mesonotum subshining and without metallic sheen, and the anepisternum entirely dark. The type series is from La Caja, Costa Rica, and was reared from the stems of an unidentified plant.

Agromyza inaequalis Malloch

Agromyza inaequalis Malloch, Proc. Ent. Soc. Washington, vol. 16, p. 89, 1914 (figs. of head and wing).

Agromyza iridescens Frost, Ann. Ent. Soc. Amer., vol. 29, p. 303, 1936.

This species has the upper-orbital setae unequal in length, the ventral being the longer and stronger (fig. 10), and a bright green sheen to the mesonotum and abdomen. The larvae make blotch mines in the leaves of *Vigna repens* Baker, *Phaseolus vulgaris* L., and *P. limensis* Macfad. I have seen specimens from Puerto Rico, Cuba, Panama Canal Zone, and Venezuela.

Agromyza isolata Malloch

Agromyza isolata Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 306, 1913.

This species belongs with those species having four developed dorsocentrals, one being presutural. The calypter has the fringe brown and there are two medial setae on the midtibia. This last character and the high, narrow eye (fig. 11) serve to separate *A. isolata* from

A. spiraeae. In addition to the type female from California there is a male in the U. S. National Museum that was collected in the District of Columbia.

Agromyza nigripes Meigen

Agromyza nigripes Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 6, p. 170, 1830.—Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 137, 1931 (figures of head and wing).

Agromyza dubitata Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 311, 1913.

A relatively common Holarctic species, *A. nigripes* is rather distinctive in having the frons wider than long and the third antennal segment subangulate (fig. 12). The mesonotum is shining black and bears three or four developed postsutural dorsocentrals. The larvae are grass miners and a series in the Illinois Natural History Survey collection were reared from *Triticum aestivum* L. at Wooster, Ohio. The species is known from Iowa, Illinois, Michigan, Ohio, New York, Massachusetts, Ontario, and Quebec.

Agromyza niveipennis Zetterstedt

Agromyza niveipennis Zetterstedt, Diptera Scandinaviae, vol. 7, p. 2741, 1848.—Hendel, *in* Lindner, Die Fleigen der palaearktischen Region, fam. 59, p. 139, 1931 (figures of head and wing).

Agromyza cinerascens (Macquart), Melander, Journ. New York Ent. Soc., vol. 21, p. 253, 1913 (1 ♂, Oroville, Wash.).

This is a rather distinctive, shining black species with the third antennal segment angulate distally, the head in profile subtriangular, and six rows of acrostichals. It has not been reported previously from North America. I have reared it from leaf mines on the following grasses in central Washington: *Secale cereale* L., *Hordeum jubatum* L., *Triticum aestivum* L., and *Agropyron repens* L. There are other specimens from Utah and Kansas.

Agromyza pallidiseta Malloch

Agromyza pallidiseta Malloch, Canadian Ent., vol. 56, p. 192, 1924.

This species is closely related to *A. aristata*, but has all body setae yellowish and the genovertical plates partially darkened (fig. 13). The frons is about as wide as long (fig. 14). Known only from the holotype female in the U. S. National Museum (64299), collected at Rock Creek Park, Washington, D. C.

Agromyza parvicornis Loew

Agromyza parvicornis Loew, Berliner Ent. Zeitschr., vol. 13, p. 49, 1869 (Centuria VIII, No. 92).—Melander (part), Journ. New York Ent. Soc., vol. 21, p. 254, 1913 (excl. 1 ♀, Wisconsin).—Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 312, 1913 (figures of head and wing).—Phillips, Journ. Agr. Res., vol. 2, p. 15, 1915 (figures of leaf mines).

A. parvicornis has the mesonotum shining black and bearing two developed dorsocentrals. The costa reaches to the end of vein M_{1+2} and the calypteral fringe is brown. The larvae mine the leaves of *Zea mays* L. It is a widespread and well known species and I have seen specimens from most of the States in the United States and from Ontario.

Agromyza reptans Fallén

Agromyza reptans Fallén, Diptera sueciae, vol. 2, No. 37 (Agromyzides), p. 3, 1823.—Melander (part), Journ. New York Ent. Soc., vol. 21, p. 253, 1913 (1 ♂, Seattle, Wash.).—Hendel, *in* Lindner, Die Fleigen der palaearktischen Region, fam. 59, p. 144, 1931 (figures of head and wing).

This is a large species (3 to 4 mm. in wing length) that has the mesonotum subshining black and bearing four postsutural dorsocentrals. The tibiae and tarsi are yellowish. *A. reptans* is a common species in Europe, but I have seen no other North American specimens than Melander's and a long series that I reared from blotch mines in the leaves of *Urtica californica* Greene in California.

Agromyza rubi Brischke

Agromyza rubi Brischke, Schrift. Naturf. Ges. Danzig, vol. 5, p. 250, 1881.—Hering, Tijdschr. Ent., vol. 97, p. 118, 1954 (figures of larval characters).

Agromyza sulfuriceps Strobl, Mitt. Naturw. Ver. Steiermark, vol. 34, p. 270, 1898.—Melander, Journ. New York Ent. Soc., vol. 21, p. 225, 1913.—Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 152, 1931 (figures of head and wing).

This rather distinctive Holarctic species belongs to the group with vein M_{1+2} at or nearest the wing tip and with no medial midtibial setae. If differs from *A. varifrons* in having the mesonotum dull gray pollinose and from *A. pallidiseta* and *A. aristata* in having the femora, tibiae, and tarsi dark and vein M_{1+2} ending at the wing tip. The larvae mine the leaves of species of *Rubus*, *Potentilla*, and *Sanguisorba* in Europe. I have seen swept specimens from Washington, Idaho, and California.

Agromyza rutiliceps Melander

Agromyza rutiliceps Melander, Journ. New York Ent. Soc., vol. 21, p. 261, 1913.

The holotype male is in the collection of A. L. Melander. Its condition is poor so no illustrations were prepared from it. *A. rutiliceps* belongs with those species having four developed dorsocentrals, one being presutural. The calypteral margin and fringe are yellow and the tibiae and tarsi are dark. The type from Montana is the only specimen of this species that I have seen.

Agromyza spiraeae Kaltenbach

Agromyza spiraeae Kaltenbach, Verh. Naturh. Ver. Preuss. Rheinlande Westfalens, vol. 24, p. 104, 1867.—Malloch, Diptera of Patagonia and South Chile, pt. 6, fasc. 5, p. 477, 1934.—Hering, Tijdschr. Ent., vol. 97, p. 121, 1954 (figures of larval characters).

Agromyza fragariae Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 307, 1913 (figure of wing).—Frost, Mem. Cornell Univ. Exp. Sta., vol. 78, p. 43, 1924 (figure of leaf mine on *Rubus*).

Agromyza sanguisorbae Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 149, 1931 (figure of wing).

Malloch's holotype was compared with five specimens (one in the U. S. National Museum) sent by E. M. Hering. Hering restricted the concept of *A. spiraeae* to those specimens the larvae of which mine the leaves of the Rosoideae or tribe Roseae. This group includes the genera *Rubus*, *Fragaria*, and *Rosa*, but not *Spiraea*. *A. spiraeae* belongs with those species having four developed dorsocentrals, one being presutural. The margin and fringe of the calypter are brown, and this species may be separated from *A. isolata* by the lack of medial setae on the midtibia and the eye being more subcircular (fig. 15). *A. spiraeae* has been reared from serpentine mines in the leaves of species of *Fragaria* and *Rubus* in California, New York, New Jersey, and Pennsylvania.

Agromyza subnigripes Malloch

Agromyza subnigripes Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 334, 1913.

Agromyza aprilina Malloch, Bull. Illinois Nat. Hist. Surv., vol. 11, p. 359, 1915 (figure of head).

The adults are quite distinctive in the shape of the head and the angulate third antennal segment (fig. 16). The shining mesonotum bears five developed dorsocentrals and only four rows of acrostichals. The larval host plants are unknown for this species, but are probably in the Gramineae. I have seen specimens from Iowa, Illinois, Indiana, New Hampshire, and from Manitoba.

Agromyza varifrons Coquillett

Agromyza varifrons Coquillet, Journ. New York Ent. Soc., vol. 10, p. 189, 1902.

This species is very similar to *A. trebinjensis* Strobl, 1900. It belongs to the group with M_{1+2} at or nearest the wing tip (fig. 17) and without midtibial setae. The head has the genovertical plates darkened nearly to the dorsal lower-orbital (fig. 18) and the gena relatively narrow (fig. 19). The mesonotum is shining black and bears two developed dorsocentrals. These latter two characters separate *A. varifrons* from *A. aristata*, *A. pallidiseta*, and *A. rubi*. No larval host plants are known and the species is not common. I have studied only five specimens, from Iowa, Illinois, District of Columbia, and Pennsylvania.

Agromyza viridula Coquillett

Agromyza viridula Coquillett, Journ. New York Ent. Soc., vol. 10, p. 190, 1902.—Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 313, 1913.

As far as I know, this is the only species found in the United States with a greenish sheen to the mesonotum, scutellum, and abdomen. The mesonotum is subshining and bears two developed dorsocentrals and one small dorsocentral. The head is shaped as in the illustration (fig. 20). The larvae form blotch mines in the leaves of red oak (*Quercus* sp.). *Agromyza quercus* Sasakawa, 1954, is very closely related and the larvae mine the leaves of *Quercus glauca* Thunb. in Japan. The Japanese species differs in having a dark brown margin and fringe to the calypter. I have seen specimens from Georgia in the south to Massachusetts in the north. The specimens reared from red oak were from Indiana. Probably widespread over the eastern half of the United States. The Puerto Rican specimens doubtfully referred to this species by Malloch are all in very poor condition. I can find no references to red oaks occurring in the West Indies so these specimens are no doubt of another species.

2. Genus *Melanagromyza* Hendel

Melanagromyza Hendel, Arch. Naturg., Abt. A., vol. 84, p. 126, 1920.
Limnoagromyza Malloch, Bull. Brooklyn Ent. Soc., vol. 15, p. 147, 1920.

In North America this genus contains 25 described species. The halteres are black but there is no carina between the antennae as occurs in *Ophiomyia* (fig. 45) and *Tylomyza* spp., even though the antennae may be widely separated. The orbital setulae are either inclined in several directions or are all reclinate as in the genera *Agromyza* and *Ophiomyia*.

There are several unusual features not found in the Palaearctic fauna. The first is the reddish lunule and ventral half of the frontal vitta of *Melanagromyza diadema*. The frons is black in all other species. *M. dianthereae* has the only sexual dimorphism in the family of which I am aware. The third segment of the male antenna is much more setulose (fig. 27) than that of the female (fig. 28). None of the North American species has elongate mouthparts as do two in Europe that belong to what could be called the *longilingua* group.

If one were to continue the designation of species groups as Hendel (1931) did for the genus *Agromyza*, two *Melanagromyza* species groups not represented in Europe are known here. The first, the *burgessi* group (couplet 3), has nearly all orbital setulae erect to reclinate except for a few anterior ones (fig. 24). *M. virens* is the sole representative of its group (couplet 4). The orbital setulae are very irregular and are inclined in three directions (fig. 42). The *aeneiventris* group (couplet 5) contains *M. angelicae* and *M. tamia, M. aeneiventris* sens. str. not occurring in North America. Hering and others in Europe have recently restricted the name *aeneiventris* Fallén to the species with dark calypteral margin and fringe, the larvae of which mine the stems of *Urtica* spp. I have not seen this species in North America and Melander's specimens have the calypteral fringe white. *M. lappae* (Loew) must be dropped from the North American list for the reasons stated under *M. angelicae* (Frost). The *cunctata* group is missing in North America. This group has the calypteral margin and fringe dark and the orbital setulae irregular with the posteriormost proclinate.

The next three groups are interesting when compared to the Palaearctic fauna. The *cunctans* group (couplet 7) has all orbital setulae reclinate and the calypteral margin and fringe white. North America has nine species, of which four are Neotropical, in contrast to Europe's two with one extending into North Africa. The next group (couplet 16) may be called the *pulicaria* group. Here the calypteral margin and fringe are brown or black and the genovertical plates do not extend beyond the eye margin (fig. 33). North America has five Neotropical representatives while there are two in the southern Palaearctic region, one extending into Europe. *M. pulicaria* is deleted from the North American list because Melander's specimens of *morionella* obtained from Strobl belong to the genus *Ophiomyia*.

The last group (couplet 20) may be named *schineri*, for the oldest described species. The calypteral margin and fringe are dark and the genovertical plates extend beyond the eye margin (fig. 38). There are nine known species from central and northern Europe and six Nearctic species. The biologies are known for seven of these species and the larvae of all but one form galls on the twigs of such woody plants as *Cytissus, Salix, Populus,* and *Tilia* spp. The larvae of the other species, *M. simplex*, mine the stems of *Asparagus* sp.

Key to the described species of *Melanagromyza*

1. Orbital setulae either all reclinate or reclinate with a few anterior ones proclinate (fig. 24) 2
   Orbital setulae either mostly proclinate (fig. 22), or irregular with the posterior setulae erect (fig. 42) 4
2. Orbital setulae with a few anterior ones proclinate, all others erect to reclinate (fig. 24) 3
   Orbital setulae all reclinate (fig. 21) 6
3. Calypter with margin and fringe white . . . . **diauthereae**
   Calypter with margin and fringe brown . . . . **burgessi**
4. Orbital setulae proclinate, except for a few that are erect adjacent to the eye margin (fig. 22) 5
   Orbital setulae irregular—proclinate, erect, and reclinate, posteriormost erect (fig. 42) . . . . **virens**

5. Costa reaching to the end of vein M_{1+2}; mesonotum without a green sheen and bearing two dorsocentrals . . . . **angelicae**
Costa reaching to the end of R_{4+5}; mesonotum with a green sheen and bearing three dorsocentrals . . . . **tamia**

6. Calypter with margin and fringe white or yellowish 7
Calypter with margin and fringe dark brown 15

7. Mesonotum and abdomen with a bronzy or greenish metallic sheen . . . 8
Mesonotum and abdomen without a metallic sheen 12

8. Foretibia medially without a strong posterolateral seta 9
Foretibia medially with a strong posterolateral seta . . . . **caerulea**

9. Mesonotum and abdomen with both bronzy and greenish sheen; crossvein m-m more than its length from r-m 10
Mesonotum and abdomen with greenish sheen only; m-m not more than its length from r-m 11

10. Eye setulose, especially on dorsal half; subcranial margin rounded from vibrissa to posterior angle (fig. 23) . . . . **approximata**
Eye bare; subcranial margin straight from vibrissa to posterior angle (fig. 21). **aldrichi**

11. Lunule very high, about as high above antennal bases as frontal vitta is long; frontal triangle reaching lunule . . . . **viridis**
Lunule lower, about one-half as high as frontal vitta is long; frontal triangle shorter, reaching to two-thirds of the distance to lunule . . . . **gibsoni**

12. Costa reaching to the end of vein M_{1+2} 13
Costa reaching to the end of vein M_{4+5} . . . . **winnemanae**

13. Head with three lower-orbital setae (figs. 35 and 39) 14
Head with two lower-orbital setae (fig. 32) . . . . **mallochi**

14. Vein M_{3+4} with penultimate section subequal to the ultimate . . . **riparella**
Vein M_{3+4} with penultimate section about twice as long as the ultimate. **subvirens**

15. Head, viewed in profile, with genovertical plates not extending beyond eye margin (fig. 31) 16
Head, viewed in profile, with genovertical plates extending beyond eye margin (figs. 36 and 38) 20

16. Mesonotum and abdomen without a metallic green sheen 17
Mesonotum and abdomen with a metallic green sheen . . . . . **minima**

17. Lunule and ventral half of frontal vitta black to very dark brown 18
Lunule and ventral half of frontal vitta reddish . . . . **diadema**

18. Midtibia medially with at least one posterolateral seta 19
Midtibia medially without a posterolateral seta . . . . **crotonis**

19. Foretibia medially without a posterolateral seta; midtibia medially with three posterolateral setae . . . . **longiseta**
Foretibia medially with a posterolateral seta; midtibia medially with one posterolateral seta . . . . **orbitalis**

20. Costa reaching to or slightly beyond the end of R_{4+5} 21
Costa reaching to the end of M_{1+2} 23

21. Mesonotum with two strong dorsocentrals 22
Mesonotum with three strong dorsocentrals . . . . **salicis**

22. Genovertical plates dull; anterior half of mesonotum with acrostichal setae in six to eight rows . . . . **similata**
Genovertical plates shining; anterior half of mesonotum with acrostichal setae in eight to ten rows . . . . **simplex**

23. Head with two or three lower-orbital setae 24
Head with four or five lower-orbital setae (fig. 37) . . . . . . **setifrons**

24. Crossvein m-m about two-thirds of its length from r-m; gena buccate (fig. 41). **tiliae**
    Crossvein m-m about its own length from r-m; gena not buccate, sloping posteroventrally from eye margin . . . . **schineri**

Melanagromyza aldrichi Frick

Agromyza tibialis Frost (not Fallén, 1823), Ann. Ent. Soc. Amer., vol. 29, p. 312, 1936.
Melanagromyza aldrichi Frick, Univ. California Publ. Ent., vol. 8, p. 377, 1952.

The holotype male is in the U. S. National Museum (No. 62970). This large species has the eye nearly as large as the head (fig. 21), both a bronzy and greenish sheen to the mesonotum and abdomen, and a wing length of 2.5 to 3 mm. The setulae on the arista vary in length from one to two times the basal diameter of the arista. Larval host plants are unknown. I have studied 14 specimens in S. W. Frost's collection from Panama, Panama Canal Zone, and Guatemala. The species appears to be common in Central America.

Melanagromyza angelicae (Frost)

Agromyza lappae (Loew), Hendel (part), *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 167, 1931 (figures of head and wing).
Agromyza pseudocunctans (Strobl), Melander (part), Journ. New York Ent. Soc., vol. 21, p. 251, 1913 (1 ♂, Pullman, Wash.; 1 ♀, Almota, Wash.).
Agromyza angelicae Frost, Ent. News, vol. 45, p. 40, 1934.

European workers—K. A. Spencer in England and E. M. Hering in Berlin—have separated the *Angelica*-mining species from the true *M. lappae*, the larvae of which are found only on *Arctium lappa* L. I compared specimens from these two workers with the holotype of *M. angelicae* and found them to be the same. *M. angelicae* is most closely related to *M. tamia* in having the orbital setulae proclinate, except for a few that are erect adjacent to the eye margin (fig. 22) but lacking a green sheen to the mesonotum. The larvae of *M. angelicae* mine the stems of *Angelica atropurpurea* L. in New York and *A. silvestris* L. in England and Germany. Melander's specimens must belong to this species and not to *M. lappae* because Piper and Beattie (1914) list two species of *Angelica*, *lyalii* Wats. and *canbyi* C. & R., from eastern Washington and do not mention *Arctium lappa* L.

Melanagromyza approximata (Frost)

Agromyza approximata Frost, Ann. Ent. Soc. Amer., vol. 29, p. 316, 1936.

The holotype male is in the U. S. National Museum (No. 62969). There is a paratype female in the collection of S. W. Frost that seems to be of the same species. Closely related to *M. aldrichi*, this species is smaller (2.3 mm. in wing length) and has a deeper gena and a rounded subcranial margin (fig. 23). The holotype is from Guatemala and the paratype is from the Panama Canal Zone.

Melanagromyza burgessi (Malloch)

Agromyza burgessi Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 323, 1913 (figure of head).

Melanagromyza burgessi (Malloch), Frick, Canadian Ent., vol. 85, p. 69, 1953.

This is a large species with a wing length of 3 mm. The orbital setulae are erect to reclinate except for a few anterior ones that are proclinate (figs. 24 and 25). The only other species with such an arrangement is *M. dianthereae.* The latter has the margin and fringe of the calypter white. No larval host plants are known. The species has a wide range and there are specimens from Colorado, Kansas, North Dakota, Michigan, Illinois, Indiana, New York, and Massachusetts.

Melanagromyza caerulea (Malloch)

Agromyza caerulea Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 322, 1913 (figure of wing).—Bailey and Plank, Journ. Econ. Ent., vol. 33, p. 704, 1940.

Agromyza plumiseta Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 324, 1913.

This is the only North American species known to me that has a green sheen to the mesonotum and abdomen and a strong seta medially on the foretibia. *M. orbitalis* has a foretibial seta but lacks the green sheen and has the calypteral fringe black. The head of *M. caerulea* is relatively high and narrow (fig. 26). The larvae feed in the seeds of several species of *Ipomoea,* including *I. batatas* Poir. The species is known from the Gulf coast of Texas and from Mexico, Puerto Rico, and Jamaica.

Melanagromyza crotonis (Frost)

Agromyza crotonis Frost, Ann. Ent. Soc. Amer., vol. 29, p. 313, 1936.

The holotype male is in the U. S. National Museum (No. 62975). There are only three specimens (two headless) of this species, all from Barro Colorado Island, Panama Canal Zone. The larvae mine the leaves of *Croton billbergianus* Muell. This is a small species (1.3 mm. in wing length) and there is no medial seta on the midtibia. The 16 specimens reared from leaf mines on *Clitoria* sp. are of a dinerent species.

Melanagromyza diadema (Melander)

Agromyza diadema Melander, Journ. New York Ent. Soc., vol. 21, p. 259, 1913.

This unique species is known from a single female from Haiti in the A. L. Melander collection. The lunule and lower half of the frontal vitta are reddish in contrast to the black or brown in all other species of *Melanagromyza.*

Melanagromyza dianthereae (Malloch)

Limnoagromyza dianthereae Malloch, Bull. Brooklyn Ent. Soc., vol. 15, p. 147, 1920.

Melanagromyza dianthereae (Malloch), Frick, Univ. California Publ. Ent., vol. 8, p. 378, 1952.

This is an extraordinarily large species with wing lengths of 3 to 3.75 mm. There is a sexual difference in the third antennal segment, that of the male being more heavily setulose (fig. 27) than that of the female (fig. 28). The orbital setulae are inclined (fig. 29) as they are in *M. burgessi* (fig. 24). The larvae mine the stems of *Justicia* (=*Dianthera*) *americana* (L.) Vahl. Known only from Illinois and Indiana.

Melangromyza gibsoni (Malloch)

Agromyza gibsoni Malloch, Proc. U. S. Nat. Mus., vol. 49, p. 106, 1915 (figure of head, wing, and puparial characters).

The mesonotum and abdomen have a greenish sheen and crossvein m-m is not more than its length from r-m, and usually closer. The head has the genovertical plates slightly extending beyond the eye margin and the four orbital setae are about equidistant from one another (fig. 30). The larvae mine the stems of *Medicago sativa* L. in the western United States. I have identified specimens from California, Arizona, western Texas, and Colorado.

Melanagromyza longiseta (Malloch)

Agromyza longiseta Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 326, 1913 (figure of head).—Shewell, Canadian Ent., vol. 85, p. 468, 1953.

This species belongs to *Melanagromyza* sens. str. because of the single vibrissa and the approximate antennal bases, even though the head (fig. 31) has a distinctive profile. There is only one known specimen, the holotype female from Frontero, Tabasco, Mexico.

Melanagromyza mallochi (Hendel)

Agromyza eupatoriae Malloch (not Kaltenbach, 1874), Proc. U. S. Nat. Mus., vol. 49, p. 107, 1915.

Agromyza mallochi Hendel, Konowia, vol. 2, p. 145, 1923.

M. mallochi belongs to the group with white calypteral fringe and no metallic sheen. The head is relatively high and narrow and bears only two lower-orbital setae (fig. 32). The larvae mine in *Eupatorium odoratum* L. in Puerto Rico.

Melenagromyza minima (Malloch)

Agromyza minima Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 328, 1913.

Agromyza longicauda Curran (part), Scientific survey of Porto Rico and the Virgin Islands, vol. 11, pt. 1, p. 65, 1928 (allotype ♀, Virgin Islands).

Agromyza longiseta (Malloch), Frost, Ann. Ent. Soc. Amer., vol. 29, p. 318, 1936.

A small species (1.5 to 2 mm. in wing length) without unusual features on the head (fig. 33), *M. minima* is characterized by the extremely long ovipositor (two to three times the length of the sixth tergite), dark brown calypteral fringe, and a metallic green sheen. I have seen specimens from Trinidad, Puerto Rico, Virgin Islands, Panama Canal Zone, and Guatemala. Larval host plants remain unknown.

Melanagromyza orbitalis (Frost)

Agromyza orbitalis Frost, Ann. Ent. Soc. Amer., vol. 29, p. 314, 1936.

The holotype male from Barro Colorado Island, Panama Canal Zone, is in the American Museum of Natural History. It is the only specimen of this species. The head has several of the setae broken (fig. 34). There is a medial seta on the foretibia but *M. orbitalis* has the calypteral fringe black and lacks the metallic sheen found in *M. caerulea.*

Melanagromyza riparella (Hendel)

Agromyza riparia Malloch (*not* van der Wulp, 1871), Proc. U. S. Nat. Mus., vol. 49, p. 105, 1915 (figures of head and wing).
Agromyza riparella Hendel, Konowia, vol. 2, p. 145, 1923.

This species belongs to the group with all orbital setulae reclinate, white calypteral fringe, and body without metallic sheen. It is characterized by having three lower-orbital setae, a relatively wide gena (fig. 35), and vein M_{3+4} with the two sections subequal in length. I have seen 30 specimens, all from Illinois.

Melanagromyza salicis (Malloch)

Agromyza salicis Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 314, 1913 (figure of wing).

The holotype is now wingless but Malloch's figure shows the venation. *M. salicis* is unusual in having very prominent genovertical plates (fig. 36) and three strong dorsocentral setae. The larvae form galls on the twigs of willow (*Salix* spp.). At present the species is known from Illinois, Ohio, New York, and Massachusetts.

Melanagromyza schineri (Giraud)

Agromyza schineri Giraud, Verh. Zool.-Bot. Ges. Wien, vol. 11, p. 484, 1861.
Melanagromyza schineri (Giraud), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 174, 1931 (figures of head and wing).

This species has prominent genovertical plates and a relatively small gena that slopes posteroventrally from the eye margin, while the gena of *M. tiliae* is buccate (fig. 41). Crossvein m-m is about its own length from r-m while it is only about two-thirds of its length from r-m in *M. tiliae.* The larvae form galls on the twigs of *Populus* spp. *Salix* spp. are also attacked in Europe. The specimens that I have seen are from such widely scattered localities as Washington, Colorado, Massachusetts, and Ontario.

Melanagromyza setifrons (Melander)

Agromyza setifrons Melander, Journ. New York Ent. Soc., vol. 21, p. 260, 1913.

In addition to the holotype from Troy, Idaho, Melander has a second male from Avon, Idaho. Distinctive in having six or seven orbital setae and an eye that is high and narrow (fig. 37).

Melanagromyza similata (Malloch)

Agromyza similata Malloch, Canadian Ent., vol. 50, p. 178, 1918.

The holotype male from Dubois, Ill., is the only specimen of this species. *M. similata* is similar to *M. simplex* in having the costa end at vein R_{4+5} and with two pairs of dorsocentral setae. However, in this species the genovertical plates are dull and there are only six to eight rows of acrostichal setae. The dorsal upper-orbital is situated very close to the vertex (fig. 38).

Melanagromyza simplex (Loew)

Agromyza simplex Loew, Berliner Ent. Zeitschr., vol. 13, p. 46, 1869 (Centuria VIII, No. 84).

Melanagromyza simplex (Loew), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 176, 1931 (figures of head and wing).

M. simplex can be distinguished from *M. similata* by the shining genovertical plates and the eight to ten rows of acrostichal setae of the former species. The larvae mine under the epidermis of asparagus stems close to the ground level. Found wherever *Asparagus officinalis* L. is grown, it has been reported from many States.

Melanagromyza subvirens (Malloch)

Agromyza subvirens Malloch, Proc. U. S. Nat. Mus., vol. 49, p. 105, 1915 (figures of head and wing).

This species is close to *M. riparella* in having three lower-orbital setae (fig. 39), but it differs in having the penultimate section of M_{3+4} about twice as long as the ultimate. Also, crossvein m-m usually is at an obtuse angle to the penultimate section of M_{1+2} instead of being perpendicular. I have identified specimens from Iowa, Illinois, Virginia, and Pennsylvania.

Melanagromyza tamia (Melander)

Domomyza tamia Melander, Journ. New York Ent. Soc., vol. 21, p. 258, 1913.

M. tamia is known from six specimens from Washington. It is close to *M. angelicae* in the arrangement of the orbital setulae (fig. 40) but differs widely in having a green sheen, three dorsocentral setae, and the costa ending at vein R_{4+5}.

Melanagromyza tiliae (Couden)

Agromyza tiliae Couden, Proc. Ent. Soc. Washington, vol. 9, p. 35, 1908 (figures of adult, puparium, and twig galls).—Malloch, Bull. Illinois Nat. Hist. Surv., vol. 11, p. 351, 1915 (figures of puparial characters).

Many of the type series are teneral but one has the head in good condition. The gena is buccate, rounded ventrally, and is high, being about one-fourth the eye height (fig. 41). *M. tiliae* differs from *M. schineri* in having the large gena and in crossvein m-m being about two-thirds of its length from crossvein r-m. The larvae make galls in twigs of *Tilia americana* L. The species has been positively identified only from Missouri and Illinois.

Melanagromyza virens (Loew)

Agromyza virens Loew, Berliner Ent. Zeitschr., vol. 13, p. 46, 1869 (Centuria VIII, No. 85).

M. virens sens. str. is a larger species (2.5 to 3.3 mm. in wing length) than the one considered by Malloch to be *M. virens*. Malloch had specimens of *M. virens* sens. str. under the manuscript name of *Agromyza lasiops*. The orbital setulae are very irregular, with the posteriormost being erect (fig. 42). The eyes are setulose, particularly in the males, and the mesonotum and abdomen have a greenish sheen. No specimens reared from larvae are known. The species has been found in Illinois, Indiana, District of Columbia, Maryland, New Jersey, Pennsylvania, and Massachusetts.

Melanagromyza viridis (Frost)

Agromyza viridis Frost, Canadian Ent., vol. 63, p. 277, 1931.

The holotype female is in the U. S. National Museum (No. 62964). *M. viridis* is a moderately sized species with a relatively high, narrow eye (fig. 43). The antennae are somewhat ventrally situated and the lunule is very high—subequal to the height of the frontal vitta. The type series was reared from *Zinnia* sp., and I have identified two reared from *Encelia* sp. as belonging to the same species. Both lots are from the southern half of California.

Melanagromyza winnemanae (Malloch)

Agromyza winnemanae Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 314, 1913.

This is the only species in the group with reclinate orbital setulae, white calypteral fringe, and without metallic sheen that has the costa terminating at vein R_{4+5}. The head in profile shows no unusual features (fig. 44) but the antennae are separated by one-half the diameter of a basal antennal segment. The type female from Maryland is the only known specimen.

3. Genus *Ophiomyia* Braschnikov

Ophiomyia Braschnikov, Ann. Inst. Agr. Moscow, vol. 3, p. 40, 1897.

This is a relatively small genus that is characterized by having the halteres black, the orbital setulae reclinate, and a fusiform carina between the antennae (fig. 45). The males of all but one European species have a fasciculus at the vibrissal angle (fig. 51). This fasciculus may be composed of only a few setae (fig. 47) or it may be very short (fig. 48). The vibrissa of the females is always a single seta (fig. 52). There are 11 North American species of which four are Neotropical, five are Nearctic, and two are found in both regions. Three species are Holarctic, with one, *O. proboscidea*, extending into Central America.

None of the North American species has the costa reaching only to R_{4+5}, while 7 out of 13 Palaearctic species have the costa abbreviated. *O. punctohalterata* is unique in having a white spot on the knob of the halter.

There is one group of species that is sufficiently closely related to be called a species group, the *proboscidea* group (couplet 3). These species have the vibrissal angle extended anteriorly into an acute angle (figs. 48, 51, 53, 54). The remaining species are widely divergent from one another.

Key to the described species of *Ophiomyia*

1. Halter black 2
   Halter with a white spot on the knob . . . . **punctohalterata**
2. Head, viewed in profile, with a vibrissal angle of 45° to 60° (fig. 51) 3
   Head, viewed in profile, with a vibrissal angle of about 90° (fig. 49) 5
3. Head with subcranial margin straight (figs. 48, 51) 4
   Head with subcranial margin curved (figs. 53, 54) . . . . **texana**
4. Anterior half of mesonotum with six to eight rows of acrostichal setae; head with vibrissal angle about 60° (fig. 51) . . . . **proboscidea**
   Anterior half of mesonotum with nine to ten rows of acrostichals; vibrissal angle about 45° (fig. 48) . . . . **coniceps**
5. Head, viewed in profile, with gena narrow, midway between vibrissal and posterior angles from one-fifth to one-eighth the eye height (fig. 49) . . . 6
   Head, viewed in profile, with gena wide, midway between vibrissal and posterior angles about one-third the eye height . . . . **major**
6. Calypter with margin and fringe dark brown to black 7
   Calypter with margin and fringe whitish . . . . **buscki**
7. Anterior half of mesonotum with acrostichal setae in nine to ten irregular rows 8
   Anterior half of mesonotum with acrostichal setae in six to eight irregular rows 9

8. Midtibia medially with one or two setae; head, viewed in profile, with genovertical plates not extending beyond eye margin (fig. 49) . . . **curvibrissata**
   Midtibia medially without setae; genovertical plates extending beyond eye margin (fig. 47) . . . . **congregata**
9. Vein M_{3+4} with ultimate section shorter than penultimate; crossvein r-m distinctly distad of junction of R_1 in the costa 10
   Vein M_{3+4} with ultimate section subequal to the penultimate; r-m directly beneath the junction of R_1 in the costa. . . . . **insularis**
10. Head, viewed in profile, with gena one-seventh to one-eighth the eye height; eye four-fifths as long as high. **maura**
    Head viewed in profile, with gena one-fifth to one-sixth the eye height; eye two-thirds as long as high. . . . . **lantanae**

Ophiomyia buscki (Frost)

Agromyza buskei Frost, Ann. Ent. Soc. Amer., vol. 29, p. 315, 1936.

The proboscis is greatly elongate and the fasciculus at the blunt vibrissal angle is very small (fig. 46). The gena is relatively narrow and the calypteral fringe is white. The holotype male, the only known specimen, was collected in the Panama Canal Zone.

Ophiomyia congregata (Malloch)

Agromyza congregata Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 328, 1913.

This species is somewhat intermediate between *Melanagromyza* and *Ophiomyia* as stated by Shewell (1953). It is closer to *Ophiomyia* in having a slight median carina widening below the antennal bases, divergent antennae, and a definite, if sparse, fasciculus at the vibrissal angle (fig. 47). This is a large species with a wing length of more than 2 mm. I have seen specimens from Arizona, Colorado, and North Dakota.

Ophiomyia coniceps (Malloch)

Agromyza coniceps Malloch, Proc. U. S. Nat. Mus., vol. 49, p. 107, 1915 (figure of head).

The holotype is headless but Malloch illustrated the head and I have included one from a male collected at Santa Cruz, Calif. This species has an extremely elongate vibrissal angle (fig. 48). The larvae mine the stems of *Sonchus asper* (L.). The species is widespread and I have assigned specimens to it from Washington, California, Utah, Louisiana, Indiana, Manitoba, and Quebec.

Ophiomyia curvibrissata (Frost)

Agromyza curvibrissata Frost, Ann. Ent. Soc. Amer., vol. 29, p. 309, 1936.

The holotype male and a female on the same pin are in the U. S. National Museum (No. 62974). The eye is subrectangular and relatively long for its height (fig. 49). The vibrissal fasciculus is elongate, being about one-half the eye height in length. The two type specimens are from Guatemala.

Ophiomyia insularis (Malloch)

Agromyza insularis Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 318, 1913 (figure of male head).

The male from which Malloch illustrated the head is now represented by part of one wing. The female is in good condition and the head is illustrated (fig. 50). The head is very similar to that of *O. lantanae* except that the gena is a little higher in this species. The type is from Cuba.

Ophiomyia lantanae (Froggatt)

Agromyza lantanae Froggatt, Agr. Gaz. New South Wales, vol. 30, p. 665, 1919.
Agromyza curvipalpis (Zetterstedt), Melander (part), Journ. New York Ent. Soc., vol. 21, p. 251, 1913 (4 from Hawaii).
Agromyza longicauda Curran, Scientific survey of Porto Rico and the Virgin Islands, vol. 11, pt. 1, p. 65, 1928.

O. lantanae is similar to *O. maura* but has the gena wider and the eye is relatively high and narrow like that of *O. insularis* (fig. 50). The larvae feed in the seeds of *Lantana camara* L. and possibly other *Lantana* sp. I have seen specimens reared from larvae from southern California, southern Texas, and Florida in the United States. Other North American localities include Cuba, Puerto Rico, Trinidad, Panama, Costa Rica, and Honduras.

Ophiomyia major (Strobl)

Agromyza major Strobl, Wiss. Mitt. Bosnien Herzegovina, vol. 7, p. 266, 1900.
Ophiomyia major (Strobl), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 187, 1931 (figure of head).
Agromyza vibrissata Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 316, 1913 (figures of ♂ and ♀ heads and wing).

This is a large species (2.75 mm. in wing length) for an *Ophiomyia*. The gena is high (about one-third the eye height), only the dorsal upper-orbital seta is reclinate, and the most ventral lower-orbital is reclinate as well as inwardly directed. No larval host plants are known, even in Europe where *O. major* is rather widespread. The type series of *O. vibrissata* is from Georgia.

Ophiomyia maura (Meigen)

Agromyza maura Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 7, p. 399, 1838.
Ophiomyia maura (Meigen), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 188, 1931 (figures of ♂ and ♀ heads and wing).
Agromyza affinis Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 317, 1913.
Agromyza texana (Malloch), Frost (part), Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 42, 1924 (figures of leaf mines on *Aster* sp. and *Solidago* sp.).

This species is similar to *O. lantanae* but has a very narrow gena and the eye is relatively wide for its height (in a ratio of 4:5). The vibrissal fasciculus of the male is shorter (about one-third of the eye height) than that of *O. lantanae* (about one-half). The larvae form long slender mines in the leaves of species of *Solidago* and *Aster*. I have identified specimens from California, Michigan, New York, Pennsylvania, Maryland, and Georgia as belonging to this species.

Ophiomyia proboscidea (Strobl)

Agromyza proboscidea Strobl, Wiss. Mitt. Bosnien Herzegovina, vol. 7, p. 641, 1900.
Ophiomyia proboscidea (Strobl), Hendel, *in* Lindner Die Fliegen der palaearktischen Region, fam. 59, p. 194, 1931 (figures of head and wing).
Agromyza oralis Frost, Ann. Ent. Soc. Amer., vol. 29, p. 309, 1936.

This species is certainly very similar to *O. texana* but may be separated by the straight subcranial margin (fig. 51), the somewhat shorter male fasciculus, and the slightly larger size of about 2 mm. in wing length (about 1.75 mm. for *O. texana*). The larvae mine in species of *Hieracium* and *Satureia* in Europe and it has been reared from *Nepeta* sp. in North America. Only a few specimens have been identified as *O. proboscidea* and they were from Michigan, Indiana, New York, New Jersey, and Louisiana, in the United States, and from Guatemala.

Ophiomyia punctohalterata (Frost)

Agromyza punctohalterata Frost, Ann. Ent. Soc. Amer., vol. 29, p. 311, 1936.

The holotype female is in the U. S. National Museum (No. 62968). There is also a paratype female in the S. W. Frost collection. The head is high and narrow and is forwardly inclined (fig. 52). The halter has a white spot on the knob, which is a unique character for this genus. Known from two specimens collected in Guatemala.

Ophiomyia texana (Malloch)

Agromyza texana Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 319, 1913.

The slightly smaller size (1.75 mm. in wing length as against 2 mm. for *O. proboscidea*) and the curving subcranial margin (figs. 53, 54) serve to separate this species from *O. proboscidea*. The larvae have been reared from stem mines in two cruciferous plants, *Roripa* sp. and *Sophia* sp. *O. texana* is spread across the United States from Washington, Utah, New Mexico, Texas, Colorado, Wyoming, Kansas, and South Dakota, to Illinois, Indiana, and Michigan.

4. Genus *Tylomyza* Hendel

Tylomyza Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 181, 1931 (as subgenus).

This is a small genus of two species, one Palaearctic (*T. pinguis* Fallén) and the other Holarctic (*T. nasuta* Melander). There is a hemispherical carina between the antennae, and the orbital setulae are all proclinate. The males lack the upper-orbital setae (fig. 55). The mouthparts, including the labella, are greatly elongate.

Tylomyza nasuta (Melander)

Agromyza nasuta Melander, Journ. New York Ent. Soc., vol. 21, p. 260, 1913.

Agromyza curvipalpis (Zetterstedt), Melander (part), Journ. New York Ent. Soc., vol. 21, p. 251, 1913 (4♀♀, Idaho and Washington).

Agromyza simplex (Loew), Melander (part), Journ. New York Ent. Soc., vol. 21, p. 252, 1913 (1♀, White Plains, N. Y.).

Agromyza youngi Malloch, Ent. News, vol. 25, p. 312, 1914.

Ophiomyia madizina (Hendel), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 185, 1931 (figures of head and wing).

This is a Holarctic species that may be distinguished from the Palaearctic *T. pinguis* by the three dorsocentral setae (the anterior is about one-half the length of the posterior) and crossvein m-m being less than (from one-third to three-fourths) its own length from r-m (fig. 56). The head is illustrated to show the proclinate orbital setulae and the absence of the upper-orbital setae in the male (fig. 55). The larvae have been reared from *Taraxacum officinale* Weber (=*T. dens-leonis*). I have seen specimens from across the northern half of the United States from Washington to New York and from Ontario and Quebec in Canada.

5. Genus *Phytobia* Lioy

Phytobia Lioy, Atti Ist. Veneto, ser. 3, vol. 9, p. 1313, 1864.

Dizygomyza Hendel, Arch. Naturg., Abt. A, vol. 84, p. 130, 1920.

The genus *Phytobia* contains 52 described species, making it the largest in North America. No other genus has such a diversity of species, not only in regard to adult morphology but that of the larvae as well. Ten subgenera have been described in an effort to systematically arrange all of the diverse groups. Giving generic status to them is not accepted herein because of the annectant species found throughout the genus and the over-all similarity of the male terminalia (Frick, 1952).

Two unusual species have been described from the Neotropical region. The first is *P.* (*Phytobia*) *kallima* that has the wings marked with brown (fig. 60). The other is *P.* (*Phytobia*) *picta* that has the scutellum and sides of the mesonotum yellow (fig. 61). Such a character usually places a species into *Liriomyza* and would do so in this case except that vein R_{4+5} is nearer the wing tip than is M_{1+2} (fig. 60) and the midtibia bears strong setae medially.

The similarity between *Phytobia* and *Liriomyza* also may be shown by the enlarged third segment of the male antennae. Such a characteristic is common to the subgenus *Dizygomyza* (fig. 80). One *Liriomyza* species, *commelinae*, also has the third segment enlarged (fig. 102).

All of the 10 Palaearctic subgenera are represented in North America and there are no subgenera peculiar to this continent. The numbers of species found in each subgenus except *Calycomyza* are in about the same proportions in the Palaearctic region as they are in North America. Subgenus *Calycomyza* contains only five Palaearctic species while it has 17 in North America north of Panama.

The arrangement of subgenera has always been somewhat arbitrary and was originally based upon a combination of adult and larval characters (Hendel, 1931). I have modified the position of two subgenera. Subgenus *Amauromyza* is placed next to subgenus *Nemorimyza* and therefore close to subgenus *Phytobia*. This puts the larger, dark colored species together into a group of less specialized genera.

Subgenus *Dizygomyza* properly belongs with subgenus *Icteromyza* on the basis of the form of the lunule and close to subgenus *Poëmyza*, according to the recent work of Groschke (1954) and my study of *Phytobia* (*Dizygomyza*) *thompsoni*. Groschke has described species in subgenus *Poëmyza* that have a low lunule approaching those found in subgenus *Dizygomyza*, while I found a very high lunule in *Phytobia* (*Dizygomyza*) *thompsoni* (fig. 83). However, in spite of the height of the lunule in the latter species, the lunule is in the plane of the frontal vitta and is sharply raised above the mesofacial plate. The highly modified forms of the posterior spiracles of the larvae also indicate a close relationship between these three subgenera.

Key to the subgenera of *Phytobia*

1. Halter with knob white or yellow. 2
   Halter with knob partially or entirely brown or black . . **5c. Amauromyza**
2. Lunule low, with height less than one-half the width of the lunule at the antennal bases (fig. 92); if higher, then either frontal vitta entirely bright yellow (fig. 85) or lunule in the plane of the frontal vitta and abruptly raised above the mesofacial plate (fig. 83) 3
   Lunule higher, height more than one-half its width (fig. 78); frontal vitta at least one-half brown or black and in the plane of the mesofacial plate, somewhat sunken below the frontal vitta . . . . **5e. Poëmyza**
3. Antennal bases widely separated; lunule broad, large, semicircular above, in the plane of the frontal vitta, abruptly raised above the mesofacial plate (fig. 83) 4
   Antennal bases usually approximate, or if separated, then lunule flattened above, angulate outwardly (fig. 65); or lunule smaller, in the plane of the mesofacial plate, somewhat sunken below the frontal vitta (fig. 92) . . . 5
4. Frontal vitta primarily brown or black; frontal triangle not larger than ocellar triangle (fig. 83). **5f. Dizygomyza**
   Frontal vitta bright yellow; frontal triangle reaching lunule (fig. 85).
   5g. Icteromyza
5. Vein R_{4+5} ending nearest wing tip; prescutellar seta developed 6
   Vein M_{1+2} ending nearest wing tip; prescutellar absent or not differentiated . 7

6. Presutural dorsocentral present. . . . . **5a. Phytobia**
   Presutural dorsocentral absent. . . . . **5b. Nemorimyza**
7. Head with two upper-orbital setae reclinate; gena narrow (fig. 89), posteriorly not more than one-third of the eye height; if higher (fig. 93), then femora yellow. 8
   Head usually with only one upper-orbital, or if two, then only dorsal one reclinate; gena wide (fig. 67), posteriorly about one-half of the eye height; femora primarily dark . . . . **5d. Cephalomyza**
8. Mesonotum usually with one presutural and three postsutural dorsocentral setae, if with only three postsuturals, then anepisternum and femora yellow . . 9
   Mesonotum with either only three postsutural dorsocentrals or with four postsutural and none to three presuturals; anepisternum and femora mostly black . . . . **5h. Calycomyza**
9. Genovertical plates at most slightly raised above the frontal vitta, usually in the plane of the frontal vitta (fig. 88) . . . . **5i. Trilobomyza**
   Genovertical plates very abruptly raised above the frontal vitta, distinctly above the plane of the frontal vitta (fig. 92) . . . . . **5j. Praspedomyza**

5a. Subgenus *Phytobia* Lioy

Phytobia Lioy, Atti Ist. Veneto, ser. 3, vol. 9, p. 1313, 1864.
Dendromyza Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 22, 1931.

This is considered a generalized subgenus, based upon adult morphology. There is usually more than one intraalar seta, a well developed prescutellar, usually one or more posterolateral setae medially on the midtibia, and vein R_{4+5} ends closest to the wing tip (fig. 60). There are usually four well-developed dorsocentrals but Kangas (1955) has found species in Europe with only two or three, one always being presutural. The flies are large and the wing length ranges from 2.5 to 5.0 mm. The larvae mine in the cambium of various woody plants. The larvae are highly specialized and vary from 15 to 30 mm. in length and up to 1 mm. in diameter when full grown. The posterior spiracles each consist of three short bulbs.

This subgenus is well represented in North America. Only two of the species are Neotropical and are very unusual in that *P. kallima* has brown markings on the wing (fig. 60) and the other, *P. picta*, has the scutellum and mesonotal margins yellow. Of the Nearctic species, *P. waltoni* is unusual in lacking medial setae on the midtibia.

Key to the described species of *Phytobia* (*Phytobia*)

1. Scutellum concolorous with mesonotum, black or heavily gray pollinose . . 2
   Scutellum and margin of mesonotum yellow, central part of mesonotum dull black (fig. 61) . . . . **picta**
2. Wing without brown markings 3
   Wing with brown markings (fig. 60). . . . . **kallima**
3. Costa reaching to the end of R_{4+5}, or slightly beyond 4
   Costa reaching to the end of M_{1+2} 5

4. Vein M_{3+4} with the ultimate section about 1.5 times as long as the penultimate . . . . **pruni**
   Vein M_{3+4} with the ultimate section from 2 to 2.5 times as long as the penultimate. . . . . **indecora**
5. Maxillary palpus black or brown 6
   Maxillary palpus yellow . . . . **pruinosa**
6. Third antennal segment reddish; crossvein m-m about its own length from r-m 7
   Third antennal segment brown; m-m not more than six-tenths of its length from r-m. . . . . **waltoni**
7. Head with only one upper-orbital reclinate (fig. 57); dorsal margin of lunule semicircular, smoothly curving (fig. 58); midtibia medially with three posterolateral setae . . . . **amelanchieris**
   Head with both upper-orbitals reclinate (fig. 64); dorsal margin of lunule flattened, outwardly angulate (fig. 65); midtibia medially with one or two posterolateral setae. . . . . **setosa**

***Phytobia (Phytobia) amelanchieris* (Greene)**

Agromyza setosa (Loew), Melander, Journ. New York Ent. Soc., vol. 21, p. 253, 1913.

Agromyza amelanchieris Greene, Journ. Agr. Res., volume 10, p. 314, 1917 (figures of larva and puparium).

P. amelanchieris is most closely related to *P. setosa* but has the eye about as long as high (fig. 57) and the lunule smoothly rounded above (fig. 58). Also there are at least three lower-orbitals and all of the femora are distally reddish. The larvae mine the cambium of *Amelanchier canadensis* (L.). Melander has a specimen of this species in his collection from Oroville, Wash., labeled as *Agromyza pruinosa*, thereby extending the distribution to the far west. The species is now known from Washington, Michigan, Tennessee, North Carolina, West Virginia, and Massachusetts.

***Phytobia (Phytobia) indecora* (Malloch)**

Agromyza indecora Malloch, Canadian Ent., vol. 50, p. 132, 1918.

The head of the type male is illustrated to show the three lower-orbitals (fig. 59). There are frequently as many as four or five. This species is similar to *P. pruni* in having the costa ending at vein R_{4+5}. *P. indecora* may be separated by the long ultimate section of M_{3+4} (2 to 2.5 times as long as the penultimate). No larval host plants are known. I have seen about 44 specimens, all from Illinois.

***Phytobia (Phytobia) kallima* (Frost)**

Agromyza kallima Frost, Ann. Ent. Soc. Amer., vol. 29, p. 299, 1936.

This species is unique in having brown markings on the wing (fig. 60). *P. kallima* is known only from the holotype male from Barro Colorado Island, Panama Canal Zone.

Phytobia (*Phytobia*) *picta* (Coquillett)

Agromyza picta Coquillett, Journ. New York Ent. Soc., vol. 10, p. 188, 1902.
Agromyza dorsocentralis Frost, Ann. Ent. Soc. Amer., vol. 29, p. 307, 1936.

P. picta is a striking and unique species in that the scutellum and margin of the mesonotum are yellow (fig. 61). The head is somewhat unusual in not having the genovertical plates extending beyond the eye margin (fig. 62). No larval host plants are known. Specimens have been studied from Mexico, Honduras, Costa Rica, and the Panama Canal Zone. The New Mexico specimen referred to by Malloch (1913) could not be found.

Phytobia (*Phytobia*) *pruinosa* (Coquillett)

Agromyza pruinosa Coquillett, Journ. New York Ent. Soc., vol. 10, p. 189, 1902—Greene, Journ. Agr. Res., vol. 1, p. 471, 1914 (figures of adult, puparium, larva, and cambium mines).

This species is similar to *P. amelanchieris* in the shape of the head and in having one upper-orbital seta reclinate and three lower-orbitals (fig. 63). However, the maxillary palpus is yellow and the femora are brown in *P. pruinosa.* The larvae mine the cambium of *Betula nigra* L. The species is known from Colorado, Illinois, District of Columbia, and New York.

Phytobia (*Phytobia*) *pruni* (Grossenbacher)

?*Agromyza nigripes* (Meigen), Melander, Journ. New York Ent. Soc., vol. 21, p. 254, 1913.
Agromyza pruni Grossenbacher, Bull. Torrey Bot. Club, vol. 32, p. 235, 1915 (figure of wing).—Malloch, Bull. Illinois Nat. Hist. Surv., vol. 11, p. 349, 1915 (figures of ovipositor, larval and puparial characters).

Melander has in his collection a female from Colorado that does not entirely conform to Malloch's redescription. Because none of Grossenbacher's specimens could be located, a positive identification is impossible. The species is similar to *Phytobia indecora* in having the costa terminate at vein R_{4+5}, but *P. pruni* has the ultimate section of M_{3+4} only about 1.5 times as long as the penultimate. Grossenbacher's specimens were reared from the cambium of *Prunus avium* and *Prunus domestica* in New York.

Phytobia (*Phytobia*) *setosa* (Loew)

Agromyza setosa Loew, Berliner Ent. Zeitschr., vol. 13, p. 45, 1869 (Centuria VIII, No. 83).
Agromyza aceris Greene, Journ. Agr. Res., vol. 10, p. 313, 1917 (figures of larva and puparium).

Most closely related to *P. amelanchieris*, this species has the eye higher than wide (fig. 64), lunule flattened above (fig. 65), usually two lower-orbital setae, and the femora distally brownish. The larvae mine the cambium of *Acer rubrum* L. I have seen specimens from Iowa, Indiana, Michigan, Virginia, District of Columbia, Maryland, New York, Massachusetts, and Quebec.

Phytobia (*Phytobia*) *waltoni* (Malloch)

Agromyza waltoni Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 303, 1913 (figures of head and wing).

This species differs from *P. amelanchieris* and *P. setosa* in having a brown antenna, crossvein m-m not more than six-tenths of its length from r-m, and the lack of medial posterolateral setae on the midtibia. It was originally described from a female from northern New York. There is a male from Tennessee in the Iowa State College collection.

5b. Subgenus *Nemorimyza* Frey

Nemorimyza Frey, Notulae Ent., vol. 26, p. 42, 1946.

This subgenus was erected for a single species having the characters of *Phytobia* except that the presutural dorsocentral is absent. Such a separation is justified because the larva is a leaf miner of the usual type and is up to 5 mm. long when full grown. There are three short bulbs on each posterior spiracle.

Phytobia (*Nemorimyza*) *posticata* (Meigen)

Agromyza posticata Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 6, p. 172, 1830.—Frost, Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 50, 1924 (figure of leaf mine).

Dizygomyza (*Dendromyza*) *posticata* (Meigen), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 30, 1931 (figure of head and wing).

Agromyza terminalis Coquillett, Proc. Acad. Nat. Sci. Philadelphia, vol. 47, p. 318, 1895.

Agromyza taeniola Coquillett, Proc. Ent. Soc. Washington, vol. 6, p. 191, 1904.

Agromyza parvicornis (Loew), Melander (part), Journ. New York Ent. Soc., vol. 21, p. 254, 1913 (1 ♀, Wisconsin).

This species is shining black and has the lunule white tomentose, only three postsutural dorsocentrals, setae medially on the midtibia, vein R_{4+5} nearest the wing tip, and the male abdomen primarily yellow. It is a very common and widespread Holarctic species. The larvae form blotch mines in the leaves of species of *Solidago* and *Aster*. There are specimens from States in all parts of the country and it may be considered as occurring throughout the United States. I have seen specimens from Ontario and Quebec in Canada.

5c. Subgenus *Amauromyza* Hendel

Amauromyza Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 59, 1931.

This is a small subgenus that has six European species (Hendel, 1931) and two North American species. The halter is totally or partially brown or black. One North American species, *Phytobia maculosa*, is atypical; the characters it has in common with *Phytobia* were discussed by Frick (1952). The larvae have three bulbs on each posterior spiracle, none of which are elongate or modified.

Key to the described species of *Phytobia* (*Amauromyza*)

1. Halter dark brown; mesonotum dull brown . . . . **abnormalis**
   Halter black with a white spot on knob; mesonotum shining black . **maculosa**

***Phytobia* (*Amauromyza*) *abnormalis* (Malloch)**

Agromyza abnormalis Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 320, 1913 (figure of wing).

Dizygomyza (*Amauromyza*) *abnormalis* (Malloch), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 59, 1931 (figures of head and wing).

This Holarctic species is completely dull brown to black with the halter, wing base, and calypter dark. Even the wing is not clear, but has a gray to brownish tinge. The larvae mine the stems of *Amaranthus* spp. and *Chenopodium album* L. I have seen specimens from Kansas, Iowa, and District of Columbia.

***Phytobia* (*Amauromyza*) *maculosa* (Malloch)**

Agromyza maculosa Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 302, 1913.

Unique among North American *Phytobia* species in having a black spot on the knob of the halter. Frick (1952) discussed the subgeneric position of this species and listed four host plants. Other larval hosts include *Chrysanthemum* spp., *Bidens pilosa* L., *Helianthus annuus* L., and *Lactuca sativa*, cultivated var. The larvae form large blotch mines. The species is widespread in the United States and is also known from Bermuda, Jamaica, Puerto Rico, Uruguay, Argentina, and Hawaii.

5d. Subgenus *Cephalomyza* Hendel

Cephalomyza Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 32, 1931.

This subgenus is an odd and diverse group that has the frontal vitta, antenna, and mesofacial plate primarily yellow, either has one upper-orbital or has two with only one upper-orbital reclinate, gena posteriorly about one-half the eye height, genovertical plates extending beyond the eye margin (fig. 66), an epistoma present between the subcranial margin and the mesofacial plate, and the legs primarily dark. The larvae of one European species is known and each posterior spiracle bears about nine bulbs.

Key to the described species of *Phytobia* (*Cephalomyza*)

1. Mesonotum with two or three well-developed dorsocentral setae; genovertical plates dark from vertex to lowest orbital seta (fig. 67) 2
   Mesonotum with four well-developed dorsocentral setae; genovertical plates dark from vertex to upper-orbital, lower-orbitals on yellow (fig. 68) . **indecisa**
2. Mesonotum dull black, somewhat pollinose; third antennal segment dark brown to black (fig. 67) . . . . **auriceps**
   Mesonotum shining black; third antennal segment yellowish (fig. 66). **albidohalterata**

Phytobia* (*Cephalomyza*) *albidohalterata **(Malloch)**

Agromyza albidohalterata Malloch, Psyche, vol. 23, p. 52, 1916.
Phytobia (*Cephalomyza*) *albidohalterata* (Malloch), Frick, Canadian Ent., vol. 85, p. 69, 1953.

The figure of the head (fig. 66) is of a male from White Heath, Ill., because the head of the type male is partially collapsed. This is a shining black species that has the femora narrowly light brown distally and with not more than three well-developed dorsocentral setae. *Phytobia* (*Cephalomyza*) *albidohalterata* is atypical for this subgenus in having two upper-orbital setae, but only the dorsal is reclinate. There are specimens from Iowa and Illinois.

Phytobia* (*Cephalomyza*) *auriceps **(Melander)**

Agromyza auriceps Melander, Journ. New York Ent. Soc., vol. 21, p. 262, 1913.

A rather large species (2.25 mm. in wing length) that differs from *Phytobia* (*Cephalomyza*) *albidohalterata* in having the third antennal segment dark brown (fig. 67), the mesonotum dull, and the femora entirely dark brown. The type series is from Idaho and Colorado.

Phytobia* (*Cephalomyza*) *indecisa **(Malloch)**

Agromyza indecisa Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 292, 1913.

This species (fig. 68) is the most yellow of the three in the subgenus, with the antenna, maxillary palpus, and most of the genovertical plates being of that color. The femora are brown with yellowish streaks. There is a single specimen, a female from New Mexico.

5e. Subgenus *Poëmyza* Hendel

Poëmyza Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 35, 1931.

The species included in this subgenus were once considered to be very distinctive in having a high lunule laterally constricted by the genovertical plates (fig. 78). However, Groschke (1954) described European species that have a much lower lunule and modified the key to read: "Height more than one-half its width; frontal vitta at least one-half brown or black." But I have had to consider the plane of the lunule because of the very high lunule of *Phytobia* (*Dizygomyza*) *thompsoni;* this lunule is in the plane of the frontal vitta and abruptly raised above the mesofacial plate (fig. 83). The lunule in the subgenus *Poëmyza* is in the plane of the mesofacial plate and is somewhat sunken below the frontal vitta. The genovertical plates are broad, rather sharply raised above the plane of the frontal vitta, and usually widest immediately dorsal of the antennal base (fig. 78). The larvae have three bulbs on each posterior spiracle (fig. 71). These are variously modified and are usually strongly sclerotized. One or two of the bulbs may be greatly elongate and acuminate.

Of the six described species of this subgenus, four are Holarctic and none is Neotropical. *Phytobia* (*Poëmyza*) *angulata* and *Phytobia* (*Poëmyza*) *subangulata* belong to the *scutellaris* group that has the prescutellar seta developed. The larvae of species whose life histories are known mine the leaves of species in the plant family Cyperaceae. Those without a prescutellar seta mine the leaves of species of Gramineae.

Phytobia atra has been deleted from the North American list. Frick (1952) took the synonymy of Hendel (1931). A subsequent study of the specimens showed that *P. angulata* of Melander is *angulata* sens. str. and the *angulata* of Malloch (1931) is actually *P. incisa.*

Key to the described species of *Phytobia* (*Poëmyza*)

1. Mesonotum with prescutellar seta present and developed 2
   Mesonotum with prescutellar seta absent or not differentiated 3
2. Crossvein r-m beyond center of cell $1-M_2$; m-m about its own length from r-m (fig. 77); forefemur distally yellow, others dark . . . . **subangulata**
   Crossvein r-m about at center of cell $1-M_2$; m-m about 1.5 times its length from r-m; all femora distally yellow . . . . **angulata**
3. Femora distally dark or, if yellow, then for a distance subequal to the femoral diameter 4
   Femora distally yellow for one-third to one-half the femoral length . **muscina**
4. Vein M_{3+4} with ultimate section about 1.5 times as long as penultimate; humerus and notopleural triangle dark 5
   Vein M_{3+4} with ultimate section subequal to penultimate; notopleural triangle and part of humerus yellow . . . . **lateralis**
5. Legs with all femora distally yellow . . . . **inconspicua**
   Legs with forefemur yellow, others dark . . . . **incisa**

***Phytobia* (*Poëmyza*) *angulata* (Loew)**

Agromyza angulata Loew, Berliner Ent. Zeitschr., vol. 13, p. 47, 1869 (Centuria VIII, No. 87).

Agromyza neptis Loew, Berliner Ent. Zeitschr., vol. 13, p. 50, 1869 (Centuria VIII, No. 93).

Dizygomyza semiposticata Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 49, 1931 (figures of head, wing, and puparial characters).

Agromyza cinereifrons Frost, Canadian Ent., vol. 63, p. 276, 1931.

Phytobia angulata is close to *P. subangulata* because both have the prescutellar seta present. However, the former has the eye smoothly rounded anteriorly (fig. 69) as compared to the irregular curvature shown by *P. subangulata* (fig. 79). The lunule is not abruptly narrowed immediately above the antenna as it is in *P. subangulata* (fig. 78). All femora are narrowly yellow distally. The wing has crossvein r-m at about the center of cell 1–M_2 and m-m is about 1.5 times its length from r-m. There are no North American specimens known to me that have been reared, but the larvae mine species of *Carex* in Europe. There are specimens from widely scattered States and it is probable that the species is present in every State of the United States. It is known from Ontario and Quebec in Canada.

***Phytobia (Poëmyza) incisa* (Meigen)**

Agromyza incisa Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 6, p. 182, 1830.

Dizygomyza (Poëmyza) incisa (Meigen), Hendel, Die Fliegen der palaearktischen Region, fam. 59, p. 38, 1931 (figures of head, wing, and puparial characters).

This species is rather distinctive in having crossvein m-m approximately beneath the junction of R_1 in the costa. The prescutellar seta is not developed and the species is subshining black with only the forefemur yellow distally. *Phytobia inconspicua* is similar but has all femora distally yellow. The larvae form blotch mines in the leaves of many species of grass. There may be several larvae per mine. Frick (1952) listed four host plants; other North American grasses from which adults have been reared are *Phleum pratense L.*, *Triticum aestivum* L., *Setaria lutescens* (Weigel) Hubb., and *Phalaris arundinacea* L. There are specimens from many States in the northern half of the United States and from Ontario in Canada.

***Phytobia (Poëmyza) inconspicua* (Malloch)**

Agromyza inconspicua Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 310, 1913.

This species is very similar to *Phytobia incisa* but is smaller (1.75 mm. in wing length), has the third antennal segment slightly angulate, and has all femora distally yellow. The head of the type (fig. 70) is somewhat distorted because the specimen is teneral. This species is known from a single male reared from a mine on *Agropyron* sp. in Colorado. The puparium is on the same pin and illustrations of the posterior end and spiracles are included (figs. 71, 72, and 73). The spiracles are different from any others that I have seen.

***Phytobia (Poëmyza) lateralis* (Macquart)**

Agromyza lateralis Macquart, Histoire naturelle des Insectes, Diptera, vol. 2, p. 609, 1835.

Dizygomyza (Poëmyza) lateralis (Macquart), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 40, 1931 (figures of head and wing).

Agromyza coquilletti Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 295, 1913 (figure of head).

Agromyza marginata (Loew), Melander, Journ. New York Ent. Soc., vol. 21, p. 256, 1913.

Paratype males of *Phytobia coquilletti* were compared with two males lent by E. M. Hering. The distinctive keel on the ninth tergite (figs. 74, 75), first described by Shewell (1953), is also present on the European males. Malloch's figure of the head is somewhat inaccurate and I have redrawn it (fig. 76). This species is quite yellow with most of the head, most of the humerus, notopleural triangle, all femora distally, and all tergites posteriorly being yellowish. The larvae mine the leaves of many species of grass and there are North American records from the following: *Avena sativa* L., *Elymus canadensis* L., *Hordeum jubatum* L., *Triticum aestivum* L., and *Zea mays* L. I have seen specimens from many of the States in the northern half of the United States and from Manitoba in Canada.

Phytobia (*Poëmyza*) *muscina* (Meigen)

Agromyza muscina Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 6, p. 177, 1830.

Dizygomyza (*Poëmyza*) *muscina* (Meigen), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 44, 1931 (figures of head and wing).

Agromyza marginata Loew, Berliner Ent. Zeitschr., vol. 13, p. 49, 1869 (Centuria VIII, No. 91).

Agromyza superciliosa (Zetterstedt), Melander, Journ. New York Ent. Soc., vol. 21, p. 256, 1913.

Phytobia muscina is a distinctive species because the femora are distally yellow for about one-third of their length. The genovertical plates are yellowish on the dorsal half and usually are brownish for the full length, contrasting with the black frontal vitta. The larvae mine the leaves of several species of grass. The only reared specimens that I have seen from North America were from leaf mines on *Agropyron repens* (L.), *Ehrharta erecta* Lam., and *Hordeum murinum* L. I have seen specimens from California (including Los Angeles), Oregon, Washington, Idaho, Illinois, Indiana, Michigan, District of Columbia, Maryland, Pennsylvania, New York, and Massachusetts. The species also occurs in the North West Territories of Canada.

Phytobia (*Poëmysa*) *subangulata* (Malloch)

Agromyza subangulata Malloch, Psyche, vol. 23, p. 51, 1916.

This species is similar to *Phytobia angulata* in having the prescutellar seta developed. However, it differs in having only the forefemur distally yellow, the other femora distally reddish brown, crossvein r-m definitely distad of center of cell 1–M_2 and slightly beyond the junction of R_1 in the costa (fig. 77). There is a narrow but rather prominent keel between the antennae, and the lunule is abruptly narrowed immediately dorsad of the antenna (fig. 78). The eye is not as smoothly rounded anteriorly (fig. 79) as it is in *P. angulata* (fig. 69). I have seen no reared specimens but in Europe this group mine the leaves of species of *Carex*, *Cyperus*, and *Scirpus*. I have identified only a few specimens as belonging to this species, all from Illinois. Most of the specimens Malloch placed under *Phytobia subangulata* belong to *P. angulata* sens. str.

5f. Subgenus *Dizygomyza* Hendel

Dizygomyza Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 83, 1951.

Of the six described species of this subgenus two are Nearctic and four are Holarctic. The adults placed in this subgenus are characterized by a very large lunule. The lunule is in the plane of the frontal vitta and abruptly raised above the plane of the mesofacial plate (fig. 83). This is in contrast to subgenus *Poëmyza* where the lunule is sunken somewhat below the frontal vitta and is in the plane of the mesofacial plate (fig. 78). The height of the lunule is usually less than one-half its width at the antennal bases. However, the lunule may be higher (fig. 83), as it is in *Phytobia* (*Dizygomyza*) *thompsoni*, but the lunule being in the plane of the frontal vitta separates the latter species from species of the subgenus *Poëmyza*. Subgenus *Dizygomyza* has the frontal triangle no larger than the ocellar triangle (fig. 83), in contrast to the elongate frontal triangle found in subgenus *Icteromyza* which reaches to the lunule (fig. 85). The third antennal segment of the males is greatly enlarged. The larvae have three bulbs on each posterior spiracle. One or more of these is usually elongate, heavily sclerotized, acuminate, and variously curved. The posterior spiracles of some species are quite similar to some found in subgenus *Poēmyza*.

Key to the described species of *Phytobia* (*Dizygomyza*)

1. Anterior half of mesonotum with acrostichal setae numerous, in six to eight irregular rows 2
   Anterior half of mesonotum with acrostichals relatively sparse, in four to five irregular rows 4
2. Legs with all femora distally light yellow for a distance subequal to the femoral diameter 3
   Legs with forefemur distally light yellow, others light brown . . . . . **iridis**
3. Head rounded in profile, genovertical plates at most barely extending beyond eye margin; tarsi dark brown; small species, two to 2.3 mm. in wing length. **iraeos**
   Head subtriangular in profile, genovertical plates strongly extending beyond eye margin (fig. 82); tarsi yellowish; large species, 2.75 to 3.0 mm. in wing length . . . . **thompsoni**

4. Legs with all femora distally light yellow for a distance subequal to the femoral diameter 5
   Legs with forefemur distally light yellow, others black . . . . . . **luctuosa**
5. Abdomen with basal two or three tergites laterally yellow . . . . . **morosa**
   Abdomen with basal two or three tergites laterally black . . . **magnicornis**

Phytobia (*Dizygomyza*) *iraeos* (Robineau-Desvoidy)

Agromyza iraeos Robineau-Desvoidy, Rev. Mag. Zool., ser. 2, vol. 3, p. 393, 1851.

Dizygomyza (*Dizygomyza*) *iraeos* (Robineau-Desvoidy), Hendel, Die Fliegen der palaearktischen Region, fam. 59, p. 86, 1931 (figures of larval spiracles).

Agromyza taeniola (Coquillett), Melander (part), Journ. New York Ent. Soc., vol. 21, p. 256, 1913 (1 ♀, Douglas, Alaska).

This species is very similar to *Phytobia* (*Dizygomyza*) *iridis*, another Holarctic species, but may be separated by the three light yellow "knees." The key characters of rounded head, dark tarsi, and small size serve to separate this species from *P.* (*D.*) *thompsoni.* The larvae mine in *Iris* spp. There are reared specimens from Indiana and Louisiana; other specimens that I have seen are from Michigan and Alaska.

Phytobia (*Dizygomyza*) *iridis* (Hendel)

Dizygomyza iridis Hendel, Zool. Anz., vol. 69, p. 253, 1927.

This Holarctic species is very similar to *Phytobia* (*Dizygomyza*) *iraeos* but is distinguished by having only the forefemur light yellow distally, the others being light brown. The larvae mine in *Iris* spp. I have identified specimens from California and Michigan.

Phytobia (*Dizygomyza*) *luctuosa* (Meigen)

Agromyza luctuosa Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 6, p. 182, 1830.

Dizygomyza (*Dizygomyza*) *luctuosa* (Meigen), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 88, 1931 (figures of head, wing, and puparial spiracles).

Agromyza taeniola (Coquillett), Melander (part), Journ. New York Ent. Soc., vol. 21, p. 256, 1913 (2 ♀ ♀, Portland, Oreg., and Monroe, Wash.).

A rather distinctive species among the species having relatively sparse acrostichals in that the midfemora and hind femora are all black. No reared specimens are known from North America, but the larvae mine species of *Carex* and *Juncus* in Europe. At present this species is known from California, Oregon, Washington, and New York, in the United States, and from Nova Scotia in Canada.

Phytobia (*Dizygomyza*) *magnicornis* (Loew)

Agromyza magnicornis Loew, Berliner Ent. Zeitschr., vol. 13, p. 46, 1869 (Centuria VIII, No. 86).

This is a Nearctic species that may be separated from the closely related *Phytobia* (*Dizygomyza*) *morosa* in having the abdominal tergites laterally black or brown; the basal two or three tergites of *P.* (*D.*) *morosa* are laterally yellow. The head (fig. 80) and wing (fig. 81) of the holotype male are illustrated in order to help identify this previously misidentified species. The larval host plants are not known. I have seen specimens from Illinois, Indiana, Michigan, District of Columbia, Pennsylvania, and New Hampshire as well as from British Columbia.

Phytobia (*Dizygomyza*) *morosa* (Meigen)

Agromyza morosa Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 6, p. 170, 1830.

Dizygomyza (*Dizygomyza*) *morosa* (Meigen), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 90, 1931 (figures of head and puparial spiracles).

Another Holarctic species that is little known in North America. It is distinctive in having the basal two or three tergites yellow laterally. No larval host plants are known in North America but the larvae mine in species of *Scirpus* and *Carex* in Europe. Thus far known only from South Dakota, Illinois, Indiana, and Maryland.

Phytobia (*Dizygomyza*) *thompsoni* Frick

Agromyza magnicornis (Loew), Coquillett, *in* Thompson, Psyche, vol. 14, p. 74, 1907 (figure of leaf galls).

Agromyza laterella (Zetterstedt), Malloch (part), Ann. Ent. Soc. Amer., vol. 6, p. 300, 1913.—Claassen, Ann. Ent. Soc. Amer., vol. 11, p. 9, 1918 (figures of adult, puparium, larva, and leaf mines and galls).

This is a large species (2.75 to 3 mm. in wing length) for a species of the subgenus *Dizygomyza*. The head is subtriangular in profile with the genovertical plates strongly extending beyond the eye margin (fig. 82). The lunule is high for this subgenus, extending halfway to the anterior ocellus from the antennal base (fig. 83). The male terminalia is characterized by the large yellow knob on the ninth tergite (fig. 84). The larvae mine the leaves of *Iris versicolor* L., *Iris* sp. (blue flag), and *Typha* spp. There are specimens from Illinois, Michigan, Pennsylvania, New York, and Massachusetts.

5g. Subgenus *Icteromyza* Hendel

Icteromyza Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 51, 1931.

The adults are characterized by the bright yellow frontal vitta and lunule, the elongate frontal triangle reaching to the lunule, the very large lunule that is in the plane of the frontal vitta and abruptly raised above the mesofacial plate, and the widely spaced antennal bases (fig. 85). This subgenus may be separated from subgenus *Poëmyza* by the bright yellow frontal vitta and the lunule in the plane of the frontal vitta and from subgenus *Dizygomyza* by the color of the frontal vitta and the elongate frontal triangle. The third antennal segment of the males is not enlarged. The eye may be setulose, as it is in *Phytobia* (*Icteromyza*) *pollinosa* (fig. 87). The wing is relatively long and slender (fig. 86) as compared to the wings in the subgenera *Phytobia* (fig. 60), *Poëmyza* (fig. 77), and *Dizygomyza* (fig.81). The larva of *Phytobia* (*Icteromyza*) *longipennis* is the only one known from the subgenus. The anterior spiracle has two small bulbs and is very small. Each posterior spiracle of the third stage or full grown larva is long, ventrally directed, sclerotized, acuminate, and bears about 20 very small bulbs in a single row. Such a highly modified spiracle compares favorably with the unusual and diverse types found in the subgenera *Poëmyza* and *Dizygomyza* and supports the close relationship shown by the adults of the three subgenera.

Key to the described species of *Phytobia* (*Icteromyza*)

1. Maxillary palpus yellow; femora distally broadly yellow for a distance subequal to one-third the femoral length 2
   Maxillary palpus black; femora distally narrowly yellow for a distance subequal to the femoral diameter . . . . **capitata**
2. Eye setulose; third antennal segment yellow. . . . . **pollinosa**
   Eye practically bare; third antennal segment mostly brown or black. **longipennis**

***Phytobia* (*Icteromyza*) *capitata* (Zetterstedt)**

Agromyza capitata Zetterstedt, Diptera Scandinaviae, vol. 7, p. 2750, 1848.

Dizygomyza (*Icteromyza*) *capitata* (Zetterstedt), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 52, 1931 (figures of head and wing).—de Meijere, Tijdschr. Ent., vol. 84, p. 15, 1941.

Agromyza genualis Melander, Journ. New York Ent. Soc., vol. 21, p. 261, 1913.

Agromyza coloradensis Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 297, 1913.

This Holarctic species is large, with a wing length of 2.5 to 3.5 mm. The maxillary palpus is black and the femora are distally yellow for a distance equal to the femoral diameter. A front view of the head shows the form of the lunule and frontal triangle (fig. 85). De Meijere found an adult of this species on the stems of *Juncus* sp. and surmised that the larvae mined in *Juncus* spp. *Dizygomyza* (*Icteromyza*) *capitata* is northern in distribution but extends down the Sierra Nevada mountain chain into southern California. It also occurs in Oregon, Washington, Idaho, Montana, Utah, Colorado, North Dakota, Michigan, Illinois, Maine, and Ontario.

***Phytobia* (*Icteromyza*) *longipennis* (Loew)**

Agromyza longipennis Loew, Berliner Ent. Zeitschr., vol. 13, p. 48, 1869 (Centuria VIII, No. 90).—Melander, Journ. New York Ent. Soc., vol. 21, p. 255, 1913.—Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 296, 1913.

This species is smaller (2.5 mm. in wing length) than *Phytobia* (*Icteromyza*) *capitata*, has the palpus yellow, and all femora distally broadly yellow for about one-third the length. From *P.* (*I.*) *pollinosa* it differs by having the third antennal segment brown or black and the eye bare. The wing is typical of those found in this subgenus in being relatively long and narrow (fig. 86). I have reared *P.* (*I.*) *longipennis* from leaf and stem mines in *Juncus xiphioides* Meyer in California. This is the first positive record of a host plant for species of the subgenus *Icteromyza.* I have seen specimens from many States throughout the United States and from Manitoba and Quebec in Canada.

***Phytobia* (*Icteromyza*) *pollinosa* (Melander)**

Agromyza pollinosa Melander, Journ. New York Ent. Soc., vol. 21, p. 263, 1913.

The eyes are heavily pollinose (fig. 87), a character which separates this species from other North American species. It is closest to *Phytobia* (*Icteromyza*) *longipennis* in having the palpus yellow and the distal third of the femora yellow, but it has the third antennal segment yellow. There are only two known specimens, both from Sikta, Alaska.

5h. Subgenus *Calycomyza* Hendel

Calycomyza Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 65, 1931.—Frick, Ann. Ent. Soc. Amer., vol. 49, p. 284, 1956 (figures of larval characters and types of leaf mines of five species).

This subgenus is placed among the more specialized subgenera on the basis of the usual lack of a presutural dorsocentral and the circular or irregular form of the posterior spiracles of two of the six described larvae. The species found north of Mexico were recently revised by Frick (1956b). Previously, species of the subgenus *Calycomyza* were distinguished by the three postsutural dorsocentral setae and the black legs. A number of North American species were described in which the forefemur is distally narrowly yellow and two—*Phytobia* (*Calycomyza*) *majuscula* and *P.* (*C.*) *gigantea*—that have four postsutural and none to three presutural dorsocentrals. *P.* (*C.*) *meridiana* has the third antennal segment yellow, a unique character for this subgenus. The larvae of only six species are known. There are usually three bulbs on each posterior spiracle but one Palaearctic species has from three to five while one Nearctic species has five to eight in a circle and one Holarctic species has about 10 irregularly arranged.

The large number of species found in North America was surprising considering that only five are known in the well-collected Palaearctic region. Of the 17 species described from North America, three are Holarctic, three others are found in both Nearctic and Neotropical regions, eight are strictly Nearctic, and four are Neotropical only.

The revision did not include species found south of the United States because of the poor condition of the type series of P. (C.) *ipomoeae* and P. (C.) *cassiae*. Complete descriptions are impossible and these species are placed in the key by using rather minor characters. Short descriptions are included for the three Neotropical species not included in the revision. The notes under the other species are limited to larval host plant records and distributions because the revision included descriptions of all species considered therein.

Key to the described species of *Phytobia* (*Calycomyza*)

1. Calypter with margin and fringe white or yellow 2

   Calypter with margin and fringe dark brown or black 6

2. Third antennal segment rounded, subcircular; anterior half of mesonotum with about six rows of acrostichal setae 3

   Third antennal segment with an anterodorsal angle, flattened dorsally beyond base of arista; about five rows of acrostichals 5

3. Genovertical plates dark from vertex to at least the dorsal upper-orbital seta; forefemur entirely black 4

   Genovertical plates dark not more than halfway between inner vertical seta and dorsal upper-orbital; forefemur distally narrowly yellow. **lantanae**

4. Second dorsocentral seta more than one-half the length of the third dorsocentral; genovertical plates dark from vertex to at least halfway between the two upper-orbital setae . . . . **promissa**

   Second dorsocentral one-half or less the length of the third; genovertical plates dark usually to dorsal upper-orbital, sometimes beyond, rarely to ventral upper-orbital . . . . **jucunda**

5. Mesofacial plate dark except for narrow yellow epistomal margin; calypter with margin and fringe white . . . . **humeralis**

   Mesofacial plate yellow; margin and fringe yellow . . . . **solidaginis**

6. Mesofacial plate at least one-half dark 7

   Mesofacial plate yellow, not more than antennal bases dark 10

7. Genovertical plates dark from vertex to at least ventral upper-orbital . . 8

   Genovertical plates dark from vertex to dorsal upper-orbital . **artemisiae**

8. Genovertical plates dark, at least narrowly, from vertex to the ventral lower-orbital; second dorsocentral more than one-half the length of the third dorsocentral 9

   Genovertical plates dark to ventral upper-orbital or dorsal lower-orbital; second dorsocentral less than one-half the third . . . . **cynoglossi**

9. Mesonotum shining, six rows of acrostichals; humeral seta on black . **majuscula**

   Mesonotum dull, pollinose, four or five rows of acrostichals; humeral seta on yellow . . . . **gigantea**

10. Genovertical plates yellow, rarely dark from vertex to halfway to dorsal upper-orbital; third antennal segment ovoid, longer than wide 11

    Genovertical plates dark at least to dorsal upper-orbital; third antennal segment subcircular 12

11. Inner postalar seta on yellow of mesonotum . . . . **flavinotum**

    Inner postalar on black of mesonotum . . . . **allecta**

12. Third antennal segment black 13
    Third antennal segment yellow . . . . **meridiana**
13. Genovertical plates dark from vertex to at least the ventral upper-orbital . 14
    Genovertical plates dark from vertex to dorsal upper-orbital 15
14. Arista subequal in length to the eye height; mesonotum with about 19 setulae in the intraalar row posterior to the transverse suture . . . . **cassiae**
    Arista not more than four-fifths of the eye height; about 16 setulae in the intraalar row . . . . **malvae**
15. Forefemur brown or black, at most lighter brown distally 16
    Forefemur distally yellow for a distance subequal to the femoral diameter. **ipomoeae**
16. Frontal vitta relatively wide, not more than 1.4 times as high as wide. **ambrosiae**
    Frontal vitta relatively narrow, not less than 1.7 times as high as wide. **verbenae**

Phytobia (*Calycomyza*) *allecta* (Melander)

Agromyza lateralis Williston, (not Macquart, 1835), Trans. Ent. Soc. London, 1896, pt. 3, p. 428, 1896 (figure of head).

Phytobia (*Calycomyza*) *allecta* (Melander), Frick, Ann. Ent. Soc. Amer., vol. 49, p. 298, 1956.

The larvae have elongate anal lobes and form large blotch mines in the leaves of *Bidens frondosa* L., *Helianthus* spp., and *Rudbeckia* spp. The species occurs east of the Rocky Mountains in the United States and Canada and on the islands of St. Vincent, Haiti, and Puerto Rico in the West Indies.

Phytobia (*Calycomyza*) *ambrosiae* Frick

Phytobia (*Calycomyza*) *ambrosiae* Frick, Ann. Ent. Soc. Amer., vol. 49, p. 299, 1956.

This species has been reared from *Ambrosia artemisiifolia* L. and *A. trifida* L. Thus far it has been found in Indiana, Tennessee, and Florida.

Phytobia (*Calycomyza*) *artemisiae* (Kaltenbach)

Agromyza artemisiae Kaltenbach, Verh. Naturh. Ver. Preuss. Rheinlande West falens, vol. 13, p. 236, 1856.

Dizygomyza (*Calycomyza*) *artemisiae* (Kaltenbach), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59. p. 66, 1931 (figures of head, wing, and puparium).

Phytobia (*Calycomyza*) *artemisiae* (Kaltenbach), Frick, Ann. Ent. Soc. Amer., vol. 49, p. 294, 1956 (figures of larval characters and leaf mines).

The larvae of this Holarctic species make blotch mines in the leaves of *Artemisia* spp. and *Rudbeckia* spp. in North America. The species appears to be generally distributed over the United States and Canada. It is known from Guatemala.

Phytobia (*Calcomyza*) *cassiae* (Frost)

Agromyza sp., Frost, Sci. Month., vol. 30, p. 445, 1930 (figure of leaf mines).
Agromyza cassiae Frost, Ann. Ent. Soc. Amer., vol. 29, p. 306, 1936.

The holotype female is in the U. S. National Museum (No. 62965). *Phytobia* (*Calycomyza*) *cassiae* is very similar to *P.* (*C.*) *malvae* and, because the type series is in poor condition, separation of the two species is difficult. The very long arista, subequal in length to the eye height, is probably the best character to use at this time. The larvae make serpentine mines in the leaves of *Cassia bacillaris* L. The type series is from the Panama Canal Zone and I have identified two specimens from Puerto Rico as belonging to *Phytobia* (*Calycomyza*) *cassiae*.

Phytobia (*Calycomyza*) *cynoglossi* Frick

Phytobia (*Calycomyza*) *cynoglossi* Frick, Ann. Ent. Soc. Amer., vol. 49, p. 295, 1956.

The larvae mine the leaves of *Cynoglossum* spp. This species is general throughout Canada but is not known west of Kansas in the United States.

Phytobia (*Calycomyza*) *flavinotum* Frick

Agromyza allecta (Melander), Frost (part), Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 38, 1924.
Phytobia (*Calycomyza*) *flavinotum* Frick, Ann. Ent. Soc. Amer.. vol. 49, p. 297, 1956 (figure of antenna).

This is a distinctive species in that the inner postalar seta is on yellow. The larvae have elongate anal lobes and make large blotch mines in the leaves of *Arctium lappa* L., *Eupatorium purpureum* L., and *Viburnum pubescens* Pursh.

Phytobia (*Calycomyza*) *gigantea* Frick

Agromyza platyptera (Thomson), Malloch (part), Ann. Ent. Soc. Amer., vol. 6, p. 293, 1913.
Phytobia (*Calycomyza*) *gigantea* Frick, Ann. Ent. Soc. Amer., vol. 49, p. 296, 1956.

This is the largest species (1.75–2.5 mm. in wing length) known in the subgenus. The larval host plants are unknown. This species is recorded in the United States from Illinois, Virginia, Maryland, and in Canada from Ontario and from Quebec.

Phytobia (*Calycomyza*) *humeralis* (von Roser)

Agromyza humeralis von Roser, Korresp.-Blatt. Wuertt. Landw. Ver., vol. 8, p. 63, 1840.
Phytobia (*Calycomza*) *humeralis* (von Roser), Frick, Ann. Ent. Soc. Amer., vol. 49, p. 290, 1956 (figures of antenna, larval characters, and leaf mines).

The larvae are unique in having eight to ten bulbs in the posterior spiracles. Many larval host plants in the Compositae are known both in Europe and the United States. Frick (1956b) reported the larvae mining *Penstemon procerus* Dougl., family Scrophulariaceae, in California. The species is widely distributed in the United States and Canada.

Phytobia (Calycomyza) ipomoeae (Frost)

Agromyza ipomaeae Frost, Ent. News, vol. 42, p. 74, 1931.

The type series is teneral and therefore rather difficult to characterize fully. However, the forefemur is distally yellow for a distance subequal to its diameter and the midfemora and hindfemora are reddish distally. These characteristics separate *Phytobia (Calycomyza) ipomoeae* from *P.* (*C.*) *ambrosiae* and *P.* (*C.*) *verbenae.* The larvae mine the leaves of *Ipomoea batatas* Poir. in Puerto Rico.

Phytobia (Calycomyza) jucunda (van der Wulp)

Agromyza jucunda van der Wulp, Tijdschr. Ent., vol. 10, p. 161, 1867.

Phytobia (*Calycomyza*) *jucunda* (van der Wulp), Frick, Ann. Ent. Soc. Amer., vol. 49, p. 288, 1956 (figures of larval characters and leaf mines).

Agromyza platyptera Thomson, Diptera, *in* Kongliga Svenska Fregatten *Eugenies* . . . , vol. 6, pt. 2, p. 608, 1868.

Agromyza coronata Loew, Berliner Ent. Zeitschr., vol. 13, p. 48, 1869 (Centuria VIII, No. 89).

This species is Nearctic in distribution and is commonly found throughout the United States and Canada. The larvae mine the leaves of a rather large number of plants in the family Compositae.

Phytobia (Calycomyza) lantanae Frick

Phytobia (*Calycomyza*) *lantanae* Frick, Ann. Ent. Soc. Amer., vol. 49, p. 287, 1956.

The larvae mine the leaves of *Lantana camara* L., possibly other *Lantana* spp., and *Lippia helleri* Britt. This is a Neotropical species known from southern Texas, Mexico, Puerto Rico, and Trinidad.

Phytobia (Calycomyza) majuscula Frick

Phytobia (*Calycomyza*) *majuscula* Frick, Ann. Ent. Soc. Amer., vol. 49, p. 295, 1956 (figures of larval characters and leaf mines).

This is a moderately large species, the larvae of which make blotch mines in the leaves of *Senecio lugens* var. *exaltatus* Gray in central California. Also known from Washington, Idaho, Saskatchewan, and Ontario.

Phytobia (Calycomyza) malvae (Burgess)

Oscinis malvae Burgess, U. S. Dep. Agr. Ann. Rep. (1879), p. 202, 1880.

Phytobia (*Calycomyza*) *malvae* (Burgess), Frick, Ann. Ent. Soc. Amer., vol. 49, p. 298, 1956.

Agromyza jucunda (Van der Wulp), Coquillett (part), U. S. Dep. Agr., Div. Ent. Bull. 10, p. 77, 1898.

Agromyza cassiae Frost (part), Ann. Ent. Soc. Amer., vol. 29, p. 306, 1936.

The larvae mine the leaves of the following malvaceous plants: *Malva rotundifolia* L., *Abutilon theophrasti* Medic., *Althaea* sp., *Malvastrum coromandelianum* L., and *Sida spinosa* L. The species has been collected in scattered locations throughout the United States and from the Panama Canal Zone.

Phytobia (Calycomyza) meridiana (Hendel)

Agromyza meridionalis Malloch (not Strobl, 1900), Trans. Amer. Ent. Soc., vol. 40, p. 35, 1914.

Agromyza meridiana Hendel, Konowia, vol. 2, p. 145, 1923.

This species is unique among species of the subgenus *Calycomyza* in having the third antennal segment yellow. No larval host plants are known. I have seen specimens from Costa Rica and Mexico.

Phytobia (Calycomyza) promissa Frick

Phytobia (Calycomyza) jucunda (van der Wulp), Frick (part), Univ. California Publ. Ent., vol. 8, p. 395, 1952.

Phytobia (Calycomyza) promissa Frick, Ann. Ent. Soc. Amer., vol. 49, p. 287, 1956 (figures of antenna, larval characters, and leaf mines).

This species was described from linear-blotch mines in the leaves of *Aster chilensis* Nees in central California. Several specimens from Manitoba and Ontario were placed under this name because the only observable difference was the slightly larger size.

Phytobia (Calycomyza) solidaginis (Kaltenbach)

Agromyza solidaginis Kaltenbach, Verh. Naturh. Ver. Preuss. Rheinlande Westfalens, vol. 26, p. 196, 1869.

Phytobia (Calycomyza) solidaginis (Kaltenbach), Frick, Ann. Ent. Soc. Amer., vol. 49, p. 292, 1956.

The larvae mine the leaves of *Solidago* spp. Found throughout the United States, eastern Canada, and Europe.

Phytobia (Calycomyza) verbenae (Hering)

Agromyza jucunda (van der Wulp), Coquillett (part), U. S. Dep. Agr., Div. Ent. Bull. 10, p. 77, 1898.

Dizygomyza (Calycomyza) verbenae Hering, Notulae Ent., vol. 31, p. 42, 1951.

Phytobia (Calycomyza) verbenae (Hering), Frick, Ann. Ent. Soc. Amer., vol. 49, p. 300, 1956.

The larvae mine the leaves of *Verbena* spp. in the southwestern and eastern United States. The species appears to be common.

5i. Subgenus *Trilobomyza* Hendel

Trilobomyza Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 71, 1931.

This is a small subgenus that contains three described Nearctic species. It is characterized by the genal height not exceeding one-third that of the eye (fig. 90), two upper-orbital setae (fig. 89), the lunule low, and the genovertical plates not abruptly raised above the frontal vitta (fig. 88) as they are in species of the subgenus *Praspedomyza* (fig. 92). The frontal vitta is usually yellow but when it is dark the abdomen is also dark. A small pair of prescutellar setae may be present. The larvae have three short recurved bulbs on each posterior spiracle. The subgenus *Trilobomyza* is placed among the more specialized subgenera because of the similarity of the adults to those of the subgenus *Praspedomyza.*

One diverse species, *Phytobia* (*Trilobomyza*) *pleuralis*, is included here although it is an example of one that belongs strictly to no one subgenus. However, the adults have more characters in common with species of the subgenus *Trilobomyza* than with species in the other subgenera.

Key to the described species of *Phytobia* (*Trilobomyza*)

1. Frontal vitta yellowish; femora yellow 2
   Frontal vitta black; femora dark brown . . . . **calyptrata**
2. Mesonotum with four dorsocentrals; anepisternum brown, dorsally about one-fourth yellow . . . . **varia**
   Mesonotum with three postsutural dorsocentrals; anepisternum yellow. **pleuralis**

Phytobia (*Trilobomyza*) *calyptrata* (Hendel)

Agromyza nigrisquama Malloch (not Malloch, 1914), Psyche, vol. 23, p. 53, 1916.
Agromyza calyptrata Hendel, Konowia, vol. 2, p. 145, 1923.

This species may be separated from others in the subgenus *Trilobomyza* by the over-all dark brown coloration, particularly that of the frontal vitta and the femora. The head is illustrated to show the subcircular eye (fig. 89). The holotype from Illinois is the only specimen that I have seen.

Phytobia (*Trilobomyza*) *pleuralis* (Malloch)

Agromyza pleuralis Malloch, Ent. News, vol. 25, p. 311, 1914.
Agromyza clara (Melander), Frost, Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 41, 1924.

Frick (1953a) discussed the subgeneric position of this atypical species, which has more characters in common with subgenus *Trilobomyza* than with any other subgenus. The head has the gena relatively wide (fig. 90). The larvae form serpentine-blotch mines in the leaves of *Catalpa* spp. At present the known distribution is limited to Illinois and Ohio.

Phytobia (Trilobomyza) varia (Melander)

Agromyza varia Melander, Journ. New York Ent. Soc., vol. 21, p. 264, 1913.

This species is typical of those in the subgenus *Trilobomyza* in having yellow frons and femora. The head bears only one lower-orbital (fig. 91) and is of a much different shape than that of *Phytobia* (*Trilobomyza*) *pleuralis* (fig. 90). The dark area on the anepisternum and the four strong dorsocentral setae also serve to separate *P.* (*T.*) *varia* from *P.* (*T.*) *pleuralis*. The holotype and only known specimen is from Idaho.

5j. Subgenus *Praspedomyza* Hendel

Praspedomyza Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 77, 1931.

This subgenus is considered the most specialized because of the form of the posterior spiracles of the larvae. Each is circular and bears from 10 to 18 short bulbs. The adults are very similar to those in the subgenus *Trilobomyza* but may be separated by the broad prominent genovertical plates. These are distinctly above the plane of the frontal vitta and are abruptly raised above it (fig. 92). The adults are usually dark and may be distinguished from the dark *Phytobia* (*Trilobomyza*) *calyptrata* by the aforementioned genovertical plates.

There are only two species in North America that belong to the subgenus *Praspedomyza* sens. str. One, *Phytobia* (*Praspedomyza*) *morio*, is Holarctic while *Phytobia (Praspedomyza) subinfumata* is Nearctic. *Phytobia (Praspedomyza) clara* is included here only because the posterior spiracles of the larvae each have 10 to 12 bulbs arranged in a circle. The adults are yellow and the gena is extremely wide, being nearly two-thirds as high as the eye (fig. 93). The Nearctic *Phytobia clara* and Palaearctic *P. hilarella* are very similar species that are not closely related to other *Phytobia* species. The larvae of both mine the fronds of *Pteridium aquilinum* (L.) Kuhn.

Key to the described species of *Phytobia* (*Praspedomyza*)

1. Frontal vitta brown or black; femora primarily brown 2
   Frontal vitta yellow; femora yellow . . . . **elara**
2. Head with three or four lower-orbital setae; femora brown . . **subinfumata**
   Head with two lower-orbital setae; femora brown except for forefemur being narrowly yellow distally . . . . **morio**

Phytobia (Praspedomyza) clara (Melander)

Agromyza clara Melander, Journ. New York Ent. Soc., vol. 21, p. 265, 1913.
Agromyza citreifrons Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 290, 1913.

This is a small (1.3 to 1.75 mm. in wing length) yellowish species that contrasts strongly with the predominately dark species typical of the subgenus *Praspedomyza*. *Phytobia hilarella*, a very similar species, was placed into *Praspedomyza* by Hendel because of larval characters. *Phytobia clara* is retained here for the same reason although the demarcation between the frontal vitta and the genovertical plates is not as clearly defined as it is in most species of the subgenus *Praspedomyza*. I have illustrated the head (fig. 93) to show the contrast between *Phytobia clara* and *P. hilarella*, the latter figured by Hendel (1931). The larvae form mines in the fronds of *Pteridium aquilinum* (L.) Kuhn. I have seen specimens from California, Washington, Michigan, Tennessee, and Maine in the United States and from Ontario, Canada.

Phytobia (Praspedomyza) morio (Brischke)

Agromyza morio Brischke, Schrift. Naturf. Ges. Danzig, vol. 5, p. 258, 1881.
Dizygomyza (*Praspedomyza*) *morio* (Brischke), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 80, 1931 (figures of head and wing).

This is a small black species that has the third antennal segment and the forefemur distally yellow. Malloch had a Maryland specimen in the U. S. National Museum labeled "*A. luteicornis* Malloch MS." I have reared the species from *Galium trifidum* L. and *G. aparine* L. in California. No other North American specimens are known.

Phytobia (Praspedomyza) subinfumata (Malloch)

Agromyza infumata Malloch, (not Czerny and Strobl, 1909), Canadian Ent., vol. 47, p. 15, 1915.
Agromyza subinfumata Malloch, Proc. U. S. Nat. Mus., vol. 49, p. 108, 1915.

This species is dark brown and lacks the yellow third antennal segment and distally yellow forefemur of *Phytobia morio*. The head has the genovertical plates extending beyond the eye margin and bearing three or four lower-orbital setae (fig. 94). Known only from Illinois.

6. Genus *Cerodontha* Rondani

Cerodontha Rondani, Dipt. Ital. Prodr., vol. 4, p. 10, 1861.

This is a relatively small genus that is characterized by having only the distal pair of scutellar setae present (fig. 95). The third antennal segment is always angulate distally. Two widely divergent subgenera have been recognized. One, the subgenus *Xenophytomyza*, could be very properly placed as a synonym of *Phytobia* (*Praspedomyza*) except for the two scutellar setae and the *Cerodontha* (*Cerodontha*) type of male terminalia.

Key to the subgenera of *Cerodontha*

1. Third antennal segment distally bearing a spine or strongly projecting into a very acute angle; thorax and abdomen partially yellow. **6a. Cerodontha**
Third antennal segment with a blunt angle distally; thorax and abdomen shining brown or black . . . . **6b. Xenophytomyza**

6a. Subgenus *Cerodontha* Rondani

Cerodontha Rondani, Dipt. Ital. Prodr., vol. 4, p. 10, 1861.

The adults placed in this subgenus are relatively slender and elongate and the body is always partially yellow. The third antennal segment either bears a spine or is produced distally into a very acute angle. Crossvein m-m is always present. There are eight species recognized in Europe but only one in North America.

Cerodontha (*Cerodontha*) *dorsalis* (Loew)

Odontocera dorsalis Loew, Berliner Ent. Zeitschr., vol. 7, p. 54, 1863 (Centuria III, No. 98).

Cerodontha dorsalis (Loew), Melander, Journ. New York Ent. Soc., vol. 21, p. 249, 1913 (figure of head) (east of Rocky Mountains).—Aldrich, Ann. Ent. Soc. Amer., vol. 11, p. 63, 1918.

Cerodontha femoralis (Meigen), Melander, Journ. New York, Ent. Soc., vol. 21, p. 249, 1913 (Rocky Mountains, westward).

The type is in the Museum of Comparative Zoology (No. 13433). This species varies greatly in the proportions of yellow and black. Aldrich (1918) showed that the dark western form came from the region of cool nights and the more yellowish eastern form is from the region of warm nights. Spring and fall collections, during seasons of cool nights, produced the dark form in the east. Frick (1952) showed that the male terminalia were the same for both color forms. The mesonotum of the holotype female is illustrated to show the color pattern (fig. 95). The larvae mine the leaves of many grasses, pupating in the sheath. *Cerodontha dorsalis* is one of the most common and widespread species in the United States and Canada.

6b. Subgenus *Xenophytomyza* Frey

Xenophytomyza Frey, Notulae Ent., vol. 26, p. 51, 1946.—Frick, Kansas Ent. Soc., vol. 25, p. 150, 1952 (figure of head).

This subgenus contains three species, two Palaearctic and one Nearctic. The adults are robust and shining brown or black. The third antennal segment has a blunt angle distally in contrast to the very acute angle of the species of *Cerodontha* sens. str. Crossvein m-m is absent in one European species.

Phytobia (*Xenophytomyza*) *illinoensis* (Malloch)

Agromyza illinoensis Malloch, Diptera of Patagonia and South Chile, pt. 6, fasc. 5, p. 483, 1934.

Cerodontha (*Xenophytomyza*) *illinoensis* (Malloch), Frick, Journ. Kansas Ent. Soc., vol. 25, p. 151, 1952 (figure of head).

A dark robust species having a blunt angle distally on the third antennal segment. It is most easily separated from the dark *Phytobia* species by the single pair of scutellar setae. It is known from swept specimens from Illinois and Virginia.

7. Genus *Liriomyza* Mik

Liriomyza Mik, Wiener Ent. Zeit., vol. 13, p. 289, 1894.

The genus *Liriomyza* is large, with 35 described North American species. Of these, 30 are Nearctic, four are Neotropical, and one is found in both regions. Six are Holarctic in distribution.

This genus is characterized by the partially or totally yellow scutellum, vein M_{1+2} being at or very near the wing tip (fig. 108), and the orbital setulae reclinate (fig. 107) or erect (fig. 110). There are usually numerous orbital setulae but they may be very sparse (fig. 112). Most of the species have some yellow on the head or body. There are a few that are as over-all dark as some species included in *Metopomyza*. The genovertical plates are narrower in *Liriomyza* species (the widest is shown in fig. 104). These plates are very broad throughout their full length in species of *Metopomyza* (fig. 128). There are no setae medially on the midtibia except for *Liriomyza braziliensis* (Frost) and *L. ecuadorensis* (Frost).

Although *Liriomyza* and *Haplomyza* appear to be separated on rather superficial characters in the key, the separation is justified by the two widely divergent types of male terminalia and larvae found in the two genera. Certain European species of *Liriomyza* have as many as three of the *Haplomyza* characters; e. g., if the mesonotum is heavily gray pollinose and there are two rows of acrostichals and only one upper-orbital, then crossvein m-m is present. In North America, two *Haplomyza* characters may occur together. As an example, *Liriomyza assimilis* has the mesonotum dull gray pollinose and has only two rows of acrostichals (fig. 99), but crossvein m-m is present and there are two upper-orbitals (fig. 98). Crossvein m-m is absent in *L. chlamydata* but the mesonotum is shining and bears four rows of acrostichals and there are two reclinate upper-orbitals.

Several unusual characters might be briefly mentioned here. The *sorosis* group is unusual in having either two postsutural dorsocentrals (fig. 111) or three with the third anterior to the supraalar seta and the third and fourth at least two times as far apart as the second and third (fig. 124). The usual arrangement is for the third dorsocentral to be opposite or only slightly anterior to the supraalar with the third and fourth dorsocentrals about 1.5 times as far apart as the second and third (figs. 101, 120). *L. commelinae* is the only *Liriomyza* species known to me that has the third antennal segment of the male enlarged (fig. 102). This characteristic is found in all species of the subgenus *Dizygomyza* of *Phytobia*. *Liriomyza fumicosta* has the costal margin of the wing infuscated (fig. 108). Probably the most distinctive North American species that I have seen is *L. deceptiva*. The genovertical plates are very prominent and raised above the plane of the frontal vitta (fig. 104). Near the lunule these plates widen to equal about one-third of the width of the frons. The genovertical plates are proportionately broader for their full length in species of *Metopomyza* (fig. 128).

Besides the aforementioned *sorosis* group, three others, all within the *pusilla* complex, may be designated. These are based primarily on the colors of the vertex and genovertical plates (Frick, 1956a). The first may be called the *trifolii* group (couplet 34). Both vertical setae are on yellow and there are two rows of acrostichals. The second is the *eupatorii* group (couplet 29). Here the verticals arise from black, the genovertical plates are yellow, and there are four rows of acrostichals. The last group (couplet 27) contains *pictella* and is named for it. The genovertical plates being infuscated separate this group from that of *eupatorii*. The remaining species cannot be placed into groups because of wide differences between them.

Several species are herein deleted from the North American list. These include *L. pusilla* (Meigen) and *L. virgo* (Zetterstedt), neither of which I have seen in my studies. The South American *Agromyza xanthophora* (Schiner) apparently belongs to *Phytobia* (*Phytobia*) and may be the same as *P.* (*Phytobia*) *picta*. No type specimens of *A. xanthophora* can be located.

Key to the described species of *Liriomyza*

1. Mesonotum with a prescutellar yellow rectangular or triangular area between the dorsocentral setae extending anteriorly at least to the fourth dorsocentral (figs. 99, 101) 2
   Mesonotum without such a prescutellar yellow area but sometimes with a wide yellow crossband, centrally not extending to the fourth dorsocentral (figs. 103, 109) 16
2. Third antennal segment all or partially brown or black (figs. 115, 126) . . 3
   Third antennal segment yellow 6
3. Mesonotum subshining, not pollinose 4
   Mesonotum dull, gray pollinose 5

4. Mesonotum with inner postalar seta about one-third as long as outer postalar (fig. 120); one or two lower-orbital setae . . . . **reverberata**
Mesonotum with inner postalar subequal to outer; three lower-orbitals (fig. 126) . . . . **variata**
5. Wing with costal area light brown from R_1 to R_{2+3} (fig. 108); scutellum without basal lateral black triangles (fig. 109) . . . . **fumicosta**
Wing with costal area colorless; scutellum with large black triangles, basal scutellar seta on black . . . . **pacifica**
6. Mesonotum with three or four dorsocentral setae, the third strongly anterior to the supraalar seta, third and fourth at least two times as far apart as the second and third (figs. 111, 124) 7
Mesonotum with four dorsocentrals, the third opposite or only slightly anterior to the supraalar, third and fourth about 1.5 times as far apart as the second and third (figs. 101, 113) 9
7. Mesonotum with dark area of two colors, either light reddish centrally with dark brown lateral stripes (fig. 111), or dark brown centrally and light reddish laterally 8
Mesonotum with dark area uniformly dark brown or black (fig. 124) . **sorosis**
8. Mesonotum with three dorsocentrals, central area reddish brown, lateral stripes dark brown (fig.111) . . . . **marginalis**
Mesonotum with four dorsocentrals, central area black, lateral stripes light reddish . . . . **barrocoloradensis**
9. Third antennal segment rounded 10
Third antennal segment angulate dorsoanteriorly (fig. 96) . . **angulicornis**
10. Scutellum without basal lateral dark triangles 11
Scutellum with basal lateral dark triangles (fig. 101) 12
11. Mesonotum dark brown; acrostichal setae in four rows, a small intraalar present, about twice as long as an acrostichal . . . . **melampyga**
Mesonotum light reddish brown; acrostichals in two rows; intraalar absent. **lutea**
12. Anepisternum with a dark oval or triangular area (fig. 100) 13
Anepisternum entirely yellow . . . . **schmidti**
13. Humerus with a dark area; width of gena posteriorly not more than one-half the eye height (fig. 98) 14
Humerus entirely yellow; gena very wide, posteriorly subequal to the eye height . . . . **borealis**
14. Maxillary palpus yellow 15
Maxillary palpus brown . . . . **tubifer**
15. Acrostichal setae about 13 in number, in four rows; prescutellar yellow area subrectangular . . . . **flavonigra**
Acrostichals five or six in number, in two rows; yellow area triangular (fig. 99) . . . . **assimilis**
16. Third antennal segment totally dark brown or black, or if mostly yellow then darkened distally (fig. 126) 17
Third antennal segment entirely light yellow 21
17. Wing with m-m crossvein present, or if absent, then mesiperon at least one-half yellow 18
Wing with m-m crossvein absent; mesepimeron black . . . . **chlamydata**
18. Third antennal segment yellowish, infuscated distally 19
Third antennal segment entirely black 20
19. Mesepimeron at least one-half yellow; pteropleuron about one-half yellow. **langei**
Mesepimeron black; pteropleuron black or very dark grayish black . **dianthi**

20. Crossvein m-m about one-fourth of its length from r-m; distally femora brown. **quadrisetosa**

Crossvein m-m about twice its length from r-m; femora brown; distally yellow for a distance subequal to the femoral diameter . . . . **baptisiae**

21. Anepisternum brown except for a narrow yellow dorsal band subequal in width to a suture 22

Anepisternum not more than three-fourths brown (fig. 116), dark area usually triangular 23

22. Genovertical plates yellow; inner vertical seta arising from yellow (fig. 106). **discalis**

Genovertical plates dark from vertex nearly to lunule; both vertical setae arising from black of occiput (fig. 104) . . . . **deceptiva**

23. Femora primarily yellow, usually marked with brown or black streaks or spots 24

Femora dark brown, distal one-third yellow . . . . **flaveola**

24. Calypter with margin and fringe blackish 25

Calypter with margin and fringe white . . . . **lima**

25. Head with both vertical setae arising from black of occiput, inner usually at edge of dark color 26

Head with both vertical setae on yellow 31

26. Genovertical plates darkened between orbital setae and eye margin . . . 27

Genovertical plates yellow, concolorous with frontal vitta 29

27. Anepisternum at least one-half brown or black, dark area subrectangular . 28

Anepisternum less than one-half brown or black, dark area triangular. **brassicae**

28. Anepisternum about three-fourths dark (fig. 116); first dorsocentral seta small, subequal to an acrostichal in length and about one-fourth the fourth dorsocentral in length . . . . **propepusilla**

Anepisternum about one-half dark; first dorsocentral larger, about one-third the length of the fourth dorsocentral . . . . **pictella**

29. Crossvein m-m not more than its length from r-m; ultimate section M_{3+4} about three times as long as penultimate 30

Crossvein m-m 1.5 to two times its length from r-m; ultimate section M_{3+4} about two times as long as the penultimate . . . . **eupatorii**

30. Inner postalar seta about one-half as long as the outer postalar; seven to nine setulae in the intraalar row posterior to the transverse suture . . **munda**

Inner postalar seta about one-fourth to one-third as long as the outer; about five setulae in the intraalar row posterior to the transverse suture. **verbenicola**

31. Mesonotum with four irregular rows of acrostichal setae 32

Mesonotum with two irregular rows of acrostichal setae 34

32. Humerus without a dark spot 33

Humerus with a dark spot . . . . **alliovora**

33. Head with black of the occiput reaching to eye margin (fig. 107); anepisternum with a small dark ventral area . . . . **felti**

Head with black of the occiput not reaching to eye margin (fig. 102); anepisternum entirely yellow . . . . **commelinae**

34. Head with black of the occiput not reaching to eye margin; inner postalar seta on yellow 35

Head with black of the occiput reaching the eye margin; inner postalar seta on black . . . . **trifolii**

35. Mesonotum dull, heavily gray pollinose; basal scutellar seta arising from black of lateral triangle . . . . **allia**
Mesonotum subshining, not pollinose; basal scutellar seta arising from yellow, at edge of black triangle . . . . **phaseolunata**

Liriomyza allia (Frost)

Agromyza allia Frost, Journ. New York Ent. Soc., vol. 51, p. 257, 1943.
Liriomyza allia (Frost), Frick, Journ. Kansas Ent. Soc., vol. 28, p. 90, 1955 (figure of head).

The holotype male is in the U. S. National Museum (64300). This species varies from *Liriomyza alliovora* in having only two rows of acrostichals. *L. allia* has the mesonotum heavily gray pollinose in contrast to *L. trifolii* and *L. phaseolunata*, which are subshining and not pollinose. No larval host plants are known. In addition to the holotype there is a paratype male; both are from Manhattan, Kans.

Liriomyza alliovora Frick

Liriomyza alliovora Frick, Journ. Kansas Ent. Soc., vol. 21, p. 88, 1955 (figure of head).

This species differs from *Liriomyza felti* and *L. commelinae* in having a dark spot on the humerus and from *L. allia* in having four rows of acrostichals. The head of *L. allivora* does not have the black from the occiput reaching the eye margin, as does *L. felti* (fig. 107), and the anepisternum has a ventral black area, unlike *L. commelinae.* The larvae mine the leaves of *Allium* sp. in Iowa.

Liriomyza angulicornis (Malloch)

Agromyza angulicornis Malloch, Canadian Ent., vol. 50, p. 79, 1918.
Liriomyza angulicornis (Malloch), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 208, 1931 (figure of head and wing).

This Holarctic species has the third antennal segment angulate dorsoanteriorly and the gena is about one-half as wide as the eye height (fig. 96). The anepisternum has a long slender ventral dark triangle (fig. 97). There are no known larval host plants. The holotype, from Illinois, is the only known North American specimen.

Liriomyza assimilis (Malloch)

Agromyza assimilis Malloch, Canadian Ent., vol. 50, p. 80, 1918.

The head is entirely yellow in profile and both vertical setae are on yellow (fig. 98). The yellow prescutellar area is triangular in shape (fig. 99) and the dark ventral spot on the anepisternum is ovoid (fig. 100). Frost has a series of specimens reared from linear mines in the leaves of *Helianthus* sp. at Arendtsville, Pa. The holotype is from Illinois.

Liriomyza baptisiae (Frost)

Agromyza baptisiae Frost, Canadian Ent., vol. 63, p. 275, 1931.

The holotype male is in the U. S. National Museum (No. 62962). The type series is in rather poor condition but this species belongs to those species that have the third antennal segment at least partially dark and lack the prescutellar yellow spot on the mesonotum. This is a small species (1.25 to 1.5 mm. in wing length) that has the third antennal segment totally black, the femera distally yellow, and the wing with crossvein m-m about twice its length from r-m. The larvae form linear-blotch mines in the leaves of *Baptisia tinctoria* (L.) in Pennsylvania.

Liriomyza barrocoloradensis (Frost)

Agromyza barrocoloradensis Frost, Ann. Ent. Soc. Amer., vol. 29, p. 300, 1936.

The holotype male is in the U. S. National Museum (No. 62967). The head in profile is similar to that of *Liriomyza sorosis* (fig. 125). The mesonotum is shining and is marked much like that of *L. melampyga* (fig. 113) except that the marginal dark stripes are light reddish. The anepisternum is entirely yellow. The larvae mine the leaves of an unidentified plant in the Panama Canal Zone.

Liriomyza borealis (Malloch)

Agromyza borealis Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 280, 1913 (figures of head and wing).

The head of the holotype is partially collapsed but posteriorly the gena is as wide as the eye is high. The maxillary palpus is yellow. The mesonotum is marked as in the figure and the basal pair of scutellar setae arises from yellow (fig. 101). This species is known only from the holotype from British Columbia.

Liriomyza brassicae (Riley)

Agromyza brassicae Riley, U. S. Dep. Agr. Ann. Rep. (1884), p. 322, 1884.
Liriomyza brassicae (Riley), Frick, Pan-Pacific Ent., vol. 33, p. 68, 1957.
Agromyza diminuta (Walker), Coquillett (part), U. S. Dep. Agr., Div. Ent., Bull. 10, p. 78, 1898 (specimens from cabbage).
Phytomyza mitis Curran, Canadian Ent., vol. 63, p. 97, 1931.
Agromyza subpusilla Frost (part) (not Malloch, 1914), Journ. New York Ent. Soc., vol. 51, p. 255, 1943 (figure of mine of nasturtium leaf).

Liriomyza brassicae belongs to the group having yellow antennae, both varietal setae on the dark color of the vertex, and the genovertical plates darkened between the orbital setae and the eye margin. Of the three species in this group, *L. brassicae*, *L. propepusilla*, and *L. pictella*, the latter two have the anepisternum at least one-half dark, the dark area being subrectangular. The anepisternum of *L. brassicae* is subtriangular. The larvae mine the leaves of a large number of cruciferous plants and *Tropaeolum* sp. (nasturtium). I have seen specimens from many of the States throughout the United States and from Manitoba in Canada. *Liriomyza brassicae* is also a well known species in Europe.

Liriomyza chlamydata (Melander)

Antineura chlamydata Melander, Journ. New York Ent. Soc., vol. 21, p. 250, 1913.

This species belongs to the group without a prescutellar yellow spot on the mesonotum and with the third antennal segment partially dark. This species may be separated from the other three with a darkened third antennal segment by the lack of crossvein m-m. However, crossvein m-m is sometimes absent in *Liriomyza langei*, and *L. chlamydata* may be confused with those specimens of *L. langei* that lack the m-m crossvein. *L. chlamydata* may be separated by the setulae of the third antennal segment being as long as the basal diameter of the arista, six or seven very strong orbital setulae that are about one-fourth as long as the orbital setae, the humeral seta on black, and the black mesepimeron. The holotype and only known specimen is from the State of Washington.

Liriomyza commelinae (Frost)

Agromyza commelinae Frost, Ent. News, vol. 42, pl 72, 1931.

Liriomyza commelinae (Frost), Silva and Oliveira, Rev. Brasil. Biol., vol. 12, p. 293, 1952 (figures of adult and larval characters and leaf mines).

The holotype male is in the U. S. National Museum (No. 62960). This species has the third antennal segment of the male greatly enlarged and the gena about one-third as wide as the eye height (fig. 102). The mesonotum is broadly yellow posteriorly but lacks a central rectangular or triangular area extending anteriorly of the fourth dorsocentral (fig. 103). The larvae form serpentine mines in the leaves of *Commelina elegans* H. B. K., *C. longicaulis* Jacq., and *C. virginica* L. I have seen specimens from St. Vincent and Trinidad in the British West Indies. This species is known from Brazil and apparently was redescribed by Blanchard (1954) as *L. bahamondesi*, from *Commelina virginica* L. in Argentina.

Liriomyza deceptiva (Malloch)

Agromyza deceptiva Malloch, Canadian Ent., vol. 50, p. 78, 1918.

Liriomyza deceptiva is the most diverse North American species of *Liriomyza* known to me. The head is unique in having the genovertical plates broadened immediately above the antennae (fig. 104). In profile the head has the genovertical plates strongly extending beyond the eye margin (fig. 105). The pleura and abdomen are all black. There are two females that represent this species, one from Illinois and one from Virginia.

Liriomyza dianthi **Frick**

Liriomyza dianthi Frick, Proc. Ent. Soc. Washington, vol. 60, No. 1, p. 1, 1958 (figures of head and pleura).

This species is very black with relatively few yellow markings. It is similar to *Liriomyza quadrisetosa* and *L. baptisiae*, but differs in having the third antennal segment mostly yellowish and darkened distally. *L. dianthi* is very similar to *L. langei* but is darker over-all, having the mesepimeron and pteropleuron black or very dark grayish, the femora about three-fourths black, and the scutellum narrowly yellow with the distal scutellar setae being on the black triangles or not more than a setal base removed from them. *L. dianthi* is at present confined to the San Francisco Bay Area of California. The larvae make large white serpentine mines in the leaves of *Dianthus caryophyllus* L.

Liriomyza discalis **(Malloch)**

Agromyza discalis Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 277, 1913 (figure of head).

This is a very dark species of *Liriomyza* that has the pleura black except for the sutures. The head has the inner vertical seta on yellow and has a few sparse reclinate orbital setulae (fig. 106). The margin and fringe of the calypter are white. The holotype is from Arizona and is the only known specimen.

Liriomyze eupatorii **(Kaltenbach)**

Argromyza eupatorii Kaltenbach, Die Pfanzenfeinde aus der Klasse der Insekten, p. 320, 1874.

Liriomyza eupatorii (Kaltenbach), Frick, Canadian Ent., vol. 85, p. 72, 1953.

This is a Holarctic species that is little known in North America. It is close to *Liriomyza munda* and *L. verbenicola* in having the genovertical plates yellow. The most obvious distinction of *L. eupatorii* is crossvein m-m being 1.5 to 2 times its length from r-m, m-m being about at its own length in the other two species. The larvae make serpentine mines, usually beginning as a spiral, in *Solidago* spp., including *elongata* Nutt. in Washington. In Europe also found mining species of *Eupatorium*, *Lampsana*, and *Galeopsis*. Thus far found only in Washington.

Liriomyza felti **(Malloch)**

Agromyza felti Malloch, Ent. News, vol. 25, p. 310, 1914.—Frost, Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 43, 1924 (figures of leaf mines).

The holotype male is in the collection of the New York State Museum, Albany, N. Y. The head has the black of the occiput broadly reaching the eye margin and the eye is smoothly rounded anteriorly (fig. 107). This species differs from *Liriomyza commelinae* in having the gena centrally about one-fifth the eye height (about one-third in *commelinae*) and in a small dark ventral spot on the anepisternum. The larvae make blotch mines in the leaves of the ferns *Camptosorus rhizophyllus* (L.) and *Asplenium pinnatifidum* Nutt. Known from Illinois and New York.

Liriomyza flaveola (Fallén)

Argromyza flaveola Fallén, Diptera sueciae, vol. 2, No. 37 (Agromyzides), p. 6, 1823.
Liriomyza flaveloa (Fallén), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 219, 1931 (figures of head and wing).
Agromyza scutellata (Fallén), Malloch (part), Ann. Ent. Soc. Amer., vol. 6, p. 280, 1913 (1, Dunoon, Scotland).

This species may be distinguished from the other species in the so-called *pusilla* complex by having the femora basally black for two-thirds of the length and yellow distally. The anepisternum is about one-half black with the dark area triangular. The abdomen is broadly yellow laterally. The larvae mine the leaves of grasses and I have reared it from *Bromus carinatus* H. & A., *Hordeum murinum* L., and *Lolium multiflorum* Lam. Thus far this Holarctic species is known in North America only from central California.

Liriomyza flavonigra (Coquillett)

Agromyza flavonigra Coquillett, Journ. New York Ent. Soc., vol. 10, p. 189, 1902—Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 281, 1913 (figure of head).
Agromyza melampyga (Loew), Melander (part), Journ. New York Ent. Soc., vol. 21, p. 258, 1913 (1 ♂, New Mexico).

A rather large species (2.5 to 2.75 mm. in wing length) that has the genovertical plates extending beyond the eye margin. The mesonotum is dull but not pollinose and bears four developed dorsocentral setae, all on yellow. The abdomen is mostly yellow. None of the three known specimens has been reared. All are from New Mexico and Melander's is from Cloudcroft at an elevation of 9,000 feet.

Liriomyza fumicosta (Malloch)

Agromyza fumicosta Malloch, Ent. News, vol. 25, p. 310, 1914.

Unique among *Liriomyza* species in having the costal area light brown (fig. 108). The mesonotum is slightly lighter brown centrally than the marginal stripes, there are two sparse rows of acrostichals, and the scutellum is entirely yellow (fig. 109). There are two known specimens, both from Illinois.

Liriomyza langei Frick

Agromyza orbona (Meigen), Melander (part), Journ. New York Ent. Soc., vol. 21, p. 258, 1913 (2 ♀ ♀, Pullman, Wash., from peas).
Liriomyza langei Frick, Pan-Pacific Ent., vol. 21, p. 81, 1951 (figure of anepisternum); Proc. Ent. Soc. Washington, vol. 60, No. 1, p. 1, 1958 (figures of head and pleura).

This species has the third antennal segment darkened distally and the femora marked with yellow streaks. Crossvein m-m is sometimes lacking. *Liriomyza langei* may be separated from *L. chlamydata* by having the mesepimeron at least one-half yellow, humeral seta mostly on yellow, and the setulae of the third antennal segment about one-half as long as the basal diameter of the arista. Of 1,000 specimens examined, 81.7 percent have m-m present in both wings, 5.7 percent with one m-m complete and one vestigial, 1.0 percent with one crossvein complete and one absent, 6.8 percent with m-m vestigial in both wings, 2.9 percent with one vestigial and one absent, and 1.9 percent with crossvein m-m absent in both wings. Two similar species, *L. quadrisetosa* and *L. baptisiae*, have the third antennal segment black and the femora black except for being narrowly yellow distally. *L. langei* is very similar to *L. dianthi*. However, *L. langei* is over-all more yellow and has the pteropleuron and mesepimeron each about one-half yellow and the femora streaked with yellow.

The larvae of *L. langei* have been found mining the leaves of a wide range of plants as follows: *Allium cepa* L. (Liliaceae), *Beta vulgaris* L. and *Spinacia oleracea* L. (Chenopodiaceae), *Brassica oleracea* var. *botrytis* L. (Cruciferae), *Pisum sativum* L. (Leguminosae), *Apium graveolens* var. *dulce* Pers. (Umbelliferae), and *Petunia* sp. (Solanaceae), *Aster* spp., and *Lactuca sativa* L., cultivated varieties (Compositae). Thus far no uncultivated plants have been found as larval hosts. *L. langei* has been identified from Washington, Oregon, and California.

Liriomyza lima (Melander)

Agromyza lima Melander, Journ. New York Ent. Soc., vol. 21, p. 265, 1913.
Agromyza holti Malloch, Canadian Ent., vol. 56, p. 191, 1924.

This species is distinctive in the "*pusilla* complex" in having the margin and fringe of the calypter white. The head has a very wide gena and the eye subquadrate (fig. 110). Melander's series is from Idaho while Malloch's specimen is from South Dakota.

Liriomyza lutea (Meigen)

Agromyza lutea Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 6, p. 177, 1830.
Liriomyza lutea (Meigen), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 230, 1931 (figures of head of wing).—Spencer, Ent. Gaz., vol. 5, p. 185, 1954.

Liriomyza lutea is a very yellow species that has the scutellum entirely yellow. It is close to *L. melampyga* but differs in having only a few setulae on the mesonotum and the acrostichals in two rows. The dark color of the mesonotum is light reddish brown as contrasted with the dark brown of *L. melampyga*. Spencer in England has recently reared this species for the first time from *Asplenium rutamuraria* L. I have identified one specimen from Alaska that was compared with two from Europe.

Liriomyza marginalis (Malloch)

Agromyza marginalis Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 283, 1913.

This species is closely related to *Liriomyza sorosis* and *L. barrocoloradensis* but has only three dorsocentrals, one presutural and two postsutural (fig. 111). The mesonotum has the central area light reddish and the marginal stripes dark brown, whereas in *L. barrocoloradensis* the colors are reversed and in *L. sorosis* the dark area is uniformly dark brown. The head has the eye widest below the midline (fig. 112), while it is above the midline in the other two species (fig. 125). The larvae mine in *Paspalum dilatatum* Poir. I have seen specimens from Illinois, Texas, and South Carolina.

Liriomyza melampyga (Loew)

Agromyza melampyga Loew, Berliner Ent. Zeitschr., vol. 13, p. 48, 1869 (Centuria VIII, No. 88)—Melander (part), Journ. New York Ent. Soc., vol. 21, p. 258, 1913 (1 ♀, Massachusetts).

Agromyza flaviventris Johnson (not Strobl, 1898), Canadian Ent., vol. 34, p. 242, 1902.

This species has the scutellum entirely yellow and the mesonotum bearing four developed dorsocentral setae (fig. 113). The mesonotal color pattern is like that of *L. barrocoloradensis* but is all dark brown. This species is close to *L. lutea* but the mesonotal dark area of *L. lutea* is light reddish brown and there are only two rows of acrostichals. The head used for the illustration was not that of the teneral type but of a female from Glen Echo, Md. (fig. 114). The larval host plants remain unknown. I have seen specimens from Michigan, District of Columbia, Maryland, New Jersey, New York, and Massachusetts.

Liriomyza munda Frick

Liriomyza munda Frick, Pan-Pacific Ent., vol. 33, p. 61, 1957.

This species may be separated from *Liriomyza eupatorii* by having crossvein m-m at its own length from r-m and from *L. verbenicola* by a long inner postalar seta (about one-half the length of the outer) and with about twice as many setulae (seven to nine) in the intraalar row posterior to the transverse suture. The larvae make serpentine mines in the leaves of *Lycopersicon esculantum* Mill., rarely *Solanum tuberosum* L., and the native *Datura meteloides* DC. in California.

Liriomyza pacifica (Melander)

Agromyza pacifica Melander, Journ. New York Ent. Soc., vol. 21, p. 264, 1913.
Agromyza longispinosa Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 276, 1913.

This species is one of two having the mesonotum dull and pollinose and the third antennal segment black. The other, *Liriomyza fumicosta,* varies in having the costal area tinged light brown and a completely yellow scutellum. The head of *L. pacifica* is mostly yellow and the black of the occiput does not touch the eye margin (fig. 115). There is only one lower-orbital seta. Larval host plants are unknown. The species has been found in Washington, Illinois, Indiana, Michigan, Alaska, and from British Columbia and Ontario.

Liriomyza phaseolunata (Frost)

Agromyza phaseolunata Frost, Journ. New York Ent. Soc., vol. 51, p. 256, 1943.

This species has two rows of acrostichals and is therefore closely related to *Liriomyza trifolii* and *L. allia. L. phaseolunata* is more yellow than *L. trifolii* and does not have the black of the occiput reaching the eye margin, and the inner postalar seta is on yellow. In contrast to *L. allia.* the mesonotum is subshining and not pollinose. The larvae mine the leaves of *Phaseolus limensis* Macfad. in New Jersey.

Liriomyza pictella (Thomson)

Agromyza pictella Thomson, Diptera, *in* Kongliga Svenska Fregatten *Eugenies* . . . , vol. 6, pt. 2, p. 609, 1868.
Liriomyza pictella (Thomson), Frick, Pan-Pacific Ent., vol. 33, p. 66, 1957.

Liriomyza pictella is similar to *L. propepusilla* but differs in having the first dorsocentral developed and about one-third as long as the fourth dorsocentral. The anepisternum is about one-half yellow while that of *L. propepusilla* is about three-fourths dark (fig. 116). The larvae form serpentine mines in the leaves of about 16 species of native and cultivated plants throughout California. Frick (1957b) has tabulated all of the host plant and locality records. Since that paper was published I have seen a single specimen from Arizona, swept from alfalfa.

Liriomyza propepusilla (Frost)

Agromyza subpusilla Frost (not Malloch, 1914), Journ. New York Ent. Soc., vol. 51, p. 255, 1943.
Phytomyza subpusilla Frost, Ent. News, vol. 65, p. 73, 1954.
Liriomyza propepusilla Frost, Ent. News, vol. 65, p. 73, 1954.—Frick, Pan-Pacific Ent., vol. 33, p. 62, 1957.

The name of this species erroneously has been associated with the common California leaf miner, *Liriomyza pictella. L. propepusilla* is darker over-all and has the episternum about three-fourths dark (fig.

116). The first dorsocentral is very short and subequal to an acrostichal seta in length. The head (fig. 117), wing (fig. 118), and anepisternum (fig. 116) are illustrated in order to help characterize this species, which is at present known from a single male from Kansas.

Liriomyza quadrisetosa (Malloch)

Agromyza quadrisetosa Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 332, 1913.

The head of this rather diverse species is subtriangular in profile, and the genovertical plate is darkened from the vertex for about one-third of the length and bears one upper-orbital and four or five lower-orbitals (fig. 119). The third antennal segment is black, the femora are totally brown, and the wing has crossvein m-m about one-fourth of its length from r-m. There are specimens from Texas, Indiana, and New York.

Liriomyza reverberata (Malloch), new combination

Agromyza reverberata Malloch, 1924, Canadian Ent., vol. 56, p. 191, 1924.—Frick, Univ. California Publ. Ent., vol. 8, p. 375, 1952.

Of the four specimens mentioned in Malloch's description only one could be found; namely, a female paratype in the Canadian National Collection (No. 3398) labeled "Glen Echo, Maryland, V-14-1922 (J. R. Malloch), *Agromyza reverberata* Paratype." The other specimens were to remain in Malloch's personal collection, or so he stated. The U. S. National Museum acquired Malloch's collection but the types of *Liriomyza reverberata* were apparently missing. Because this species is quite distinct, a neotype designation is unnecessary. Left in *Agromyza* by Frick on the basis of the description, the species belongs in *Liriomyza*.

This species is most closely related to *L. variata* but differs in the short inner postalar seta and in having one or two lower-orbitals. The mesonotum is illustrated to show the color pattern and the fully developed intraalar seta (fig. 120). The wing has vein R_{2+3} undulating (fig. 121). The mesonotum is subshining but not pollinose. There are three specimens from Ontario in the Canadian National Collection together with the paratype from Maryland.

Liriomyza schmidti (Aldrich)

Agromyza schmidti Aldrich, Proc. Ent. Soc. Washington, vol. 31, p. 89, 1929.

This species has the anepisternum entirely yellow, dark basal scutellar triangles present, and both vertical setae arising from the black of the vertex (fig. 122). The wing has the ultimate section of vein M_{1+2} curved (fig. 123). The larvae make serpentine mines in the leaves of *Gliricidia sepium* (Jacq.) (=*G. maculata*) in Costa Rica.

Liriomyza sorosis (Williston), new combination

Agromyza sorosis Williston, Trans. Ent. Soc. London (1896), p. 429, 1896.—Melander (part), Journ. New York Ent. Soc., vol. 21, p. 258, 1913 (2 ♂♂, Texas and Illinois, excluding 1 ♂ from Bolivia).

Agromyza melampyga (Loew), Coquillett (part), U. S. Dep. Agr., Div. Ent. Bull. 10, p. 78, 1898.—Malloch (part), Ann. Ent. Soc. Amer., vol. 6, p. 282, 1913 (specimens from *Plantago* spp.)—Frost, Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 47, 1924.—Frick, Univ. California Publ. Ent., vol. 8, p. 404, 1952.

Lectotype male (British Museum, Natural History) from windward side of St. Vincent, Windward Islands, West Indies, 1907–66 (H. H. Smith). This specimen is labeled "Cotype" while a headless male in the American Museum of Natural History (No. 20332) and a female in the Snow Entomological Museum are each labeled "Type." None of the British Museum syntypes, according to H. Oldroyd, bears the label "Mt. St. Andreas at Cavalries Forest, 1,200 feet. Oct. 16." Such a specimen Williston considered as one of the typical specimens in a series that showed such variation that he mentioned the variation. *Liriomyza sorosis* includes the specimens of *Agromyza melampyga* (of authors) that had been reared from *Plantago major* L., *P. media* L., and possibly other species of *Plantago*.

Liriomyza sorosis is close to *L. marginalis* and *L. barrocoloradensis* but has the mesonotum a uniform dark brown (fig. 124). There are usually four dorsocentrals, but frequently the second is greatly reduced or absent. The head is very similar to that of *L. barrocoloradensis* in having the eye widest above the midline (fig. 125). The type series is from St. Vincent, British West Indies, but specimens have been found in the United States from South Dakota, Illinois, Indiana, Michigan, Pennsylvania, Maryland, Virginia, Florida, and Texas.

Liriomyza trifolii (Burgess)

Oscinis trifolii Burgess, Ann. Rep. U. S. Dep. Agr. (1879), p. 200, 1880.

Liriomyza congesta (Becker), Mitt. Zool. Mus., vol. 2, p. 190, 1903.

Agromyza pusilla (Meigen), Frost (part), Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 51, 1924 (figure of leaf mine on *Trifolium repens*).

This species belongs to the group with only two rows of acrostichal setae. It is slightly darker than *Liriomyza allia* or *L. phaseolunata*, has the black of the occiput reaching the eye margin, and its mesonotum has the inner postalar seta on black. The larvae form serpentine mines in the leaves of many species of legumes in Europe and I have reared it from *Trifolium hybridum* L., *T. repens* L., *Medicago sativa* L., *Melilotus alba* Desr., *M. indica* All., and *Vicia villosa* Roth in Washington. I have seen specimens from Washington, Oregon, California, Indiana, and Florida, but the species is probably present throughout the United States.

Liriomyza tubifer Melander

Liriomyza tubifer Melander, Journ. New York Ent. Soc., vol. 21, p. 266, 1913.

This species is similar to *Liriomyza borealis* in coloration but differs in having the maxillary palpus brown and the gena narrow, posteriorly not more than one-fourth the eye height. The mesonotum has the yellow of the intraalar row reaching anteriorly about two-thirds of the distance to the transverse suture. There is a single female in Melander's collection from Haiti.

Liriomyza variata (Malloch)

Agromyza variata Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 277, 1913 (figure of wing).

The holotype female is in the Museum of Comparative Zoology (No. 27062). This species is close to *Liriomyza reverberata* in having the mesonotum subshining and not pollinose. However, both postalars are subequal in length and the head has the maxillary palpus distally darkened, three lower-orbitals, and the third antennal segment subquadrate and distally darkened (fig. 126). The wing has vein R_{2+3} undulating (fig. 127). Known from a single specimen from Maine.

Liriomyza verbenicola Hering

Liriomyza verbenicola Hering, Notulae Ent., vol. 31, p. 43, 1951.

The holotype female is in the U. S. National Museum (64301). The type is in very poor condition and the head has turned black probably due to slow drying conditions following death. Therefore, the characters used to separate this species from *Liriomyza munda* are on the mesonotum. *L. verbenicola* has a short inner postalar seta (about one-fourth to one-third the outer) and has very few (about five) setulae in the intraalar row posterior to the transverse suture. The larvae form serpentine mines in the leaves of *Verbena* sp. The type series is from New Mexico. Hering has a mined leaf from Salt Lake City, Utah, that he identified with this species.

8. Genus *Metopomyza* Enderlein

Metopomyza Enderlein, Tierw. Mitteleuropas, vol. 6, No. 3, p. 180, 1936.

This is a small genus closely related to *Liriomyza*. There are about seven Palaearctic species and one from North America. *Metopomyza* is characterized by the wide, prominent genovertical plates that are abruptly raised above the plane of the frontal vitta (fig. 128). *Liriomyza deceptiva* has these plates prominent but they are proportionately narrower except immediately dorsad of the antenna (fig. 104). Species included here are mostly black or dark brown and usually have some yellow markings. There are a few *Liriomyza* species that are as dark colored.

Metopomyza interfrontalis (Melander)

Agromyza interfrontalis Melander, Journ. New York Ent. Soc., vol. 21, p. 263, 1913.

Thus far the only species of *Metopomyza* known in North America, it may be distinguished from *Liriomyza* species by the broad, prominent genovertical plates (fig. 128). This is a shining black species that has the frontal vitta dark yellow, scutellum medially yellow, calypter with margin and fringe yellow, some abdominal tergites posteriorly yellow, and all femora distally yellow for a distance subequal to the femoral diameter. No larval host plants are known. I have seen specimens from the northern half of California, Washington, Texas, Kansas, Illinois, Michigan, and Virginia. There are many specimens in the Canadian National Collection.

9. Genus *Haplomyza* Hendel

Antineura Melander (not Osten Sacken, 1881), Journ. New York Ent. Soc., vol. 21, p. 219, 1913.

Haplomyza Hendel, Ent. Mitt., vol. 3, p. 73, 1914.

The characters used in the key to separate *Haplomyza* from *Liriomyza* appear superficial. However, with the combination of four characters—(1) mesonotum dull, heavily gray pollinose, (2) two sparse rows of acrostichals, (3) crossvein m-m absent, and (4) only one upper-orbital (fig. 129)—go wide and clearcut differences in the male terminalia and posterior spiracles of the larvae. Certain species of *Liriomyza* in Europe have as many as three of the characters occurring together. Among North American *Liriomyza* not more than any two occur together. On the basis of this restricted concept of characters for *Haplomyza* species, *Antineura chlamydata* Melander belongs in *Liriomyza* because the mesonotum is shining and there are four rows of acrostichals and two upper-orbitals.

Haplomyza is a small genus with three North American species. Of the Palaearctic species described by Hendel (1931) only one, *Liriomyza deficiens* (Hendel), appears to belong here. *Haplomyza lopesi* Oliveira and Silva (1954) from Brazil seems to be properly placed.

Key to the described species of *Haplomyza*

1. Inner postalar seta arising from black; scutellum with basal scutellar seta arising from large lateral black triangle 2
   Inner postalar seta arising from yellow; scutellum broadly yellow, basal scutellar arising from yellow . . . . **palliata**

2. Third antennal segment yellow; scutellum about one-half yellow, distal scutellar seta arising from yellow . . . . **togata**
Third antennal segment brownish on distal one-third; scutellum about one-third yellow, distal scutellar arising from black . . . . **minuta**

Haplomyza minuta (Frost)

Phytomyza minuta Frost (part), Mem. Cornell Univ. Agri. Exp. Sta., vol. 78, p. 86, 1924 (1 ♀, Fargo, N. Dak.).
Haplomyza minuta (Frost), Frick, Canadian Ent., vol. 85, p. 73, 1953.

This is the darkest of the three species. The third antennal segment is distally brownish and the scutellum is not more than one-third yellow. The larvae make serpentine-blotch mines in the leaves of *Chenopodium album* L. in Washington. The lectotype female is from Fargo, N. Dak.

Haplomyza palliata (Coquillett)

Phytomyza palliata Coquillett, Journ. New York Ent. Soc., vol. 10, p. 191, 1902.

The yellowest of the three species, *Haplomyza palliata* has the black of the occiput not reaching the eye margin, the inner postalar seta on yellow, and the basal scutellar seta on yellow. The larvae mine in *Portulaca* sp. in New Mexico.

Haplomyza togata (Melander)

Antineura togata Melander, Journ. New York Ent. Soc., vol. 21, p. 250, 1913.
Phytomyza minuta Frost (part), Mem. Cornell Univ. Agri. Exp. Sta., vol. 78, p. 86, 1924 (3, New Mexico, Texas, and Bismarck, N. Dak.).—Frick, Canadian Ent., vol. 85, p. 73, 1953.

Haplomyza togata is intermediate between the more yellow *H. palliata* and the darker *H. minuta*. The third antennal segment is yellow, the inner postalar is on black, and the scutellum has the basal seta arising from black and the distal from yellow. The head is illustrated to show the single reclinate upper-orbital (fig. 129). The larvae form serpentine-blotch mines in the leaves of *Amaranthus hybridus* L. and *A. retroflexus* L. The species is apparently widespread, with identified specimens from Washington, California, New Mexico, Texas, Kansas, and North Dakota.

10. Genus *Phytoliriomyza* Hendel

Phytoliriomyza Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 203, 1931 (as subgenus).

This genus is characterized by having the orbital setulae proclinate and the costa ending at vein M_{1+2}. *Phytoliriomyza*, as its name suggests, together with the closely related *Xyraeomyia* form a connecting link between the more generalized genera and the more specialized genera related to *Phytomyza* (Frick, 1952). The head shape is very similar throughout the genus and is much like that of *Xyraeomyia conjunctimontis* (fig. 130). *Phytoliriomyza* may be separated from *Xyraeomyia* by the fully developed axillary lobe and calypter and the presence of acrostichal setae and crossvein m-m.

Phytoliriomyza is a small but widely distributed genus. There are three species from North America, two from Europe, and one each from extreme southern South America, Formosa, and Hawaii. Frick (1953b) gave a key to the species of the world known at that time. Since then the correct status of *P. arctica* (Lundbeck), *P. immaculata* (Coquillett), and *P. imperfecta* (Malloch) has been determined.

Key to the described species of *Phytoliriomyza*

1. Eye bare; anepisternum mostly yellow with a ventral dark area 2
   Eye setulose; anepisternum gray, dorsally narrowly yellow . . . . . **arctica**
2. Vein M_{3+4} with ultimate section about 1.5 times as long as penultimate section; abdominal tergites gray in lateral view . . . . **immaculata**
   Vein M_{3+4} with ultimate section about twice as long as penultimate section; abdominal tergites yellow in lateral view . . . . **perpusilla**

Phytoliriomyza arctica (Lundbeck)

Agromyza arctica Lundbeck, Vidensk. Medd. Naturh. For. Kjøbenhavn, vol. 5, p. 304, 1900 (figure of wing).

Phytoliriomyza arctica (Lundbeck), Shewell, Canadian Ent., vol. 85, p. 469, 1953.

This species is unique among North American species of *Phytoliriomyza* in having the eye setulose and the anepisternum mostly dark gray. *P. montana* Frick of Hawaii is the most similar species but has the maxillary palpi black while they are yellow in *P. arctica*. No larval host plants are known. Lundbeck notes that the species is found especially in willow thickets along the west coast of Greenland as far north as latitude 69°. The types are from Greenland and I have seen two specimens from Yale and Bear Lake, British Columbia.

Phytoliriomyza immaculata (Coquillett)

Odinia immaculata Coquillett, Journ. New York Ent. Soc., vol. 10, p. 185, 1902.

Agromyza immaculata (Coquillett), Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 289, 1913 (figure of wing).

Agromyza perpusilla (Meigen), Melander, Journ. New York Ent. Soc., vol. 21, p. 257, 1913.

The holotype of *Phytoliriomyza immaculata* is teneral and therefore easily confused with the more yellowish *P. perpusilla*. The abdominal tergites of *P. immaculata* are dark when viewed laterally as contrasted with the laterally yellow tergites of *P. perpusilla*. Also, the ultimate section of M_{3+4} is shorter (1:1.5 vs. 1:2) in *P. immaculata*. This species is widespread and I have seen specimens from California, Washington, Idaho, New Mexico, South Dakota, Minnesota, Kansas, Oklahoma, Missouri, Michigan, Indiana, Kentucky, Tennessee, Maryland, and New Hampshire as well as from British Columbia and Manitoba.

Phytoliriomyza perpusilla **(Meigen)**

Agromyza perpusilla Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 6, p. 181, 1830.

Phytoliriomyza perpusilla (Meigen), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 303, 1931 (figures of head and wing).—Frick, Univ. California Publ. Ent., vol. 8, p. 411, 1952 (figure of wing).

This is the most yellow of the three species and the abdominal tergites are mostly yellow when viewed laterally. The wing has the ultimate section of M_{3+4} twice as long as the penultimate. Apparently rare, I have seen specimens from California, Washington, Montana, and New Mexico.

11. Genus *Xyraeomyia* Frick

Xyraeomyia Frick, Univ. California Publ. Ent., vol. 8, p. 412, 1952 (figure of wing).

This genus was erected for a single species that is very closely related to *Phytoliriomyza*. *Xyraeomyia* and *Phytoliriomyza* form a connecting link between the more generalized genera and the more specialized genera related to *Phytomyza* (Frick, 1952). However, *Xyraeomyia* is the more specialized of the two in having the axillary lobe and calypter greatly reduced, crossvein m–m absent, and no acrostichals. The head has the eye forwardly inclined, the orbital setulae proclinate, and a relatively long arista (fig. 130).

Xyraeomyia conjunctimontis **Frick**

Xyraeomyia conjunctimontis Frick, Univ. California Publ. Ent., vol. 8, p. 413, 1952 (figure of wing).

This is a small species (1.15 to 1.3 mm. in wing length) that is yellow and brown, the latter being dull gray pollinose. The head has the eye forwardly inclined and an extremely long arista (fig. 130). The arista is slightly longer than the eye is high. The eye is setulose but the setulae are very short. There are no setulae on the mesonotum other than in the dorsocentral rows and the calypter is reduced to a narrow strip with brown margin and fringe. The type series, from central California, was swept.

12. Genus *Phytagromyza* Hendel

Phytagromyza Hendel, Arch. Naturg., Abt. A, vol. 84, p. 145, 1920.

This is a moderately large genus of species that vary widely from one another. They all have in common the orbital setulae either absent or reclinate (fig. 131), the costa ending at R_{4+5}, crossvein m–m absent or, when present, distad of crossvein r–m (fig. 134). In fact, the position of m–m and the presence or absence of the basal section of M_{3+4} are the only characters that separate all species of *Phytogromyza* from *Pseudonapomyza*. In *Pseudonapomyza*, m–m is basal to r–m and appears to be the basal section of M_{3+4} (fig. 135). There are species in *Phytagromyza* that lack the orbital setulae and have only one upper-orbital, one to five lower-orbitals, the third antennal segment as angulate as it is in *Pseudonapomyza* (fig. 136), two to seven dorsocentrals, and the intraalar and prescutellar setae present or absent. The larvae of the type species, *Phytogromyza flavocingulata* (Strobl), mine the leaves of grasses. The larvae of *Pseudonapomyza* species mine exclusively in species of Gramineae.

Phytagromyza and *Pseudonapomyza* are the only genera in the *Phytomyza* group that have the orbital setulae erect or reclinate. The group of genera closely related to *Phytomyza* has the costa ending at R_{4+5}, and M_{1+2} is the weakest vein (figs. 134, 145).

There are only five described species in North America, three of which are Nearctic in distribution and two are Holarctic. There are about 27 species described from the Palaearctic region.

Key to the described species of *Phytagromyza*

1. Crossvein m–m present (fig. 134) 2
   Crossvein m–m absent 4
2. Mouthparts not elongate, in length less than the eye height (fig. 133); mesonotum dull black, grayish pollinose 3
   Mouthparts elongate, in length subequal to the eye height (fig. 131); mesonotum shining dark brown . . . . **nitida**
3. Head with two or three orbital setulae (fig. 133); notopleural triangle yellow. **plagiata**
   Head with six or seven orbital setulae; notopleural triangle brown . **lonicerae**
4. Veins R_{4+5} and M_{1+2} with wing tip between them; head, pleura, and legs mostly dark brown . . . . **orbitalis**
   Vein M_{1+2} at wing tip; head, pleura, and legs yellow . . . . . . **populicola**

Phytagromyza lonicerae **(Robineau-Desvoidy)**

Phytomyza lonicerae Robineau-Desvoidy, Rev. Mag. Zool., ser. 2, vol. 3, p. 396, 1851.

Phytagromyza lonicerae (Robineau-Desvoidy), Hering, Notulae Ent., vol. 31, p. 36, 1951 (figures of larval and puparial characters).

This dark Holarctic species has the mesonotum dull black and grayish pollinose and the notopleural triangle dark brown. There are about six developed dorsocentral setae, the head is dark except for the yellow dorsal half of the frontal vitta, and the eye is about four-fifths as long as high. The larvae form very wide serpentine mines in the leaves of *Lonicera involucrata* Banks and *Symphoricarpos albus* (L.) Blake. The larvae appear early in the spring and there is only one generation a year. I have seen no specimens other than my reared series from central California.

Phytagromyza nitida (Malloch)

Agromyza nitida Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 288, 1913 (figures of head and wing).

A diverse species having the mouthparts elongate, *Phytagromyza nitida* is distinct from other North American species. The head is partially yellow and has the eye much higher than long, only the dorsal upper-orbital reclinate, and the mouthparts elongate (fig. 131). There are only two developed dorsocentral setae. No larval host plants are known. I have seen specimens from Iowa, Illinois, Maryland, Virginia, and North Carolina.

Phytagromyza orbitalis (Melander)

Phytomyza orbitalis Melander, Journ. New York Ent. Soc., vol. 21, p. 271, 1913.

Phytagromyza orbitalis and *P. populicola* lack crossvein m-m, but *P. orbitalis* has the genovertical plates yellow in contrast to the darker frontal vitta, head, and antenna (fig. 132), dark brown mesonotum, pleura, and legs, and the wing tip between R_{4+5} and M_{1+2}. In common with *P. plagiata* and *P. lonicerae* there are about six developed dorsocentral setae. The larvae form blotch mines in the leaves of *Symphoricarpos albus* (L.), *S. mollis* Nutt., and *S. rotundifolius* Gray. I have seen mined leaves on *Symphoricarpos* at Kamiac Butte, Wash., the type locality. Thus far *P. orbitalis* is known from Washington, Idaho, and California.

Phytagromyza plagiata (Melander)

Napomyza plagiata Melander, Journ. New York Ent. Soc., vol. 21, p. 273, 1913.
Agromyza brevicostalis Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 283, 1913.

This species, in common with *Phytagromyza lonicerae*, has crossvein m-m present, mouthparts not elongate (fig. 133), and mesonotum dull grayish pollinose with about six developed dorsocentral setae. It may be distinguished by the head having the gena mostly yellow and the two or three orbital setulae (fig. 133). The notopleural triangle is yellow. Larval host plants are unknown and the species is known from two specimens, one from Idaho and the other from Montana.

Phytagromyza populicola (Walker)

Phytomyza populicola Haliday (MS), Walker, Insecta Britannica, Diptera, vol. 2, p. 247, 1853.—Hendel, Arch. Naturg., Abt. A, vol. 84, p. 154, 1920.
Phytomyza populicola Walker, Kaltenbach, Die Pflanzenfeinde aus der Insekten, p. 560, 1874.—Becker, *in* Becker, Bezzi, et al., Katalog paläarktischen Dipteren, vol. 4, p. 258, 1905.
Phytagromyza populicola (Haliday), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 289, 1932 (figure of head).

This species should be credited to Walker because Haliday did not publish a description. *Phytagromyza populicola* is a small yellow species without crossvein m-m in the wing. It may be separated from *P. orbitalis* by the yellow head, antenna, pleura, and legs. The mesonotum is yellow with three light reddish brown vittae and vein M_{1+2} ends at the wing tip. E. M. Hering collected the greenish blotch mines on leaves of *Populus deltoides* Marsh. in Ontario and he identified adults in the Canadian National Collection from Ottawa, Ontario. G. E. Shewell kindly presented me with six adults and six larvae. He reports that this species suddenly appeared in large numbers for the first time in 1956.

13. Genus *Pseudonapomyza* Hendel

Pseudonapomyza Hendel, Arch. Naturg., Abt. A., vol. 84, p. 115, 1920.

Pseudonapomyza belongs to the *Phytomyza* group of genera but is most closely related to *Phytagromyza* in having the orbital setulae reclinate (fig. 136). The species of *Phytagromyza* are so diverse that all of the *Pseudonapomyza* characters but one are to be found among one or more of the *Phytagromyza* species. *Pseudonapomyza* may be separated from *Phytagromyza* by having crossvein m-m basad of crossvein r-m and appearing to be the basal section of M_{3+4} (fig. 135). The wings of *Phytagromyza* species have m-m distal to r-m (fig. 134), or absent.

There are three very similar species in the world. *Pseudonapomyza atra* is Holarctic, *P. lacteipennis* is Nearctic, and *P. spicata* (Malloch) is found on Formosa and throughout Micronesia and Hawaii. *P. spicata* may be separated from the other two by the black tarsi, shining mesonotum, and the presence of both the inner postalar and intraalar setae. All three species have one upper-orbital, three or four lower-orbitals, the third antennal segment strongly angulate (fig. 136), three dorsocentrals, and the wing as described and illustrated (fig. 135). The larvae of two species, *P. atra* and *P. spicata*, mine the leaves of grasses and have a row of elongate spines on each body segment.

Key to the described species of *Pseudonapomyza*

1. Tarsi dark brown or black; mesonotum subshining, slightly gray pollinose, one intraalar seta and no inner postalar. . . . . **atra**
   Tarsi with basal four segments yellowish, distal segment dark brown; mesonotum dull, bluish pollinose, no intraalar and one inner postalar. **lacteipennis**

Pseudonapomyza atra (Meigen)

Phytomyza atra Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 6, p. 191, 1830.

Pseudonapomyza atra (Meigen), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 302, 1932 (figures of head and wing).

Phytomyza acuticornis Loew, Wiener Ent. Monatsschr., vol. 2, p. 78, 1858.

Phytomyza nitidula Malloch, Proc. U. S. Nat. Mus., vol. 46, p. 151, 1913.

This is a subshining black species that has the tarsi dark brown or black. The mesonotum is only slightly gray pollinose and bears an intraalar seta but lacks the inner postalar. The head is very similar to that of *Pseudonapomyza lacteipennis* (fig. 136). The larvae mine the leaves of many grasses in Europe and I have reared it from *Agropyron repens* (L.) and *Secale cereale* L. in Washington.

***Pseudonapomyza lacteipennis* (Malloch)**

Phytomyza lacteipennis Malloch, Proc. U. S. Nat. Mus., vol. 46, p. 152, 1913.
Phytomyza acuticornis (Loew), Melander, Journ. New York Ent. Soc., vol. 21, p. 269, 1913.

This species is unusual in having the basal four tarsal segments yellowish. The mesonotum is dull black and heavily bluish pollinose and lacks an intraalar but bears the inner postalar seta. The head (fig. 136) is typical for a species of this genus in having the third antennal segment angulate, only one upper-orbital seta, and three or four lower-orbitals. No larval host plants are known but they are probably grasses. I have seen specimens from Washington, New Mexico, Kansas, North Dakota, and Michigan. This species is apparently common and widespread in North America.

14. Genus *Napomyza* Westwood

Napomyza Westwood, An introduction to the modern classification of insects, vol. 2, p. 152, 1840.

Napomyza is a small genus separated from *Phytomyza* by the presence of crossvein m-m. Like *Phytomyza*, the orbital setulae are proclinate (fig. 137). There are about 20 Palaearctic species, one of which is found in North America. There are three in the Nearctic region, with *N. lateralis* being Holarctic in distribution. None is known from the Neotropical region. *Napomyza anomala* of Melander is deleted because Melander's specimen is incorrectly identified.

Key to the described species of *Napomyza*

1. Acrostichal setae in two irregular rows 2
   Acrostical setae in four or five irregular rows . . . . **davisii**
2. Wing with vein M_{1+2} ending at wing tip; maxillary palpus not broadened distally . . . . **lateralis**
   Wing with tip between R_{4+5} and M_{1+2}; maxillary palpus expanded distally to about one-half the diameter of the third antennal segment (fig. 138). **parvicella**

***Napomyza davisii* (Walton)**

Agromyza davisii Walton, Ent. News, vol. 23, p. 463, 1912.—Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 284, 1913 (figure of wing).

This is a valid species and may be separated from the other two *Napomyza* species by having four or five rows of acrostichal setae and the genovertical plates not extending beyond the eye margin (fig. 137). Crossvein m-m is beyond r-m. The larvae mine the leaves of *Ranunculus* spp. I have seen specimens from Missouri, Indiana, Michigan, Wisconsin, and from Ontario.

Napomyza lateralis (Fallén)

Phytomyza lateralis Fallén, Diptera sueciae, vol. 2, No. 41 (Phytomyzides), p. 3, 1823.

Napomyza lateralis (Fallén), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 315, 1932 (figures of head and wing).

Napomyza lateralis is a Holarctic species that has two rows of acrostichal setae which separate it from *N. davisii*. From *N. parvicella*, *N. lateralis* may be distinguished by the maxillary palpus not being broadened distally and vein M_{1+2} being at the wing tip. In Europe the larvae mine in the receptacles and the pith of stems of many annual plants. In North America, this species was reared from *Achillea millefolium* var. *lanulosa* Piper in California. I have seen specimens from California, Oregon, Colorado, and Alaska.

Napomyza parvicella (Coquillett)

Agromyza parvicella Coquillett, Journ. New York Ent. Soc., vol. 10, p. 189, 1902.—Malloch, Ann. Ent. Soc. Amer., vol. 6, p. 287, 1913 (figures of head and wing).

Napomyza parvicella differs from *N. davisii* in having only two rows of acrostichals and the genovertical plates extending beyond the eye margin (fig. 138). The maxillary palpus is broadened and the wing tip is between veins R_{4+5} and M_{1+2}, characters which serve to separate *N. parvicella* from *N. lateralis*. The eye is setulose. Known from one female from Alaska.

15. Genus *Phytomyza* Fallén

Phytomyza Fallén, Specimen entomologicum novam Diptera disponendi methodum exhibens, p. 21 (No. 67), 1810 (figure of wing).

The most specialized North American genus, *Phytomyza* has the orbital setulae proclinate (fig. 139), crossvein m-m absent, and M_{1+2} the weakest vein (fig. 145). *Napomyza* is the only closely related genus and is separated by having crossvein m-m present.

There are only 39 described *Phytomyza* species in North America as compared to the 201 listed for the Palaearctic region in 1936 by Hendel. Since that time many more European species have been described. The North American species are rather evenly distributed throughout the genus as divided in Hendel's key. The first species to be separated out by the use of that key to Palaearctic species is *P. trivittata* (couplet 7), while the last is *P. loewii*, which keys out at the last couplet (No. 236).

The only closely related species that could be placed into a species group are those that are very similar to *P. ilicicola* (couplet 36). The larvae of these four species mine the leaves of woody shrubs and trees such as *Symphoricarpos* spp. (*P. periclymeni*), *Lonicera* spp. (*P. gregaria*), *Prunus* spp. (*P. persicae*), and *Ilex* spp. (*P. ilicicola*).

The following species names are not included in the present species list because I have found no specimens that agree with European specimens. These species are: *P. affinis* Fallén, *P. analis* Zetterstedt, *P. hieracii* Hendel, *P. nigritella* Zetterstedt, and *P. obscurella* Fallén.

Key to the described species of *Phytomyza*

1. Frons yellow, light orange, or reddish yellow 2
   Frons all or mostly brown or black, sometimes yellowish dorsally 29
2. Scutellum all or partially yellow 3
   Scutellum gray or black 6
3. Third antennal segment black or dark brown 4
   Third antennal segment yellow . . . . **major**
4. Head with dorsal upper-orbital seta shorter than the ventral upper orbital, or absent (fig. 147) 5
   Head with both upper-orbitals of equal length and strength (fig. 168) . **trivittata**
5. Vein R_{2+3} undulating, M_{1+2} straight or distally only slightly curved posteriorly; one lower-orbital . . . . **ranunculi**
   Vein R_{2+3} straight, M_{1+2} undulating medially (fig. 148); two lower-orbitals (fig. 147) . . . . **clemativora**
6. Femora entirely or mostly yellow, at most with brown streaks or spots . . 7
   Femora black or gray, sometimes distally yellow for a distance subequal to the femoral diameter 10
7. Antenna yellow, third segment sometimes darkened distally 8
   Antenna with third segment black, first and second yellow . . . . **nervosa**
8. Mesonotum heavily dull gray pollinose; head with two upper-orbital setae . 9
   Mesonotum shining black; only one upper-orbital . . . . **flavicornis**
9. Anepisternum three-fourths dull gray, dorsal one-fourth and a very narrow posterior margin yellow . . . . **rufipes**
   Anepisternum yellow, except for a ventral light brown triangle of about one-half the height and width of the anepisternum . . . . **genalis**
10. Third antennal segment yellow, sometimes darkened distally (fig. 152) . . 11
    Third antennal segment black 12
11. Third antennal segment setulose (fig. 144); intraalar row with two or three setulae anterior to and two or three posterior to the transverse suture . . . . **auricornis**
    Third antennal segment bare (fig. 152); intraalar row with about four or five anterior to and about six posterior to the transverse suture. **flavinervis**
12. Mesonotum laterally yellow, including humerus and notopleural triangle . . 13
    Mesonotum laterally brown or black 16
13. Head with both upper-orbital setae of equal length and strength (fig. 164) . . 14
    Head with dorsal upper-orbital seta shorter than the ventral, or absent . . . 15
14. Tarsi brown; mesonotum dull gray pollinose; gena medially about two-fifths as high as the eye height (fig. 149) . . . . **delphinii**
    Tarsi yellow; mesonotum subshining brown; gena medially about one-eighth the eye height (fig. 164) . . . . **plumiseta**

15. Anepisternum dorsally one-third to one-half yellow; only one developed upper-orbital seta . . . . **albiceps**
Anepisternum dark, dorsally not more than one-fourth yellow; two developed upper-orbitals . . . . **sphondylii**

16. Head with dorsal upper-orbital shorter than the ventral upper-orbital (fig. 140), or absent 17
Head with both upper-orbitals or equal length and strength (fig. 166) . . 18

17. Genovertical plates darkened (fig. 140); intraalar row with six to nine setulae anterior to and about five posterior to the transverse suture . . **angelicella**
Genovertical plates yellow (fig. 141); intraalar row with 10 to 12 setulae anterior to and about 13 to 15 posterior to the transverse suture . **aquilegiana**

18. Acrostichal setae in two to five rows 19
Acrostichal setae in six to eight rows (see also couplet 33) . . . . . **ilicis**

19. Acrostichal setae in two rows or absent 20
Acrostichal setae in four or five rows . . . . **aquilegiana**

20. Mesofacial plate, including subantennal grooves, brown or black 21
Mesofacial plate yellow, not more than the subantennal grooves dark . . . 23

21. Eye bare 22
Eye setulose . . . . **nigra**

22. Mesonotum without acrostichal setae or with not more than one to four; one lower-orbital present (see also couplet 26). . . . . **atricornis**
Mesonotum with about 14 acrostichals in two rows; three lower-orbitals present . . . . **affinalis**

23. Forecoxa dark, distally yellow 24
Forecoxa entirely dark 26

24. Antenna with first and second segments yellowish; arista not greatly expanded (fig. 166) 25
Antenna with first and second segments brown or black; arista greatly expanded . . . . **crassiseta**

25. Head with two strong lower-orbital setae (fig. 166); inner postalar seta present . . . . **subtenella**
Head with one strong lower-orbital, sometimes with a very small second; inner postalar absent . . . . **plantaginis**

26. Mesonotum with at least eight acrostichal setae in two rows. 27
Mesonotum without acrostichal setae, or with not more than one to four (see also couplet 22) . . . . **atricornis**

27. Third antennal segment with setulae not longer than the basal diameter of the arista (fig. 150) 28
Third antennal segment with setulae two to three times as long as the basal diameter of the arista (fig. 156) . . . . **lactuca**

28. Mesonotum with about 15 acrostichal setae; vein M_{1+2} gently undulating (fig. 143) . . . . **atripalpis**
Meonotum with about nine acrostichal setae; vein M_{1+2} straight (fig. 151) . . . . **dura**

29. Head with both upper-orbital setae of equal length and strength (fig. 159) . 30
Head with dorsal upper-orbital shorter than the ventral upper-orbital (fig. 157), or absent 39

30. Antenna dark brown or black; tarsi and tibiae black, brown or dark reddish brown 31
Antenna with first, second, and basal portion of third reddish yellow; tarsi and distal portion of tibiae yellow. . . . . **agromyzina**

31. Acrostichal setae in two rows 32
    Acrostichal setae in four to eight rows 33
32. Third antennal segment subcircular (fig. 160); first dorsocentral seta about twice as far from the transverse suture as is the second . . . . **melanella**
    Third antennal segment subrectangular, longer than wide (fig. 159); first and second dorsocentral setae about equidistant from the transverse suture. **marginalis**
33. Acrostichal setae in four or five rows 34
    Acrostichal setae in six to eight rows (see also couplet 18) . . . . . . **ilicis**
34. Intraalar row with not more than 16 setulae anterior to and not more than five posterior to the transverse suture; abdomen mostly dark 35
    Intraalar row with about 24 setulae anterior to and about 12 posterior to the transverse suture; abdomen mostly yellow . . . . **bicolor**
35. Forefemur distally yellow to reddish brown; wing veins basally yellow to light brown; wing length not exceeding 2.25 mm 36
    Forefemur entirely black; wing veins basally black; wing length 2.5 to three mm . . . . **nigrinervis**
36. Acrostichal setae extending posteriorly to the third dorsocentral 37
    Acrostichal setae extending posteriorly to the fourth dorsocentral 38
37. Eye, viewed in profile, with length at most three-fourths the eye height; mesonotum dull brownish black . . . . **gregaria**
    Eye, viewed in profile, with length subequal to eye height; mesonotum dull bluish black . . . . **periclymeni**
38. Forefemur distally reddish brown; mesonotum black, dull grayish pollinose. **persicae**
    Forefemur distally yellow; mesonotum brown, dull bluish pollinose . **ilicicola**
39. Head with one or two upper-orbital setae; one or two lower-orbitals; wing length up to 2 mm 40
    Head with one upper-orbital seta; three lower-orbitals; wing length at least 3 mm . . . . **nigripennis**
40. Intraalar row with at least three setulae posterior to the transverse suture; inner postalar about one-half as long as the outer 41
    Intraalar row with none to one setula posterior to the transverse suture; inner postalar small, up to one-third the length of the outer, or absent. **minuscula**
41. Forefemur distally brown; wing with second costal section about 1.5 times as long as the fourth (fig. 145) . . . . **centralis**
    Forefemur distally yellow; second costal section at least two times as long as the fourth (fig. 158) . . . . **loewii**

Phytomyza affinalis Frost

Phytomyza affinalis Frost, Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 84, 1924.

The holotype male is in the U. S. National Museum (No. 50025). This species has the frons yellow, mesofacial plate dark, third antennal segment, mesonotal margins, scutellum, and femora dark, and both upper-orbitals of equal length and strength. It differs from *Phytomyza atricornis* in having about 14 acrostichals in two rows and the head bearing three lower-orbitals and a wide gena (fig. 139). The type series is from Saskatchewan.

Phytomyza agromyzina Meigen

Phytomyza agromyzina Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 6, p. 191, 1830.—Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 336, 1934 (figures of head and wing).

This is a rather distinctive Holarctic species that has the frons dark and both upper-orbitals of equal length, the antenna mostly reddish yellow, and the tarsi and tibiae yellow. The larvae make serpentine mines in the leaves of *Cornus* spp. Thus far known in North America only from California and Washington.

Phytomyza albiceps Meigen

Phytomyza albiceps Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 6, p. 194, 1830.—Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 337, 1934 (figures of head and wing).

Phytomyza albiceps sens. str. is not well known in North America. It belongs to those species having a yellow frons, dark third antennal segment, scutellum, and femora, and the mesonotum bordered with yellow. The dorsal upper-orbital is absent, or, if present, not developed and about the size of an orbital setula. The minute or absent dorsalmost orbital and the one-third to one-half yellow anepisternum separate this species from *P. sphondylii.* The larvae make serpentine mines in the leaves of *Artemisia* spp. that are rather distinctive. Most mines are partially along the midrib and have the frass in two alternating lines of pellets. I have reared this Holarctic species from *Artemisia vulgaris* L. in California.

Phytomyza angelicella Frost

Phytomyza angelicella Frost, Ann. Ent. Soc. Amer., vol. 20, p. 218, 1927.

This species and *Phytomyza aquilegiana* belong to the assemblage of species having a yellow frons, dark third antennal segment, mesonotal margins, scutellum, and femora, and the dorsal upper-orbital shorter than the ventral. This species is distinguished from *P. aquilegiana* by having the genovertical plates dark (fig. 140) and relatively few setulae in the intraalar row (six to nine anterior to the suture and about five posterior). The larvae form linear mines in the leaves of *Angelica atropurpurea* in New York.

Phytomyza aquilegiana Frost

Phytomyza aquilegiae (Hardy), Melander (part), Journ. New York Ent. Soc., vol. 21, p. 271, 1913 (1 ♀, Moscow Mountain, Idaho).

Phytomyza bipunctata (Loew) Melander (part), Journ. New York Ent. Soc., vol. 21, p. 271, 1913 (1 ♀, Avon, Idaho).

Phytomyza plumiseta Frost (part), Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 87, 1924 (specimens from *Aquilegia* sp.).

Phytomyza aquilegiana Frost, Ann. Ent. Soc. Amer., vol. 23, p. 459, 1930 (figures of puparium and mined leaves).

The holotype male is in the U. S. National Museum (No. 50023). This is a common species that is similar to *Phytomyza angelicella* in having a yellow frons, dark third antennal segment, mesonotal margins, scutellum, and femora, and the dorsal upper-orbital usually shorter than the ventral (fig. 141). The length of this seta is variable and it varies from as long as the ventral upper-orbital to three-fifths its length. There is usually a very small third lower-orbital and the genovertical plates are yellow (fig. 141). The mesonotum bears four to five rows of acrostichals, and the intraalar row has numerous setulae (10 to 12 anterior to the suture and 13 to 15 posterior to it). The larvae form blotch mines in the leaves of *Aquilegia* spp. and *Thalictrum* spp. I have seen specimens from California, Washington, Idaho, Pennsylvania, and New York.

Phytomyza atricornis **Meigen**

Phytomyza atricornis Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 7, p. 404, 1838.—Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 353, 1934 (figures of head and wing).

Phytomyza chrysanthemi Kowarz, *in* Lintner, Report of the State Entomologist, *in* 44th Ann. Rep. New York State Mus., p. 243, 1892.—Smulyan, Massachusetts Agr. Exp. Sta. Bull. 157, p. 21, 1914 (figures of all instars and mined leaves).

This species is probably the most widespread and omnivorous in the Agromyzidae. It has the frons yellow, third antennal segment, mesonotal margins, scutellum, and femora dark, and both upper-orbitals of equal length and strength. The mesofacial plate may be dark or it may be yellow with the subantennal grooves dark. There is only one lower-orbital. The acrostichals are frequently absent but some specimens have one to four. The larvae form serpentine mines in the leaves of many plants. There are 27 larval host plants listed in the table at the end of this paper. Nearly 300 more larval host plants are known in Europe (Hendel, 1934). I have seen reared specimens from California, Oregon, Washington, Massachusetts, and from British Columbia.

Phytomyza atripalpis **Aldrich**

Phytomyza atripalpis Aldrich, Proc. Ent. Soc. Washington, vol. 31, p. 89, 1929.

This is a moderately large species (2.25 mm. in wing length) that has the frons yellow, the third antennal segment, mesonotal margins, scutellum, forecoxa, and femora dark. The two upper-orbitals are of equal length and strength (fig. 142) and the mesonotum has two rows of acrostichals. From *Phytomyza dura* this species may be separated by the larger gena (medially two-fifths of the eye height) (fig. 142), about 15 acrostichals, and the wing with M_{1+2} undulating (fig. 143). The larvae mine in the seeds of *Anemone multifida* Poir. Known only from British Columbia.

Phytomyza auricornis **Frost**

Phytomyza auricornis Frost, Ann. Ent. Soc. Amer., vol. 20, p. 217, 1927.

The holotype female is in the U. S. National Museum (No. 50032). *Phytomyza auricornis* and *P. flavinervis* belong with those species having a yellow frons, dark scutellum and femora, and the third antennal mostly yellow. From *P. flavinervis*, *P. auricornis* can be distinguished by its smaller size (2.5 vs. 3 mm. in wing length), the third antennal segment setulose (fig. 144), and the intraalar row barer (2 to 3 vs. 4 to 6 setulae). Known only from the holotype from New York.

Phytomyza bicolor **Coquillett**

Phytomyza bicolor Coquillett, Journ. New York Ent. Soc., vol. 10, p. 191, 1902.

A rather large species (3 mm. in wing length) that has a dark frons, antenna, and tarsi, two equal upper-orbitals, and four or five rows of acrostichals. *Phytomyza bicolor* differs from other closely related species by having the abdomen mostly yellow and the intraalar row of acrostichals very setulose, with about 24 anterior to the suture and 12 posterior to the suture. I have seen three specimens, all from New York.

Phytomyza centralis **Frost**

Phytomyza centralis Frost, Ann. Ent. Soc. Amer., vol. 29, p. 317, 1936.

The holotype male is in the U. S. National Museum (No. 62978). This is a small dark species (about 1.5 mm. in wing length) that has the frons dark, the dorsal upper-orbital small, and with two lower-orbitals. There are at least three setulae in the intraalar row posterior to the transverse suture, and the inner postalar is about one-half as long as the outer; these characters separate this species from *Phytomyza minuscula*. From *P. loewii*, *P. centralis* can be distinguished by its fore-femur being distally brown and the wing having the second costal section about 1.5 times as long as the fourth (fig. 145). The larvae mine the leaves of *Clematis* sp. in Costa Rica.

Phytomyza clemativora **Coquillett**

Phytomyza clemativora Coquillett, Proc. Ent. Soc. Washington, vol. 12, p. 131, 1910.

A relatively small yellow species with yellow frons and scutellum, dark third antennal segment, and with the mesonotum marked with reddish brown (fig. 146). The head is rather denuded, but the dorsal upper-orbital is absent (fig. 147). The frons is wider than long. The mesonotum has the setae as shown, with only about seven acrostichals (fig. 146). The wing has R_{2+3} and R_{4+5} straight and very close together and M_{1+2} undulating medially (fig. 148). Known from two males reared from *Clematis* sp. in southern Texas.

Phytomyza crassiseta Zetterstedt

Phytomyza crassiseta Zetterstedt, Diptera Scandinaviae, vol. 14, p. 6469, 1860.—Melander (part), Journ. New York Ent. Soc., vol. 21, p. 271, 1913 (2 ♀♀, Mount Constitution, and 1 ♀, Chehalis, Wash.; 1 ♀, Collins, Idaho).—Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 387, 1935 (figures of head and wing).

Phytomyza crassiseta is a Holarctic species that has the frons yellow, all three antennal segments, mesonotal margins, scutellum, and femora dark, and both upper-orbitals of equal length and strength. The mesofacial plate is dark and the forecoxa is distally yellow. Characters that separate *P. crassiseta* from closely related species are the dark first and second antennal segments and the greatly expanded arista. The larvae make serpentine mines in the leaves of *Veronica* spp. I have seen specimens from Washington and Idaho. All are females because this species is parthenogenetic.

Phytomyza delphiniae Frost

Phytomyza delphiniae Frost, Canadian Ent., vol. 60, p. 77, 1928.—Griswold, Journ. Econ. Ent., vol. 21, p. 855, 1928.

The holotype female is in the U. S. National Museum (No. 50024). This species belongs with those species having a yellow frons, dark third antennal segment, scutellum, and femora, and the mesonotum laterally bordered with yellow. *Phytomyza delphinii*, like *P. plumiseta*, has both upper-orbitals of equal length. From *P. plumiseta*, this species may be distinguished by the wide gena (medially about two-fifths the eye height) (fig. 149), the brown tarsi, and the mesonotum dull gray pollinose. The larvae form blotch mines in the leaves of *Delphinium cultorum* Voss. I have seen specimens from Ohio, Pennsylvania, and New York.

Phytomyza dura Curran

Phytomyza dura Curran, 1931, Amer. Mus. Nov., No. 492, p. 10, 1931.

Phytomyza dura has a yellow frons, dark third antennal segment, mesonotal margins, scutellum, forecoxa, and femora. The upper-orbitals are of equal length (fig. 150) and there are two rows of acrostichals. From *P. atripalpis* this species can be distinguished by its smaller gena (medially .30 of the eye height) (fig. 150) and by having only about 9 acrostichals and vein M_{1+2} straight (fig. 151). I have seen 16 swept specimens from Quebec.

Phytomyza flavicornis Fallén

Phytomyza flavicornis Fallén, Diptera sueciae, vol. 2, No. 41 (Phytomyzides), p. 4, 1823.—Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 402, 1935 (figures of head and wing).

This is a moderately large Holarctic species (2.3 to 2.6 mm. in wing length) that has yellow frons, dark scutellum, and femora mostly yellow. *Phytomyza flavicornis* is distinct from related species by having one upper-orbital and the mesonotum shining black. *P. rufipes* and *P. genalis* have the mesonotum gray pollinose and *P. nervosa* has the third antennal black. The species has not been reared in North America but the larvae mine the pith of stems of *Urtica dioica* L. in Europe. I have seen specimens from Indiana and Michigan.

Phytomyza flavinervis Frost

Phytomyza flavinervis Frost, Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 85, 1924.

The holotype female is in the U. S. National Museum (No. 50022). This is a large species (3 mm. in wing length) that has the frons yellow, scutellum and femora dark, and the third antennal segment yellow. *Phytomyza flavinervis* may be separated from *P. auricornis* by the bare third antennal segment (fig. 152) and the more setulose (4 to 6 vs. 2 to 3) intraalar row posterior to the transverse suture. The two specimens of the type series are all that are known. They are from Texas.

Phytomyza genalis Melander

Phytomyza genalis Melander, Journ. New York Ent. Soc., vol. 21, p. 272, 1913.

A large species (2.75 to 3.25 mm. in wing length) that has the frons yellow, scutellum dark, and the femora mostly yellow. The third antennal segment is yellow and the mesonotum is gray pollinose. The head has the gena extremely wide and the genovertical plates greatly extending beyond the eye margin (fig. 153). From *Phytomyza rufipes*, *P. genalis* may be separated by its anepisternum being more than one-half yellow and with a ventral brown triangle. I have seen specimens only from Illinois.

Phytomyza gregaria Frick

Phytomyza nigritella (Zetterstedt), Melander, Journ. New York Ent. Soc., vol. 21, p. 270, 1913.

Phytomyza obscurella (Fallén), Melander (part), Journ. New York Ent. Soc., vol. 21, p. 270, 1913 (excluding 1 ♀, Bellingham, Wash.).

Phytomyza gregaria Frick, Ann. Ent. Soc. Amer., vol. 47, p. 371, 1954 (figure of leaf mines).

Phytomyza gregaria is one of a group of four species having the frons, antenna, and tarsi dark, the forefemur distally yellow to reddish brown, two equally strong upper-orbitals, and four or five rows of acrostichal setae. It may be separated from *P. periclymeni*, *P. persicae*, and *P. ilicicola* in having the eye ovoid, at most three-fourths the eye height, the mesonotum dull brownish black, and with the acrostichal setae extending posteriorly to the third dorsocentral. The larvae make serpentine mines in the leaves of *Lonicera involucrata* Banks. As many larvae may be in a single leaf, they frequently form a blotch. My specimens are from California, and Melander's are from Washington and Idaho.

Phytomyza ilicicola Loew

Phytomyza ilicis Loew (not Curtis, 1846), Berliner Ent. Zeitschr., vol. 7, p. 54, 1863 (Centuria III, No. 99).

Phytomyza ilicicola Loew, Berliner Ent. Zeitschr., vol. 16, p. 114, 1872 (Centuria x, p. 290).

Phytomyza ilicicola is one of a group of four species having the frons, antenna, and tarsi dark, the forefemur distally yellow to reddish brown, two equally strong upper-orbitals, and four or five rows of acrostichals. It may be separated from *P. gregaria*, *P. periclymeni*, and *P. persicae* in having the forefemur distally yellow, mesonotum brown, dull bluish pollinose, with the acrostichals extending posteriorly to the fourth dorsocentral. From *P. ilicis* this species may be distinguished by the tan to brown frons, the narrow gena that is medially one-fourth to one-fifth the eye height (fig. 154), acrostichals in about four rows, and the second costal section 1.9 to 2.8 times as long as the fourth (fig. 155). The larvae form serpentine mines in the leaves of *Ilex opaca* Ait., *I. glabra* (L.) Gray, *I. decidua* Walt., and *I. vomitoria* Ait. I have seen specimens from Texas, Alabama, South Carolina, Virginia, District of Columbia, West Virginia, New York, Rhode Island, and Massachusetts.

Phytomyza ilicis Curtis

Phytomyza ilicis Curtis, Gardeners' Chron., July 4, 1846, p. 444, 1846.—Downes and Andison, Journ. Econ. Ent., vol. 33, p. 948, 1941.—Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 417, 1935 (figures of head and wing).

The frons is yellow on the dorsal half and grayish black below. Therefore, this species could be considered as belonging to either part of couplet 1 in the key and is so treated in the key. One of the more distinctive characteristics of this species is the six to eight rows of acrostichals. *Phytomyza ilicis* may be separated from *P. ilicicola* by the following characters: frons about one-half yellow, gena medially about one-third the eye height, acrostichals in six to eight rows, and the second costal section from 3 to 3.8 times as long as the fourth. This is an introduced European species whose larvae make serpentine-blotch mines in the leaves of *Ilex aquifolium* L. Now positively known from Oregon, Washington, and British Columbia.

Phytomyza lactuca Frost

Phytomyza lactuca Frost, Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 85, 1924 (figure of leaf mines); Canadian Ent., vol. 60, p. 77, 1928.—Needham, Frost, and Tothill, Leaf-mining insects, p. 263, 1928 (figure of leaf mine).

This species has the frons yellow and the third antennal segment, mesonotal margins, scutellum, forecoxa, and femora dark. There are two equally strong upper-orbitals and two rows of acrostichals. *Phytomyza lactuca* may be distinguished by the very long setulae on the third antennal segment (fig. 156). The larvae make serpentine mines in the leaves of *Lactuca scariola* var. *integrifolia* (Bogenh.) G. Beck. I have seen specimens from Michigan, New York, and Pennsylvania.

Phytomyza loewii Hendel

Phytomyza clematidis Loew (*not* Kaltenbach, 1859), Berliner Ent. Zeitschr., vol. 7, p. 55, 1863 (Centuria III, No. 100).

Phytomyza loewii Hendel, Konowia, vol. 2, p. 145, 1923.

Phytomyza nitida Melander (part), Journ. New York Ent. Soc., vol. 21, p. 271, 1913 (1 ♀, White Plains, N. Y.; 2 ♂♂, Troy and Bovill, Idaho).

This is a shining dark brown species with the frons dark, the dorsal upper-orbital very small, and the eye ovoid and about two-thirds as wide as high (fig. 157). It is distinguished from *Phytomyza minuscula* by the three setulae in the intraalar row posterior to the transverse suture and the inner postalar being at least one-half as long as the outer. *P. loewii* is close to *P. centralis* but is different in having the forefemur distally yellow and the second costal section of the wing at least twice as long as the fourth (fig. 158). The larvae make serpentine mines in the leaves of *Clematis* spp. and I have reared it from *Clematis ligusticifolia* Nutt. in Washington. I have seen specimens from Washington, Idaho, Indiana, District of Columbia, and Louisiana.

Phytomyza major Malloch

Phytomyza major Malloch, Proc. U. S. Nat. Mus., vol. 46, p. 150, 1913.

This is a large species (3.75 mm. in wing length) that is mostly yellow with the frons and scutellum yellow. The antennae are entirely yellow and the mesonotum has four brown vittae between the rows of setae, two between the dorsocentral rows. Both known specimens are teneral females from Labrador.

Phytomyza marginalis Frost

Phytomyza marginalis Frost, Ann. Ent. Soc. Amer., vol. 20, p. 219, 1927.

The holotype female is in the U. S. National Museum (No. 50030). This species and *Phytomyza melanella* are similar in having dark frons, antenna, and tarsi, two equal-sized upper-orbitals, and the acrostichals in two rows. From *P. melanella* this species can be distinguished by having the third antennal segment subquadrate, the genovertical plates moderately extending beyond the eye margin (fig. 159), and the first and second dorsocentrals equidistant from the transverse suture. Known from two specimens from New York.

Phytomyza melanella Frost

Phytomyza melanella Frost, Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 86, 1924 (figure of wing).

The holotype male is in the U. S. National Museum (No. 50026). This species and *Phytomyza marginalis* are quite similar in having the frons, antenna, and tarsi dark, both upper-orbitals of equal length, and two rows of acrostichals. *P. melanella* has the third antennal segment rounded and the genovertical plates hardly extending beyond the eye margin (fig. 160). Also, the first dorsocentral is about twice as far from the transverse suture as the second. I hereby restrict this species to California. The specimen labeled as a paratype from Kentucky is in very poor condition and is of another species.

Phytomyza minuscula Goureau

Phytomyza minuscula Goureau, Ann. Soc. Ent. France, ser. 2, vol. 9, p. 154, 1851.—Frost, Ann. Ent. Soc. Amer., vol. 23, p. 457, 1930 (figures of puparium and leaf mines).—Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 433, 1935 (figures of head and wing).

Phytomyza nitida Melander, Journ. New York Ent. Soc., vol. 21, p. 271, 1913.

Phytomyza aquilegia (Hardy), Coquillett (part), U. S. Dep. Agr., Div. Ent. Bull. 10, p. 78, 1898 (specimens from *Aquilegia* sp.)—Melander (part), Journ. New York Ent. Soc., vol. 21, p. 271, 1913 (2 ♂♂, Ithaca, N. Y., and New Haven, Conn.).—Cory, Journ. Econ. Ent., vol. 9, p. 419, 1916 (figures of leaf mines).—Frost (part), Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 67, 1924 (figure of leaf mines).

Phytomyza minuscula is a small dark Holarctic species (1.5 to 2 mm. in wing length) that has the frons dark. The dorsal upper-orbital is minute and the ventral lower-orbital is about one-half the size of the dorsal (fig. 161). This species is characterized by there not being more than one setula in the intraalar row posterior to the transverse suture and the inner postalar usually absent. The fourth costal section varies from 2 to 3.4 times as long as the fourth costal. The head has the eye relatively small and the antenna large (fig. 161).

The larvae form serpentine mines in the leaves of *Aquilegia* spp. and *Thalictrum* spp. I have reared it from *Aquilegia*, cultivated variety; *A. truncata* F. & M.; *A. pauciflora* Jepson; *Thalictrum*, cultivated variety; and *T. fendleri* Engelm. I have studied specimens from California, Washington, Idaho, Illinois, Indiana, District of Columbia, and Connecticut.

Phytomyza nervosa Loew

Phytomyza nervosa Loew, Berliner Ent. Zeitschr., vol. 13, p. 52, 1869 (Centuria VIII, No. 99).

The holotype female is in the Museum of Comparative Zoology (No. 13432). This species, together with several other species, has a yellow frons, dark scutellum, and femora primarily yellow. The third antennal segment is black, a character which separates *Phytomyza nervosa* from the other species. There are no acrostichals. The wing is relatively wide for its length and M_{1+2} has a distinct curve outwardly (fig. 162). I have seen specimens from Iowa, Kansas, and District of Columbia.

Phytomyza nigra Meigen

Phytomyza nigra Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 6, p. 191, 1830.—Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 436, 1935 (figures of head and wing).

This Holarctic species is unusual in having the eye setulose. It also has a yellow frons and dark third antennal segment, mesonotal margins, scutellum and femora. Both upper-orbital setae are of equal length and strength and the acrostichals are in two rows. The larvae make linear mines at the tips of leaves of *Bromus tectorum* L., *Festuca arundinacea* Schreb., *F. rubra* var. *commutata* Gaud., *Hordeum jubatum* L., *Lolium perenne* L., and *Triticum aestivum* L. I have seen specimens from Oregon and Washington reared from the grasses listed here.

Phytomyza nigrinervis Frost

Phytomyza nigrinervis Frost, Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 87, 1924.

The holotype male is in the U. S. National Museum (No. 50028). This is the darkest species among those species having a dark frons, antenna, and tarsi, two equally strong upper-orbitals, and the acrostichals in four or five rows. The head is distinctively shaped (fig. 163) and is totally brown or black. The femora are not lighter colored distally and the basal wing veins are black. The entire type series is from Colorado.

***Phytomyza nigripennis* Fallén**

Phytomyza nigripennis Fallén, Diptera sueciae, vol. 2, No. 41 (Phytomyzides), p. 2, 1823.—Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 439, 1935 (figures of head and wing).

Phytomyza clematidis (Loew), Melander, Journ. New York Ent. Soc., vol. 21, p. 269, 1913.

This is a shining black species having the frontal vitta brown, the femora distally reddish with the forefemur more yellowish, the calypter with yellow margin and fringe, and the wing strongly tinged brown. *Phytomyza nigripennis* is a large species (wing length not less than 3 mm.) having one upper-orbital and three lower-orbitals. I have seen specimens of this Holarctic species from Wisconsin and Ontario.

***Phytomyza periclymeni* de Meijere**

Phytomyza ilicicola (Loew), Melander (part), Journ. New York Ent. Soc., vol. 21, p. 270, 1913 (1 ♂, 1 ♀, Oroville, Wash.).

Phytomyza nigra (Meigen), Melander (part), Journ. New York Ent. Soc., vol. 21, p. 270, 1913 (1 ♂, Oroville, Wash.).

Phytomyza periclymeni de Meijere, *in* Hendel, Wiener Ent. Zeitschr., vol. 39, p. 71, 1922.—Hendel, *in* Lindner, Die Fliegen der palearktischen Region, fam. 59, p. 452, 1935 (figures of head and wing).—Frick, Ann. Ent. Soc. Amer., vol. 47, p. 373, 1954.

This Holarctic species is one of a group of four species having the frons, antenna, and tarsi dark, the forefemur distally yellow to reddish brown, two equally strong upper-orbitals, and four or five rows of acrostichal setae. *Phytomyza periclymeni* may be separated from *P. gregaria*, *P*, *persicae*, and *P. ilicicola* in having the eye subcircular and the mesonotum dull bluish black with the acrostichal setae extending posteriorly to the third dorsocentral. The larvae make blotch mines in the leaves of *Symphoricarpos* spp. and *Lonicera* spp. I have seen specimens from Washington and California.

***Phytomyza persicae* Frick**

Phytomyza nigritella (Zetterstedt), Frost, Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 81, 1924 (figure of leaf mine).

Phytomyza persicae Frick, Ann. Ent. Soc. Amer., vol. 47, p. 369, 1954.

Phytomyza persicae is one of a group of four species having the frons, antenna, and tarsi dark, the forefemur distally yellow to reddish brown, two equally strong upper-orbitals, and four or five rows of acrostichal setae. It may be separated from *P. gregaria*, *P. periclymeni*, and *P. ilicicola* in having the forefemur distally reddish brown, the mesonotum black, dull gray pollinose, and the acrostichals extending posteriorly to the fourth dorsocentral. The larvae make serpentine mines in the leaves of *Prunus persica* L. I have not seen

Frost's specimens from *Prunus serotina* Ehrh. and *Diervilla lonicera*, so I restrict the species to peach at this time. I have seen specimens from Ohio, Virginia, Connecticut, and Ontario.

Phytomyza plantaginis Robineau-Desvoidy

Phytomyza plantaginis Robineau-Desvoidy, Rev. Mag. Zool., ser. 2, vol. 3. p. 404, 1851.—Frost, Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 82, 1924 (figure of leaf mine).—Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 455, 1935 (figures of head and wing).

Phytomyza genualis Loew, Berliner Ent. Zeitschr., vol. 13, p. 52, 1869 (Centuria VIII, No. 100).

Phytomyza crassiseta (Zetterstedt), Melander (part), Journ. New York Ent. Soc., vol. 21, p. 271, 1913 (2 ♀♀, White Plains, N. Y., and Collins, Idaho.).

This species has the frons and first and second antennal segments yellow, the third antennal segment, mesonotal margins, scutellum, and femora dark, and the forecoxa distally yellow. There are two equally strong upper-orbitals and two rows of acrostichals. It differs from *Phytomyza subtenella* in having only one strong lower-orbital and the lack of an inner postalar. The larvae make serpentine mines in the leaves of *Plantago* spp. I have seen this Holarctic species from many widely scattered States throughout the United States.

Phytomyza plumiseta Frost

Phytomyza plumiseta Frost, Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 87, 1924; Ann. Ent. Soc. Amer., vol. 23, p. 460, 1930.

The holotype female is in the U. S. National Museum (No. 50027). *Phytomyza plumiseta* belongs to the assemblage of species that has a yellow frons, dark third antennal segment, scutellum, and femora, and the mesonotum bordered with yellow. Like *P. delphinii*, this species has both upper-orbitals of equal length and strength. *P. plumiseta* has a narrow gena (medially about one-eighth the eye height) (fig. 164), the tarsi yellow, and the mesonotum subshining. The wing is illustrated to show the undulating R_{2+3} and straight M_{1+2} (fig. 165). The larvae make blotch mines in the leaves of *Thalictrum polygamum* Muhl. and other *Thalictrum* spp. in Pennsylvania.

Phytomyza ranunculi (Schrank)

Musca ranunculi Schrank, Fauna Boica, vol. 3, p. 140, 1803.

Phytomyza ranunculi (Schrank), Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 463, 1935 (figures of head and wing).—Hering, Entomon, vol. 1, p. 207, 1949.

This species is one in a group of species having a yellow frons and scutellum and dark third antennal segment. The dorsal upper-orbital is definitely shorter than the ventral. Hendel (1935) proposed several varieties in order to distinguish the seasonal color phases of this Holarctic species, but he could find no morphological differences between the color phases, even in the male terminalia. Hering (1949) offered a key to subspecies based in part upon morphological differences. Several of the color phases considered by Hendel are known in North America and a key for their separation is presented here (all three subspecies have the mesonotum grayish black with yellow vittae).

1\. Mesonotum without a yellow prescutellar area 2
   Mesonotum with a yellow prescutellar area . . . . **ranunculi albipes**
2\. Femora mostly yellow; anepisternum about one-half yellow. **ranunculi flavoscutellata**
   Femora black or brown; anepisternum about one-third yellow. **ranunculi praecox**

The larvae form serpentine mines in the leaves of *Ranunculus* spp. and *Anemone nemorosa* L. in Europe. No host plants are known from North America.

Phytomyza ranunculi albipes Meigen

Phytomyza albipes Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 6, p. 195, 1830.
Phytomyza flava (Fallén), Melander, Journ. New York Ent. Soc., vol. 21, p. 270, 1913.

This subspecies is known from three specimens from Washington.

Phytomyza ranunculi flavoscutellata Fallén

Phytomyza flavoscutellata Fallén, Diptera sueciae, vol. 2, No. 41 (Phytomizides), p. 4, 1823.—Melander (part), Journ. New York Ent. Soc., vol. 21, p. 270, 1913 (4♂♂, Portland, Oreg., and Moscow Mountain, Idaho).
Phytomyza zetterstedti (Schiner), Melander (part), Journ. New York Ent. Soc., vol. 21, p. 270, 1913 (1♀, Moscow Mountain, Idaho).

There are five specimens in Melander's collection from Oregon and Idaho.

Phytomyza tanunculi praecox Meigen

Phytomyza rufipes Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 6, p. 194, 1830.
Phytomyza flavoscutellata (Fallén), Melander (part), Journ. New York Ent. Soc., vol. 21, p. 270, 1913 (1♀, Moscow Mountain, Idaho).

At present known from one specimen in Melander's collection from Idaho.

Phytomyza rufipes Meigen

Phytomyza rufipes Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 6, p. 192, 1830.—Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 471, 1935 (figures of head and wing).

Another rather large Holarctic species with yellow frons, dark scutellum, and mostly yellow femora. The third antennal segment is yellow and the mesonotum dull gray pollinose. This species is most closely related to *Phytomyza genalis* but may be separated by *P. rufipes* having the anepisternum three-fourths dull gray. The larvae make serpentine mines in the leaves of various crucifers in Europe. The seven North American specimens that I have seen were from central Oregon.

Phytomyza sphondylii Robineau-Desvoidy

Phytomyza spondylii Robineau-Desvoidy, Rev. Mag. Zool., ser. 2, vol. 3, p. 400, 1851.

Phytomyza sphondylii Robineau-Desvoidy, Hendel, *in* Lindner, Die Fliegen der palaearktischen Region, fam. 59, p. 483, 1935 (figures of head and wing).

Since this Holarctic species was named for the first known larval host plant, *Heracleum sphondylium* L., the proper spelling should be *sphondylii* and not *spondylii* as originally proposed. *Phytomyza sphondylii* is very similar to *P. albiceps* in having a yellow frons, dark third antennal segment, scutellum, and femora, and the mesonotum bordered with yellow. From *P. albiceps* this species is distinguished by the two developed upper-orbital setae (although the dorsal is shorter than the ventral) and the anepisternum being three-fourths dark. I have reared this species from serpentine mines in the leaves of *Heracleum lanatum* Michx. in California.

Phytomyza subtenella Frost

Phytomyza subtenella Frost, Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 89, 1924.

The holotype female is in the U. S. National Museum (No. 50021). This species has the frons yellow, the third antennal segment, mesonotal margins, scutellum, and femora dark, and the forecoxa distally yellow. The upper-orbitals are equally strong and the acrostichals are in two rows. From *Phytomyza crassiseta* this species can be separated by its having the first and second antennals yellow, the arista not greatly expanded, and two strong lower-orbitals (fig. 166). From *P. plantaginis* this species differs in having two strong lower-orbitals and an inner postalar seta. The wing has M_{1+2} undulating and the anal vein straight (fig. 167). At present known from two specimens from Washington and Wisconsin.

Phytomyza trivittata Frost

Phytomyza trivittata Frost, Mem. Cornell Univ. Agr. Exp. Sta., vol. 78, p. 89, 1924.

This is a species of moderate size (1.75 mm. in wing length) with yellow frons and scutellum and a dark third antennal segment. The head is mostly yellow and has both upper-orbitals of equal length and strength (fig. 168). The wing has the radial sector strongly curved forward (fig. 169). The mesonotum is marked with dull black and gray pollinose and is without setulae other than about four on either side anterior to the transverse suture (fig. 170). There are three known specimens: the type from Wells, Nev., and two specimens from the San Jacinto Mountains, Calif.

HOST PLANTS OF NORTH AMERICAN AGROMYZID LARVAE

(Species of Agromyzidae in italic. Plant names in parentheses are known larval hosts in Europe; to date no such host plant, or not more than one, has been reported in North America for each of the species of Agromyzidae so indicated.)

- Pteridophyta
  - Polypodiaceae
    - Asplenium pinnatifidum Nutt.: *Liriomyza felti* (Malloch)
    - (Asplenium rutamuraria L.): *Liriomyza lutea* (Meigen)
    - Camptosorus rhizophyllus (L.) Link: *Liriomyza felti* (Malloch)
    - Pteridum aquilinum (L.) Kuhn: *Phytobia* (*Praspedomyza*) *clara* (Melander)
- Spermatophyta
  - Angiospermae
    - Monocotyledoneae
      - Typhaceae
        - Typha spp.: *Phytobia* (*Dizygomyza*) *thompsoni* Frick
        - (Typha latifolia L.): *Phytobia* (*Dizygomyza*) *iraeos* (Robineau-Desvoidy)
      - Gramineae
        - Festuceae
          - Bromus carinatus Hook. & Arn.: *Cerodontha* (*Cerodontha*) *dorsalis* (Loew), *Liriomyza flaveola* (Fallén)
          - Bromus tectorum L.: *Phytobia* (*Poëmyza*) *incisa* (Meigen), *Phytomyza nigra* Meigen
          - Dactylis glomerata L.: *Cerodontha* (*Cerodontha*) *dorsalis* (Loew)
          - Eragrostis sp.: *Cerodontha* (*Cerodontha*) *dorsalis* (Loew)
          - Festuca arundinacea Schreb.: *Phytomyza nigra* Meigen
          - Festuca rubra var. commutata Gaud.: *Phytomyza nigra* Meigen
          - Poa pratensis L.: *Cerodontha* (*Cerodontha*) *dorsalis* (Loew)
        - Hordeae
          - Agropyron repens (L.) Beauv.: *Agromyza niveipennis* Zetterstedt, *Phytobia* (*Poëmyza*) *incisa* (Meigen), *P.* (*P.*) *muscina* (Meigen), *Cerodontha* (*Cerodontha*) *dorsalis* (Loew), *Pseudonapomyza atra* (Meigen)
          - Agropyron sp.: *Phytobia* (*Poëmyza*) *inconspicua* (Malloch)
          - Elymus canadensis L.: *Phytobia* (*Poëmyza*) *lateralis* (Macquart)
          - E. glaucus Buckl.: *Phytobia* (*Poëmyza*) *incisa* (Meigen), *Cerodontha* (*Cerodontha*) *dorsalis* (*Loew*)
          - Hordeum jubatum L.: *Agromyza niveipennis* Zetterstedt, *Phytobia* (*Poëmyza*) *lateralis* (Macquart), *Cerodontha* (*Cerodontha*) *dorsalis* (Loew), *Pseudonapomyza atra* (Meigen), *Phytomyza nigra* Meigen
          - H. murinum L.: *Phytobia* (*Poëmyza*) *muscina* (Meigen), *Cerodontha* (*Cerodontha*) *dorsalis* (Loew), *Liriomyza flaveola* (Fallén)
          - H. vulgare L.: *Phytobia* (*Poëmyza*) *incisa* (Meigen), *Cerodontha* (*Cerodontha*) *dorsalis* (Loew)

(Hordeum vulgare L.): *Agromyza ambigua* Fallén
Lolium multiflorum Lam.: *Phytobia* (*Poëmyza*) *muscina* (Meigen), *Cerodontha* (*Cerodontha*) *dorsalis* (Loew), *Liriomyza flaveola* (Fallén)
L. perenne L.: *Phytomyza nigra* Meigen
Lolium sp.: *Liriomyza flaveola* (Fallén)
Secale cereale L.: *Agromyza niveipennis* Zetterstedt, *Cerodontha* (*Cerodontha*) *dorsalis* (Loew), *Pseudonapomyza atra* (Meigen)
Triticum aestivum L. (including T. sativum Lam. and T. vulgare Vill.): *Agromyza nigripes* Meigen, *A. niveipennis* Zetterstedt, *Phytobia* (*Poëmyza*) *incisa* (Meigen), *P.* (*P.*) *lateralis* (Macquart), *Cerodontha* (*Cerodontha*) *dorsalis* (Loew), *Phytomyza nigra* Meigen

Aveneae
Avena sativa L.: *Phytobia* (*Poëmyza*) *lateralis* (Macquart)

Agrostidae
Agrostis alba L.: *Phytobia* (*Poëmyza*) *incisa* (Meigen)
(Calamagrostis epigeios (L.) Roth): *Agromyza ambigua* Fallén
Phleum pratense L.: *Phytobia* (*Poëmyza*) *incisa* (Meigen), *Cerodontha* (*Cerodontha*) *dorsalis* (Loew)

Chlorideae
Eleusine indica (L.) Gaertn.: *Cerodontha* (*Cerodontha*) *dorsalis* (Loew)

Phalaridae
Ehrharta erecta Lam.: *Phytobia* (*Poëmyza*) *muscina* (Meigen), *Cerodontha* (*Cerodontha*) *dorsalis* (Loew)
Phalaris arundinacea L.: *Phytobia* (*Poëmyza*) *incisa* (Meigen)
P. minor Retz.: *Cerodontha* (*Cerodontha*) *dorsalis* (Loew)

Paniceae
Digitaria sanguinalis (L.) Scop.: *Cerodontha* (*Cerodontha*) *dorsalis* (Loew)
Echinochloa crusgalli (L.) Beauv.: *Phytobia* (*Poëmyza*) *muscina* (Meigen), *Cerodontha* (*Cerodontha*) *dorsalis* (Loew)
Panicum capillare L.: *Cerodontha* (*Cerodontha*) *dorsalis* (Loew)
P. dichotomiflorum Michx.: *Cerodontha* (*Cerodontha*) *dorsalis* (Loew)
P. miliacum L.: *Cerodontha* (*Cerodontha*) *dorsalis* (Loew)
Paspalum dilatatum Poir.: *Liriomyza marginalis* (Malloch)
Setaria lutescens (Weigel) Hubb.: *Phytobia* (*Poëmyza*) *incisa* (Meigen)
S. viridis (L.) Beauv.: *Cerodontha* (*Cerodontha*) *dorsalis* (Loew)

Andropogoneae
Sorghum vulgare Purs.: *Cerodontha* (*Cerodontha*) *dorsalis* (Loew)

Tripsaceae
Zea mays L.: *Agromyza parvicornis Loew*, *Phytobia* (*Poëmyza*) *incisa* (Meigen), *P.* (*P.*) *lateralis* (Macquart)

Cyperaceae
(Carex spp.): *Phytobia* (*Poëmyza*) *angulata* (Loew), *P.* (*Dizygomyza*) *luctuosa* (Meigen), *P.* (*D.*) *morosa* (Meigen)
(Scirpus maritimus L.): *Phytobia* (*Dizygomyza*) *morosa* (Meigen)

Commelinaceae
Commeline elegans H. B. K.: *Liriomyza commelinae* (Frost)
C. longicaulis Jacq.: *Liriomyza commelinae* (Frost)
C. virginica L.: *Liriomyza commelinae* (Frost)

- Juncaceae
    - (Juncus effusus L.): *Phytobia* (*Dizygomyza*) *luctuosa* (Meigen)
    - Juncus xiphioides Meyer: *Phytobia* (*Icteromyza*) *longipennis* (Loew)
    - (Juncus sp.): *Phytobia* (*Icteromyza*) *capitata* (Zetterstedt)
- Liliceae
    - Allium cepa L.: *Liriomyza alliovora* Frick, *L. langei* Frick
    - Asparagus officinalis L.: *Melanagromyza simplex* (Loew)
- Iridaceae
    - Iris versicolor L.: *Phytobia* (*Dizygomyza*) *thompsoni* Frick
    - Iris spp.: *Phytobia* (*Dizygomyza*) *thompsoni* Frick, *P.* (*D.*) *iraeos* (Robineau-Desvoidy), *P.* (*D.*) *iridis* (Hendel)

Dicotyledoneae

- Salicaceae
    - Populus deltoides Marsh: *Agromyza albitarsis* Meigen, *Phytagromyza populicola* (Walker)
    - P. nigra var. italica Muenchh.: *Agromyza albitarsis* Meigen
    - P. trichocarpa T. & G.: *Agromyza albitarsis* Meigen
    - Populus spp.: *Agromyza albitarsis* Meigen, *Melanagromyza schineri* (Giraud)
    - Salix lasiandra Benth.: *Agromyza albitarsis* Meigen
    - Salix spp.: *Melanagromyza salicis* (Malloch)
    - (Salix spp.): *Melanagromyza schineri* (Giraud)
- Betulaceae
    - Betula nigra L.: *Phytobia* (*Phytobia*) *pruinosa* (Coquillett)
- Fagaceae
    - Quercus spp.: *Agromyza viridula* Coquillett
- Ulmaceae
    - Celtis occidentalis Micocoulier: *Agromyza aristata* Malloch
    - Ulmus americana L.: *Agromyza aristata* Malloch
- Urticaceae
    - Urtica californica Greene: *Agromyza reptans* Fallén
    - (Urtica dioica L.): *Phytomyza flavicornis* Fallén
- Chenopodiaceae
    - Beta vulgaris L.: *Liriomyza langei* Frick
    - Chenopodium album L.: *Haplomyza minuta* (Frost)
    - (Chenopodium album L.): *Phytobia* (*Amauromyza*) *abnormalis* (Malloch)
    - Spinacia oleracea L.: *Liriomyza langei* Frick
- Amaranthaceae
    - Amaranthus hybridus L.: *Haplomyza togata* (Melander)
    - A. retroflexus L.: *Haplomyza togata* (Melander)
    - Amaranthus sp.: *Phytobia* (*Amauromyza*) *abnormalis* (Malloch)
- Caryophyllaceae
    - Dianthus caryophyllus L.: *Liriomyza dianthi* Frick
- Portulacaceae
    - Portulaca sp.: *Haplomyza palliata* (Coquillett)
- Ranunculaceae
    - Anemone multifida Poir.: *Phytomyza atripalpis* Aldrich
    - (Anemone nemorosa L.): *Phytomyza ranunculi* (Schrank)
    - Aquilegia canadensis L.: *Phytomyza aquilegiana* Frost
    - A. truncata F. & M.: *Phytomyza aquilegiana* Frost, *P. minuscula* Goureau

A. truncata var. pauciflora Jepson: *Phytomyza aquilegiana* Frost, *P. minuscula* Goureau
A. vulgaris L.: *Phytomyza aquilegiana* Frost
Aquilegia spp., cult. vars.: *Phytomyza aquilegiana* Frost, *P. minuscula* Goureau
Clematis ligusticifolia Nutt.: *Phytomyza loewii* Hendel
Clematis spp.: *Phytomyza centralis* Frost, *P. clemativora* Coquillett, *P. loewii* Hendel
Delphinium cultorum Voss.: *Phytomyza delphiniae* Frost
Ranunculus abortivus L.: *Napomyza davisii* (Walton)
Ranunculus sp.: *Napomyza davisii* (Walton)
(Ranunculus spp.): *Phytomyza ranunculi* (Schrank)
Thalictrum fendleri Engelm.: *Phytomyza aquilegiana* Frost, P. *minuscula* Goureau
T. polygamum Muhl.: *Phytomyza aquilegiana* Frost, *P. plumiseta* Frost
Thalictrum spp., cult. vars.: *Phytomyza minuscula* Goureau

Cruciferae
(Armoracia lapathifolia Gilib.): *Phytomyza rufipes* Meigen
Brassica arvensis (L.) B. S. P.: *Liriomyza brassicae* (Riley)
B. campestris L.: *Liriomyza brassicae* (Riley)
B. napus L.: *Liriomyza brassicae* (Riley)
(Brassica napus L.): *Phytomyza rufipes* Meigen
Brassica nigra (L.) Koch.: *Liriomyza brassicae* (Riley)
(Brassica oleracea L.): *Phytomyza rufipes* Meigen
Brassica oleracea var. botrytis L.: *Liriomyza brassicae* (Riley), *L. langei* Frick
B. oleracea var. capitata L.: *Liriomyza brassicae* (Riley)
Brassica rapa L.: *Liriomyza brassicae* (Riley)
Descurainia (=Sophia) sp.: *Ophiomyia texana* (Malloch)
(Diplotaxis tenuifolia L.): *Phytomyza rufipes* Meigen
Erysimum inconspicuum (S. Wats.) MacM.: *Liriomyza brassicae* (Riley)
Radicula palustris Moench.: *Liriomyza brassicae* (Riley)
Raphanus sativus L.: *Liriomyza brassicae* (Riley)
R. activus var. longipinnatus Bailey: *Liriomyza brassicae* (Riley)
Rorippa sp.: *Ophiomyia texana* (Malloch)
Sisymbrium altissimum L.: *Liriomyza brassicae* (Riley)

Rosaceae
Amelanchier canadensis (L.) Medic.: *Phytobia* (*Phytobia*) *amelanchieris* (Greene)
Fragaria virginiana Duch.: *Agromyza spiraeae* Kaltenbach
Fragaria spp., cult. vars.: *Agromyza spiraeae* Kaltenbach
(Potentilla erecta L.): *Agromyza rubi* Brischke
Prunus avium L.: *Phytobia* (*Phytobia*) *pruni* (Grossenbacher)
P. domestica L.: *Phytobia* (*Phytobia*) *pruni* (Grossenbacher)
P. persica (L.) Batsch.: *Phytomyza persicae* Frick
? P. serotina Ehrh.: *Phytomyza persicae* Frick
Rubus idaeus L.: *Agromyza spiraeae* Kaltenbach
R. occidentalis L.: *Agromyza spiraeae* Kaltenbach
Rubus spp., cult. vars.: *Agromyza spiraeae* Kaltenbach
(Rubus spp.): *Agromyza rubi* Brischke
(Sanguisorba officinalis L.): *Agromyza rubi* Brischke

- Leguminosae
  - Baptisia tinctoria (L.) R. Br.: *Liriomyza baptisiae* (Frost)
  - Cassia bacillaris L.: *Phytobia* (*Calycomyza*) *cassiae* (Frost)
  - Centrosema pubescens Benth.: *Agromyza centrosemae* Frost
  - Gliricidia sepium (Jacq.) Steud.: *Liriomyza schmidti* Aldrich
  - Medicago lupulina L.: *Liriomyza pictella* (Thomson)
  - M. sativa L.: *Melanagromyza gibsoni* (Malloch), *Liriomyza pictella* (Thomson), *L. trifolii* (Burgess)
  - Melilotus alba Desr.: *Liriomyza trifolii* (Burgess)
  - M. indica All.: *Liriomyza trifolii* (Burgess), *Phytomyza atricornis* Meigen
  - Phaseolus limensis Macfad.: *Agromyza inaequalis* Malloch, *Liriomyza phaseolunata* (Frost), *L. pictella* (Thomson)
  - P. vulgaris L.: *Liriomyza pictella* (Thomson)
  - Pisum sativum L.: *Liriomyza langei* Frick, *Phytomyza atricornis* Meigen
  - Trifolium hybridum L.: *Liriomyza trifolii* (Burgess)
  - T. repens L.: *Liriomyza trifolii* (Burgess)
  - Vicia gigantea Hook: *Liriomyza pictella* (Thomson)
  - V. villosa Roth: *Liriomyza trifolii* (Burgess)
  - Vigna repens Baker: *Agromyza inaequalis* Malloch
- Tropaeolaceae
  - Tropaeolum spp.: *Liriomyza brassicae* (Riley)
- Euphorbiaceae
  - Croton billbergianus Muell.: *Melanagromyza crotonis* (Frost)
  - ? Sauvia sp.: *Phytobia* (*Calycomyza*) *allecta* (Melander)
- Aquifoliaceae
  - Ilex aquifolium L.: *Phytomyza ilicis* Curtis
  - I. decidua Walt.: *Phytomyza ilicicola* Loew
  - I. glabra (L.) Gray: *Phytomyza ilicicola* Loew
  - I. opaca Ait.: *Phytomyza ilicicola* Loew
  - I. vomitoria Ait.: *Phytomyza ilicicola* Loew
- Aceraceae
  - Acer rubrum L.: *Phytobia* (*Phytobia*) *setosa* (Loew)
- Tiliaceae
  - Tilia americana L.: *Melanagromyza tiliae* (Couden)
- Malvaceae
  - Abutilon theophrasti Medic.: *Phytobia* (*Calycomyza*) *malvae* (Burgess)
  - Althaea rosea Cav.: *Phytobia* (*Calycomyza*) *malvae* (Burgess)
  - Gossypium spp.: *Liriomyza pictella* (Thomson)
  - Malva nicaeensis All. (=borealis): *Liriomyza pictella* (Thomson), *Phytomyza atricornis* Meigen
  - M. rotundifolia L.: *Phytobia* (*Calycomyza*) *malvae* (Burgess)
  - Malvastrum coromandelianum L.: *Phytobia* (*Calycomyza*) *malvae* (Burgess)
  - Sida spinosa L.: *Phytobia* (*Calycomyza*) *malvae* (Burgess)
- Umbelliferae
  - Angelica atropurpurea L.: *Melanagromyza angelicae* (Frost), *Phytomyza angelicella* Frost
  - Apium graveolens var. dulce Pers.: *Liriomyza langei* Frick
  - Heracleum lanatum Michx.: *Phytomyza sphondylii* Robineau-Desvoidy

Cornaceae
- Cornus californica C. A. Mey.: *Phytomyza agromyzina* Meigen
- C. stolonifera Michx.: *Phytomyza agromyzina* Meigen

Convolvulaceae
- Ipomoea batatas Poir.: *Melanagromyza caerulea* (Malloch), *Phytobia* (*Calycomyza*) *ipomoeae* (Frost)
- I. laconosa L.: *Melanagromyza caerulea* (Malloch)
- I. sinuata Ort.: *Melanagromyza caerulea* (Malloch)
- Ipomoea spp.: *Melanagromyza caerulea* (Malloch)

Boraginaceae
- Cynoglossum virginianum L.: *Phytobia* (*Calycomyza*) *cynoglossi* Frick
- Cynoglossum spp.: *Phytobia* (*Calycomyza*) *cynoglossi* Frick

Verbenaceae
- Lantana camara L.: *Ophiomyia lantanae* (Froggatt), *Phytobia* (*Calycomyza*) *lantanae* Frick
- Lantana spp.: *Ophiomyia lantanae* (Froggatt), *Phytobia* (*Calycomyza*) *lantanae* Frick
- Lippia helleri Britt.: *Phytobia* (*Calycomyza*) *lantanae* Frick
- Verbena hybrida Voss.: *Phytobia* (*Calycomyza*) *verbenae* (Hering)
- V. noemexicana (Gray) Small: *Phytobia* (*Calycomyza*) *verbenae* (Hering)
- V. wrightii Gray: *Phytobia* (*Calycomyza*) *verbenae* (Hering)
- Verbena sp.: *Liriomyza verbenicola* Hering

Labiatae
- Mentha sp.: *Phytomyza atricornis* Meigen
- Nepeta cataria L.: *Ophiomyia proboscidea* (Strobl)
- Stachys bullata Benth.: *Liriomyza pictella* (Thomson), *Phytomyza atricornis* Meigen

Solanaceae
- Datura meteloides DC.: *Liriomyza munda* Frick, *L. pictella* (Thomson)
- Lycopersicon esculentum Mill.: *Liriomyza munda* Frick
- Petura sp.: *Liriomyza langei* Frick
- Solanum tuberosum L.: *Liriomyza munda* Frick

Scrophulariaceae
- Penstemon procerus Dougl.: *Phytobia* (*Calycomyza*) *humeralis* (von Roser)
- Veronica peregrina var. xalapensis (H. B. K.) Pennell: *Phytomyza crassiseta* Zetterstedt

Bignoniaceae
- Catalpa bignonioides Walt.: *Phytobia* (*Trilobomyza*) *pleuralis* (Malloch)

Acanthaceae
- Justicia (=Dianthera) americana (L.) Vahl.: *Melanagromyza diantherae* (Malloch)

Plantaginaceae
- Plantago lanceolata L.: *Phytomyza plantaginis* Robineau-Desvoidy
- P. major L.: *Liriomyza sorosis* (*Williston*), *Phytomyza plantaginis.* Robineau-Desvoidy
- P. media L.: *Liriomyza sorosis* (Williston)
- Plantago sp.: *Liriomyza sorosis* (Williston)

- Rubiaceae
  - Galium aparine L.: *Phytobia* (*Praspedomyza*) *morio* (Brischke)
  - G. trifidum L.: *Phytobia* (*Praspedomyza*) *morio* (Brischke)
- Caprifoliaceae
  - Lonicera involucrata (Rich.) Banks: *Phytagromyza lonicerae* (Robineau-Desvoidy), *Phytomyza gregaria* Frick
  - Lonicera sp., cult. var.: *Phytomyza periclymeni* de Meijere
  - Symphoricarpos albus (L.) Blake: *Phytagromyza lonicerae* (Robineau-Desvoidy), *P. orbitalis* (Melander), *Phytomyza periclymeni* de Meijere
  - S. mollis Nutt.: *Phytagromyza orbitalis* (Melander)
  - S. rotundifolius Gray: *Phytagromyza orbitalis* (Melander)
  - Viburnum pubescens Pursh: *Phytobia* (*Calycomyza*) *flavinotum* Frick
- Cucurbitaceae
  - Cucumis melo L., cult. vars.: *Liriomyza pictella* (Thomson)
- Compositae
  - Cichorieae
    - Lactuca sativa L.: *Phytobia* (*Amauromyza*) *maculosa* (Malloch), *Liriomyza langei* Frick
    - Lactuca scariola var. integrifolia (Bogenh.) G. Beck: *Phytomyza lactuca* Frost
    - Picris echioides L.: *Phytomyza atricornis* Meigen
    - Sonchus asper (L.) Hill: *Ophiomyia coniceps* (Malloch), *Phytomyza atricornis* Meigen
    - S. oleraceus L.: *Phytomyza atricornis* Meigen
    - Taraxacum kok-sghyz Rodin: *Phytomyza atricornis* Meigen
    - T. officinale Weber: *Tylomyza nasuta* (Melander)
  - Eupatorieae
    - Eupatorium odoratum L.: *Melanagromyza mallochi* (Hendel)
    - E. purpureum L.: *Phytobia* (*Calycomyza*) *flavinotum* Frick
  - Astereae
    - Aster chilensis Nees: *Phytobia* (*Calycomyza*) *humeralis* (von Roser), *P.* (*C.*) *promissa* Frick
    - A. divaricatus L.: *Ophiomyia maura* (Meigen)
    - A. leavis L.: *Phytobia* (*Nemorimyza*) *posticata* (Meigen)
    - A. novae-angeliae L.: *Ophiomyia maura* (Meigen), *Phytobia* (*Nemorimyza*) *posticata* (Meigen)
    - A. ramosissimus (T. & G.) Cronq.: *Ophiomyia maura* (Meigen), *Phytobia* (*Nemorimyza*) *posticata* (Meigen)
    - A. undulatus L.: *Ophiomyia maura* (Meigen), *Phytobia* (*Nemorimyza*) *posticata* (Meigen)
    - Aster spp., cult. vars.: *Phytobia* (*Amauromyza*) *maculosa* (Malloch), *P.* (*Calycomyza*) *humeralis* (von Roser), *Liriomyza langei* Frick, *L. pictella* (Thomson)
    - Baccharis douglasii DC.: *Phytobia* (*Amauromyza*) *maculosa* (Malloch), *P.* (*Calycomyza*) *humeralis* (von Roser)
    - Baccharis viminea DC.: *Phytobia* (*Calycomyza*) *jucunda* (Wulp)
    - Erigeron canadensis L.: *Phytobia* (*Amauromyza*) *maculosa* (Malloch), *P.* (*Calycomyza*) *humeralis* (von Roser), *P.* (*C.*) *jucunda* (Wulp)
    - Erigeron sp.: *Phytobia* (*Calycomyza*) *jucunda* (Wulp)
    - Grindelia squarrosa (Pursh) Dunal: *Phytobia* (*Calycomyza*) *jucunda* (Wulp)

Heterotheca grandiflora Nutt.: *Phytobia* (*Calycomyza*) *humeralis* (von Roser), *P.* (*C.*) *jucunda* (Wulp)
Solidago bicolor L.: *Phytobia* (*Nemorimyza*) *posticata* (Meigen)
S. caesia L.: *Ophiomyia maura* (Meigen), *Phytobia* (*Nemorimyza*) *posticata* (Meigen), *P.* (*Calycomyza*) *jucunda* (Wulp)
S. canadensis L.: *Ophiomyia maura* (Meigen), *Phytobia* (*Nemorimyza*) *posticata* (Meigen), *P.* (*Calycomyza*) *jucunda* (Wulp)
S. elongata Nutt.: *Phytobia* (*Nemorimyza*) *posticata* (Meigen), *Liriomyza eupatorii* (Kaltenbach)
S. flexicaulis L.: *Ophiomyia maura* (Meigen), *Phytobia* (*Nemorimyza*) *posticata* (Meigen), *P.* (*Calycomyza*) *jucunda* (Wulp)
S. juncea Ait.: *Ophiomyia maura* (Meigen), *Phytobia* (*Nemorimyza*) *posticata* (Meigen)
S. leiophylla Fern.: *Ophiomyia maura* (Meigen), *Phytobia* (*Nemorimyza*) *posticata* (Meigen)
S. macrophylla Pursh: *Phytobia* (*Calycomyza*) *humeralis* (von Roser)
S. nemoralis Ait.: *Phytobia* (*Nemorimyza*) *posticata* (Meigen)
Solidago spp.: *Phytobia* (*Calycomyza*) *solidaginis* (Kaltenbach)

Inuleae
Antennaria plantaginifolia (L.) Hook: *Phytomyza atricornis* Meigen
Gnaphalium leucocephalum Gray: *Phytomyza atricornis* Meigen

Heliantheae
Bidens frondosa L.: *Phytobia* (*Calycomyza*) *allecta* (Melander), *Phytomyza atricornis* Meigen
B. pilosa var. radiata Sch.: *Phytobia* (*Amauromyza*) *maculosa* (Malloch)
Dahlia pinnata Cav.: *Liriomyza pictella* (Thompson)
Encelia sp.: *Melanagromyza viridis* (Frost)
Helianthus annuus L.: *Phytobia* (*Amauromyza*) *maculosa* (Malloch), P. (*Calycomyza*) *humeralis* (von Roser), *P.* (*C.*) *jucunda* (Wulp) *Liriomyza pictella* (Thomson)
H. californicus DC.: *Phytomyza atricornis* Meigen
Helianthus spp.: *Phytobia* (*Calycomyza*) *allecta* (Melander)
Parthenium argentatum Gray: *Phytomyza atricornis* Meigen
Rudbeckia laciniata var. hortensis Bailey: *Phytobia* (*Calycomyza*) *allecta* (Melander), *P.* (*C.*) *artemisiae* (Kaltenbach)
Zinnia spp., cult. vars.: *Melanagromyza viridis* (Frost), *Phytobia* (*Calycomyza*) *humeralis* (von Roser), *P.* (*C.*) *jucunda* (Wulp), *Liriomyza pictella* (Thomson), *Phytomyza atricornis* Meigen

Madieae
Madia elegans Don.: *Phytobia* (*Calycomyza*) *humeralis* (von Roser)

Ambrosieae
Ambrosia artemisiifolia L.: *Phytobia* (*Calycomyza*) *ambrosiae* Frick, *Phytomyza atricornis* Meigen
A. trifida L.: *Phytobia* (*Calycomyza*) *ambrosiae* Frick, *P.* (*C.*) *jucunda* (Wulp)
Xanthium strumarium L.: *Phytobia* (*Calycomyza*) *jucunda* (Wulp)

Anthemideae
Achillea millefolium var. lanulosa Piper: *Napomyza lateralis* (Fallén)
Artemisia douglasiana Bess.: *Phytobia* (*Calycomyza*) *artemisiae* (Kaltenbach)

A. vulgaris L.: *Phytobia* (*Amauromyza*) *maculosa* (Malloch), *P.* (*Calycomyza*) *artemisiae* (Kaltenbach), *P.* (*C.*) *humeralis* (von Roser), *Phytomyza albiceps* Meigen, *P. atricornis* Meigen

Chrysanthemum frutescens L.: *Phytomyza atricornis* Meigen

C. indicum L.: *Phytobia* (*Amauromyza*) *maculosa* (Malloch), *Phytomyza atricornis* Meigen

C. leucanthemum L.: *Phytomyza atricornis* Meigen

C. morifolium Ramat.: *Phytomyza atricornis* Meigen

Chrysanthemum spp., cult. vars.: *Phytobia* (*Amauromyza*) *maculosa* (Malloch), *Phytomyza atricornis* Meigen

Matricaria sp., cult. var.: *Phytomyza atricornis* Meigen

Senecioneae

Petasites sp.: *Phytomyza atricornis* Meigen

Senecio cruentus DC.: *Phytomyza atricornis* Meigen

S. lugens var. exaltatus Gray: *Phytobia* (*Calycomyza*) *majuscula* Frick

S. mikanioides Otto: *Phytomyza atricornis* Meigen

Cynareae

Arctium lappa L.: *Phytobia* (*Amauromyza*) *maculosa* (Malloch), *P.* (*Calycomyza*) *flavinotum* Frick

Arctium spp.: *Phytobia* (*Calycomyza*) *jucunda* (Wulp)

Carduus pycnocephalus L.: *Phytomyza atricornis* Meigen

Cynara scolymus L.: *Phytobia* (*Calycomyza*) *jucunda* (Wulp), *Phytomyza atricornis* Meigen

Silybum marianum Gaertn.: *Phytomyza atricornis* Meigen

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Figures 1–170

Figures 1–20.—*Agromyza* and *Napomyza* species. The heads are shown in profile except where noted. The solid line equals 1 mm.

Fig. 1.—Section of wing base of *Agromyza ambigua* Fallén, showing the manner in which the subcosta and R_1 unite at the costa, greatly enlarged.

Fig. 2.—Section of wing base of *Napomyza lateralis* (Fallén), showing the manner in which the subcosta and R_1 end separately in the costa, greatly enlarged.

Fig. 3.—Head of *Agromyza ambigua* Fallén (holotype ♀ of *A. kincaidi* Malloch), dorsal upper-orbital and vertical setae missing.

Fig. 4.—Wing of *A. aristata* Malloch (holotype ♀ of *A. ulmi* Frost), one-half size.

Fig. 5.—Head of holotype ♀ of *A. aristata* Malloch.

Fig. 6.—Head of holotype ♂ of *A. barberi* Frick.

Fig. 7.—Head of holotype ♀ of *A. canadensis* Malloch.

Fig. 8.—Head of holotype ♀ of *A. currani* Frost, one-half size.

Fig. 9.—Head of holotype ♂ of *Agromyza frosti* Frick, dorsal upper-orbital and vertical setae broken off.

Fig. 10.—Head of *Agromyza inaequalis* Malloch (holotype ♂ of *Agromyza iridescens* Frost), one-half size.

Fig. 11.—Head of holotype ♀ of *Agromyza isolata* Malloch, dorsal upper-orbital and vertical setae missing.

Fig. 12.—Head of *Agromyza nigripes* Meigen (holotype ♀ of *Agromyza dubitata* Malloch).

Fig. 13.—Head of holotype ♀ of *Agromyza pallidiseta* Malloch.

Fig. 14.—Head of same, front view.

Fig. 15.—Head of *Agromyza spiraeae* Kaltenbach (holotype ♂ of *Agromyza fragariae* Malloch).

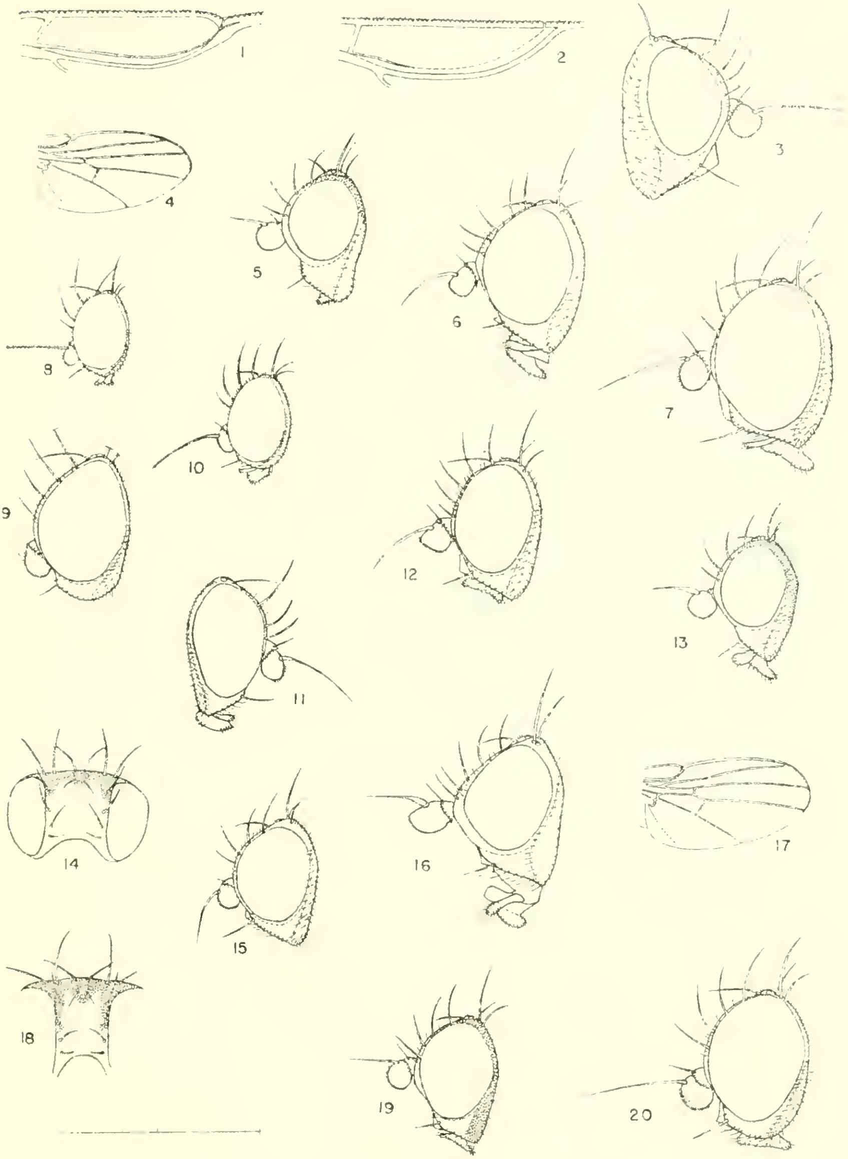
Fig. 16.—Head of *Agromyza subnigripes* Malloch (holotype ♀ of *Agromyza aprilina* Malloch).

Fig. 17.—Wing of holotype ♀ of *Agromyza varifrons* Coquillet, one-half size.

Fig. 18.—Head of same, front view.

Fig. 19.—Head of same, lateral view.

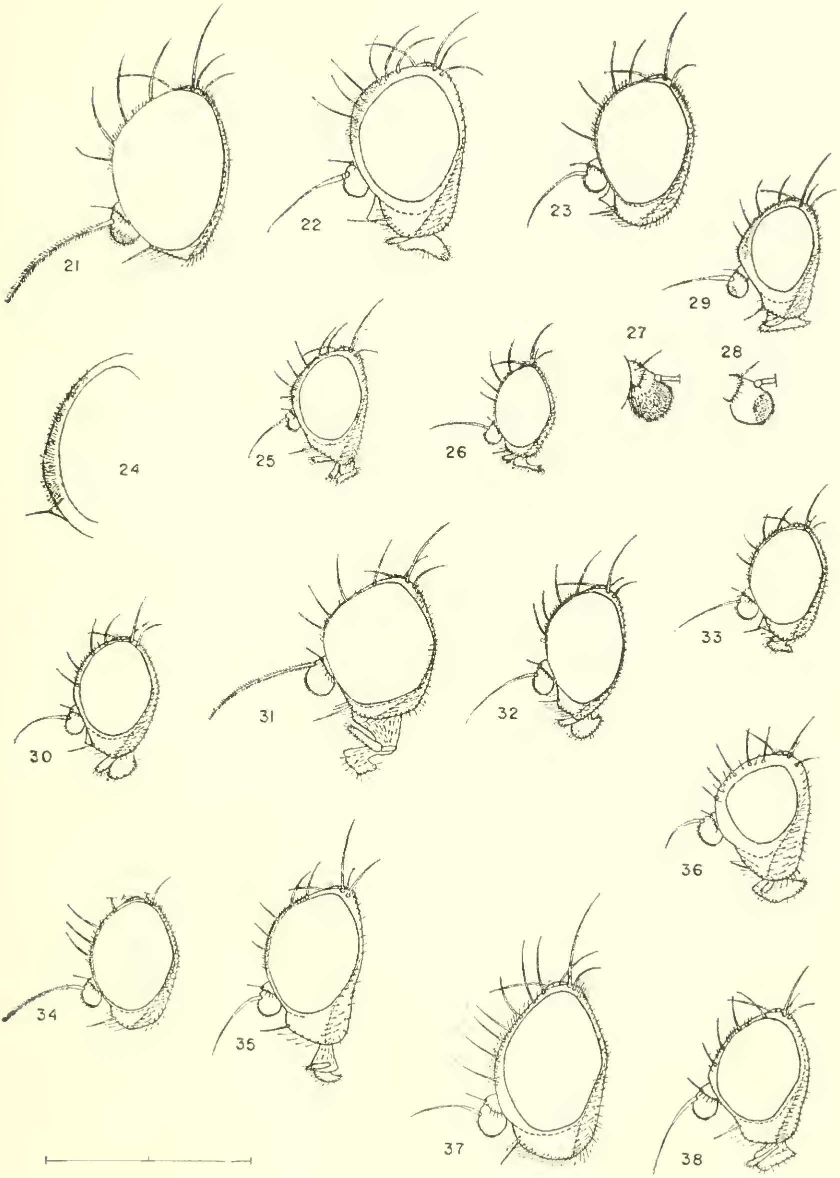
Fig. 20.—Head of holotype ♀ of *Agromyza viridula* Coquillett.



Figures 1–20.—*Agromyza* species and *Napomyza lateralis*. Explanation on facing page.

FIGURES 21–38.—*Melanagromyza* species. Heads are shown in profile. Solid line equals 1 mm.

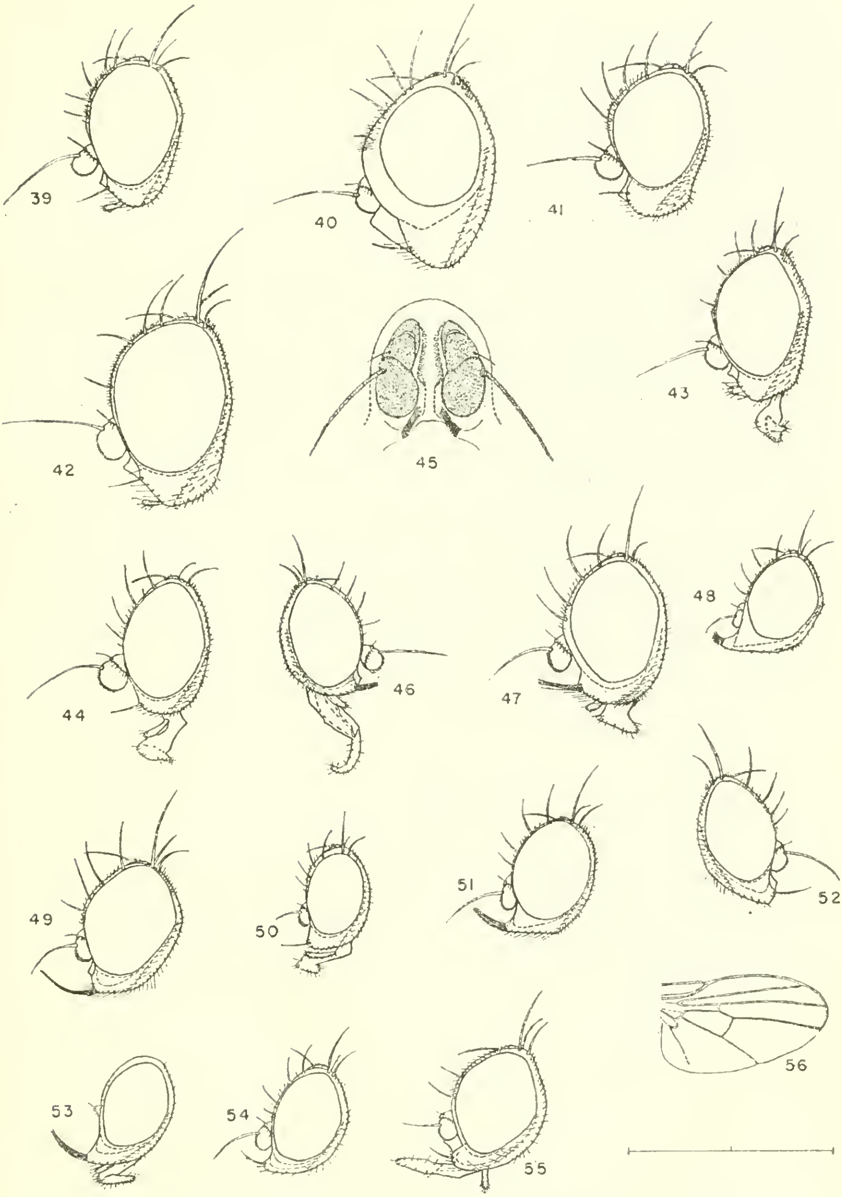
Fig. 21.—Head of holotype ♂ of *Melanagromyza aldrichi* Frick.
Fig. 22.—Head of holotype ♂ of *M. angelicae* (Frost).
Fig. 23.—Head of holotype ♂ of *M. approximata* (Frost).
Fig. 24.—Portion of head of holotype ♀ of *M. burgessi* (Malloch).
Fig. 25.—Head of same, one-half size.
Fig. 26.—Head of holotype ♀ of *M. caerulea* (Malloch), one-half size.
Fig. 27.—Antenna of allotype ♂ of *M. dianthereae* (Malloch), greatly enlarged.
Fig. 28.—Antenna of holotype ♀ of same, greatly enlarged.
Fig. 29.—Head of same, one-half size.
Fig. 30.—Head of paratype ♀ of *M. gibsoni* (Malloch).
Fig. 31.—Head of holotype ♀ of *M. longiseta* (Malloch).
Fig. 32.—Head of holotype ♂ of *M. mallochi* (Hendel).
Fig. 33.—Head of holotype ♂ of *M. minima* (Malloch).
Fig. 34.—Head of holotype ♂ of *M. orbitalis* (Frost), dorsal upper-orbital, ocellar, and inner vertical setae broken off.
Fig. 35.—Head of holotype ♀ of *M. riparella* (Hendel).
Fig. 36.—Head of holotype ♂ of *M. salicis* (Malloch).
Fig. 37.—Head of holotype ♂ of *M. setifrons* (Melander).
Fig. 38.—Head of holotype ♂ of *M. similata* (Malloch).



FIGURES 21–38.—*Melanagromyza* species. Explanation on facing page.

Figures 39–56.—*Melanagromyza, Ophiomyia,* and *Tylomyza* species. Heads are shown in profile except where noted. The solid line equals 1 mm.

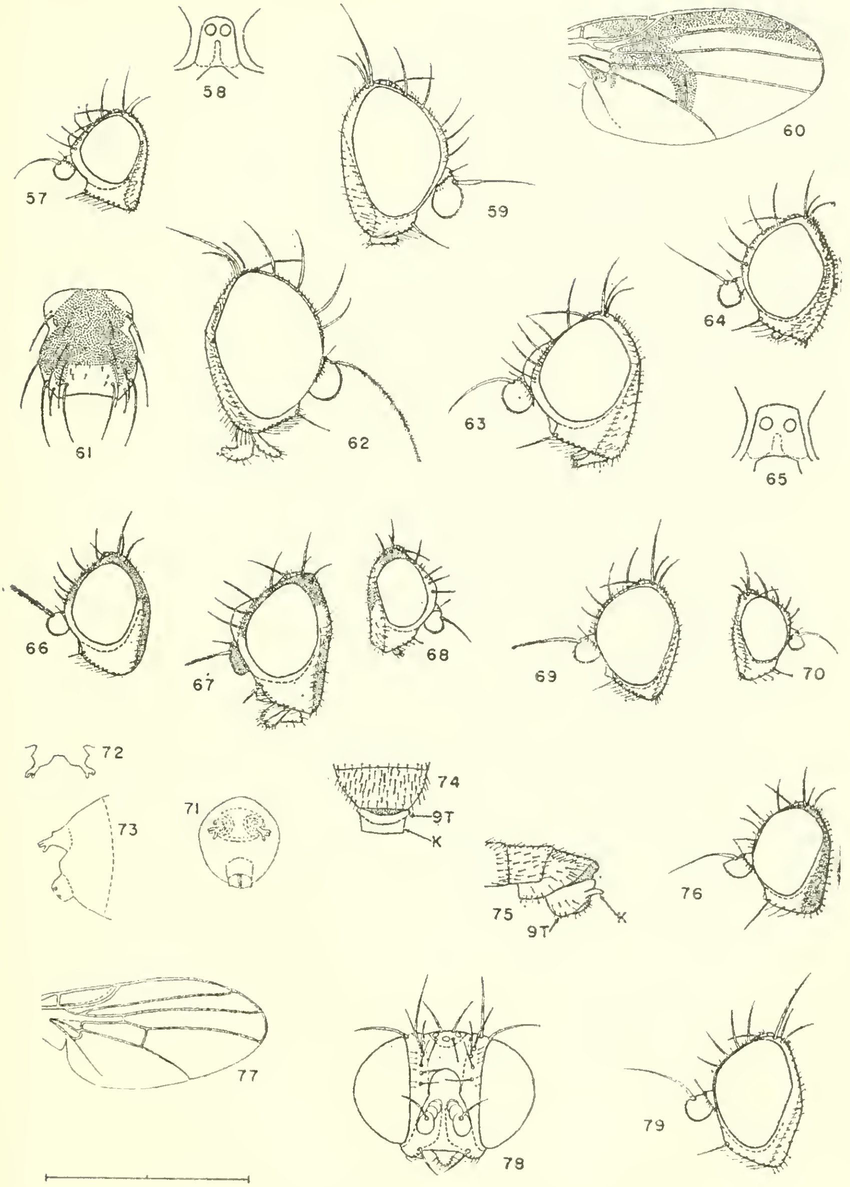
Fig. 39.—Head of holotype ♀ of *Melanagromyza subvirens* (Malloch).
Fig. 40.—Head of lectotype ♀ of *M. tamia* (Melander).
Fig. 41.—Head of paratype ♀ of *M. tiliae* (Couden).
Fig. 42.—Head of paratype ♀ of *M. virens* (Loew).
Fig. 43.—Head of holotype ♀ of *M. viridis* (Frost).
Fig. 44.—Head of holotype ♀ of *M. winnemanae* (Malloch).
Fig. 45.—Portion of head of *Ophiomyia maura* (Meigen) (♂, Germany, *ex Solidago virgaurea* L.), front view, greatly enlarged.
Fig. 46.—Head of holotype ♂ of *O. buscki* (Frost).
Fig. 47.—Head of holotype ♂ of *O. congregata* (Malloch).
Fig. 48.—Head of *O. coniceps* (Malloch) (♂, Laurel, Santa Cruz County, Calif.).
Fig. 49.—Head of holotype ♂ of *O. curvibrissata* (Frost).
Fig. 50.—Head of holotype ♀ of *O. insularis* (Malloch).
Fig. 51.—Head of *O. proboscidea* (Strobl) (♂, Germany, *ex Hieracium umbellatum* L.).
Fig. 52.—Head of holotype ♀ of *O. punctohalterata* (Frost).
Fig. 53.—Head of holotype ♂ of *O. texana* (Malloch), genovertical plates are not as in fig. 54 because the head could not be properly oriented, all setae missing.
Fig. 54.—Head of paratype ♀ of *O. texana* (Malloch).
Fig. 55.—Head of *Tylomyza nasuta* (Melander) (holotype ♂ of *Agromyza youngi* (Malloch)).
Fig. 56.—Wing of same, one-half size.



FIGURES 39–56.—*Melanagromyza*, *Ophiomyia*, and *Tylomyza* species. Explanation on facing page.

FIGURES 57–79.—*Phytobia* species, heads shown in profile except where noted. The solid line equals 1 mm.

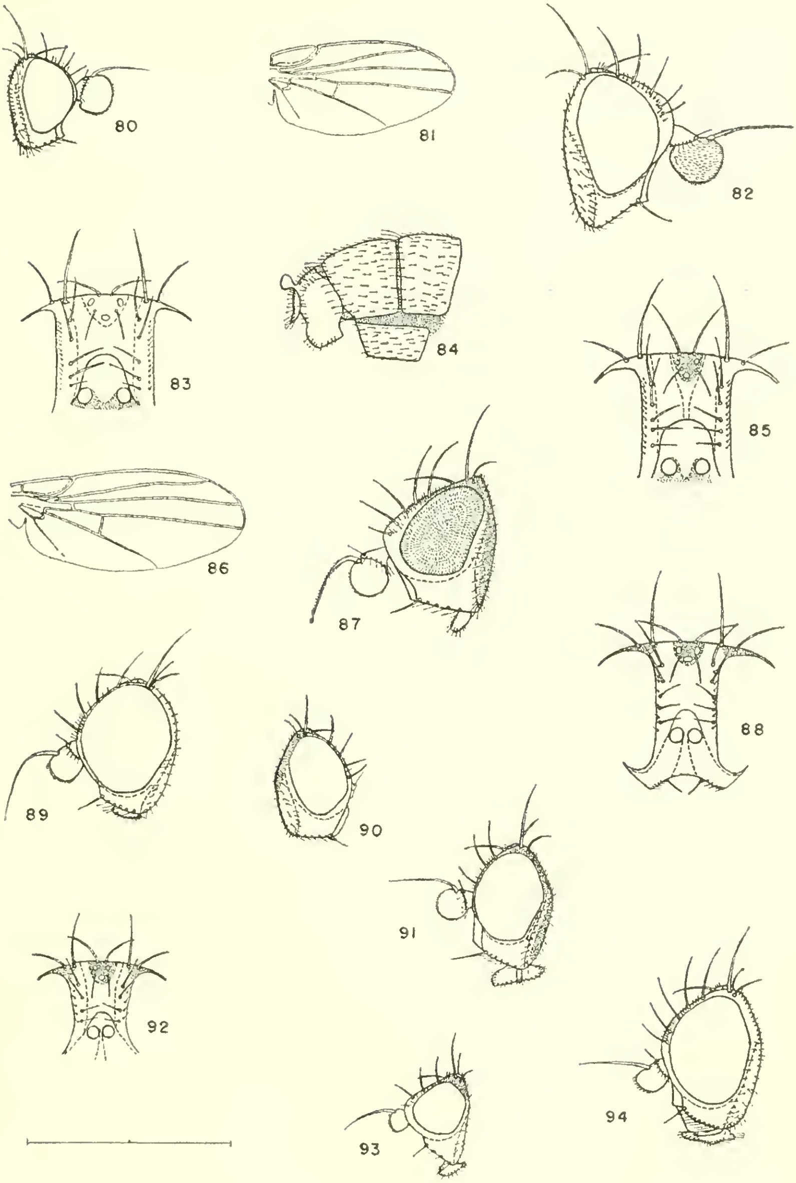
Fig. 57.—Head of holotype ♀ of *Phytobia* (*Phytobia*) *amelanchieris* (Greene), one-half size.
Fig. 58.—Mesofacial plate and lunule of same, full size.
Fig. 59.—Head of holotype ♂ of *P.* (*P.*) *indecora* (Malloch).
Fig. 60.—Wing of holotype ♂ of *P.* (*P.*) *kallima* (Frost), one-half size.
Fig. 61.—Mesonotum of holotype ♀ of *P.* (*P.*) *picta* (Coquillett), setulae on black not shown, one-half size.
Fig. 62.—Head of same, full size.
Fig. 63.—Head of holotype ♂ of *P.* (*P.*) *pruinosa* (Coquillett).
Fig. 64.—Head of *P.* (*P.*) *setosa* (Loew) (holotype ♀ of *Agromyza aceris* Greene), one-half size.
Fig. 65.—Mesofacial plate and lunule of same, full size.
Fig. 66.—Head of *P.* (*Cephalomyza*) *albidohalterata* (Malloch) (♂, White Heath, Ill.).
Fig. 67.—Head of lectotype ♀ of *P.* (*C.*) *auriceps* (Melander).
Fig. 68.—Head of holotype ♀ of *P.* (*C.*) *indecisa* (Malloch).
Fig. 69.—Head of *P.* (*Poëmyza*) *angulata* (Loew) (♂, Savanna, Illinois).
Fig. 70.—Head of holotype ♂ of *P.* (*P.*) *inconspicua* (Malloch).
Fig. 71.—Posterior end of puparium of same, spiracles above, anal opening below, posterior view.
Fig. 72.—Posterior spiracles of same, dorsal view.
Fig. 73.—Posterior end of same, lateral view.
Fig. 74.—Male terminalia of *P.* (*P.*) *lateralis* (Macquart) (paratype ♂ of *Agromyza coquilletti* Malloch), showing keel (K) of ninth tergite (9T).
Fig. 75.—Male terminalia of same, lateral view.
Fig. 76.—Head of *P.* (*P.*) *lateralis* (Macquart) (holotype ♀ of *Agromyza coquilletti* Malloch).
Fig. 77.—Wing of holotype ♂ of *P.* (*P.*) *subangulata* (Malloch), one-half size.
Fig. 78.—Head of same, front view.
Fig. 79.—Head of same, lateral view.



Figures 57–79.—*Phytobia* species. Explanation on facing page.

FIGURES 80–94.—*Phytobia* species. Heads are shown in profile except where noted. The solid line equals 1 mm.

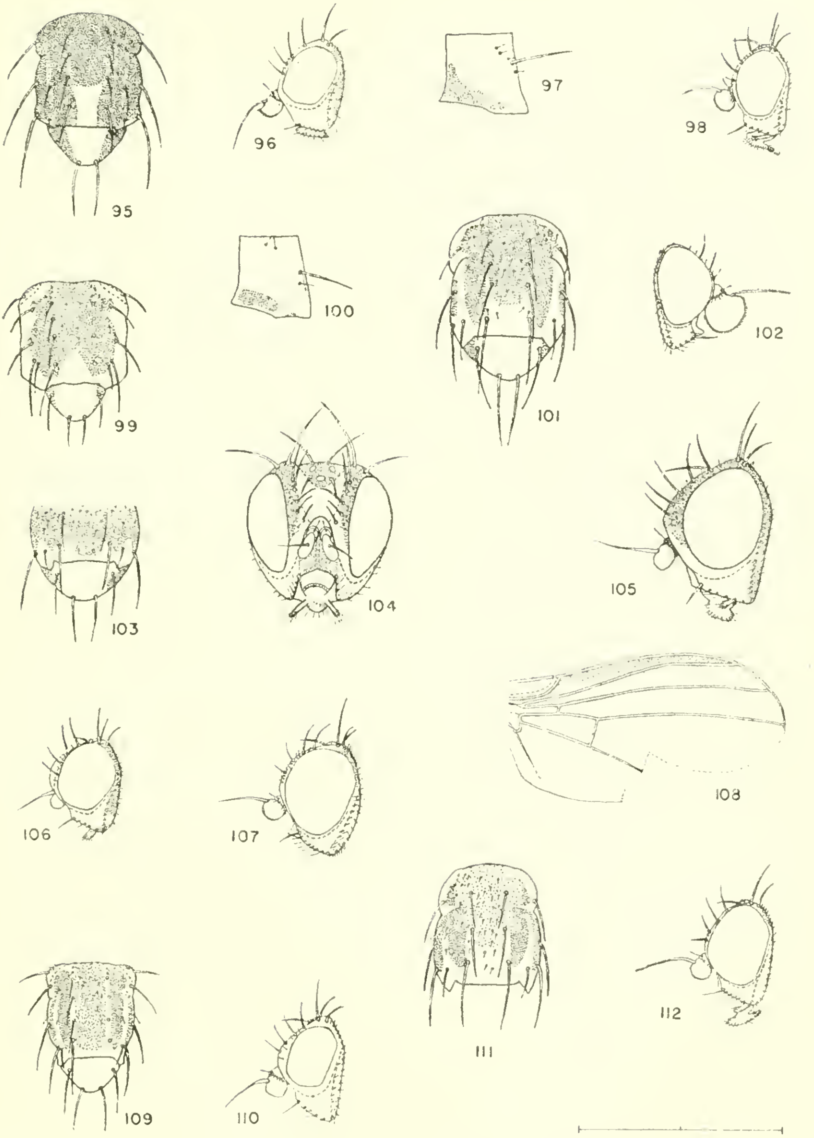
Fig. 80.—Head of holotype ♂ of *Phytobia* (*Dizygomyza*) *magnicornis* (Loew).
Fig. 81.—Wing of same, one-half size.
Fig. 82.—Head of lectotype ♂ of *P.* (*D.*) *thompsoni* Frick.
Fig. 83.—Head of same, front view.
Fig. 84.—Posterior end of abdomen and male terminalia of same, lateral view.
Fig. 85.—Head of *P.* (*Icteromyza*) *capitata* (Zetterstedt) (♂, Germany), front view.
Fig. 86.—Wing of holotype ♀ of *P.* (*I.*) *longipennis* (Loew), one-half size.
Fig. 87.—Head of lectotype ♂ of *P.* (*I.*) *pollinosa* (Melander).
Fig. 88.—Head of *P.* (*Trilobomyza*) *verbasci* (Bouché) (♂, Germany, *ex Scrophularia nodosa* L.), front view.
Fig. 89.—Head of holotype ♀ of *P.* (*T.*) *calyptrata* (Hendel).
Fig. 90.—Head of holotype ♀ of *P.* (*T.*) *pleuralis* (Malloch), third antennal segment missing.
Fig. 91.—Head of holotype ♀ of *P.* (*T.*) *varia* (Melander).
Fig. 92.—Head of *P.* (*Praspedomyza*) *approximata* (Hendel) (♀, Germany, *ex Daphne mezereum* L.), front view.
Fig. 93.—Head of *P.* (*P.*) *clara* (Melander) (♂, Mount Hermon, Santa Cruz County, Calif., *ex Pteridium aquilinum* (L.) Kuhn).
Fig. 94.—Head of holotype ♂ of *P.* (*P.*) *subinfumata* (Malloch).



Figures 80–94.—*Phytobia* species. Explanation on facing page.

FIGURES 95–112.—*Cerodontha* and *Liriomyza* species. Heads are shown in profile except where noted. The solid line equals 1 mm.

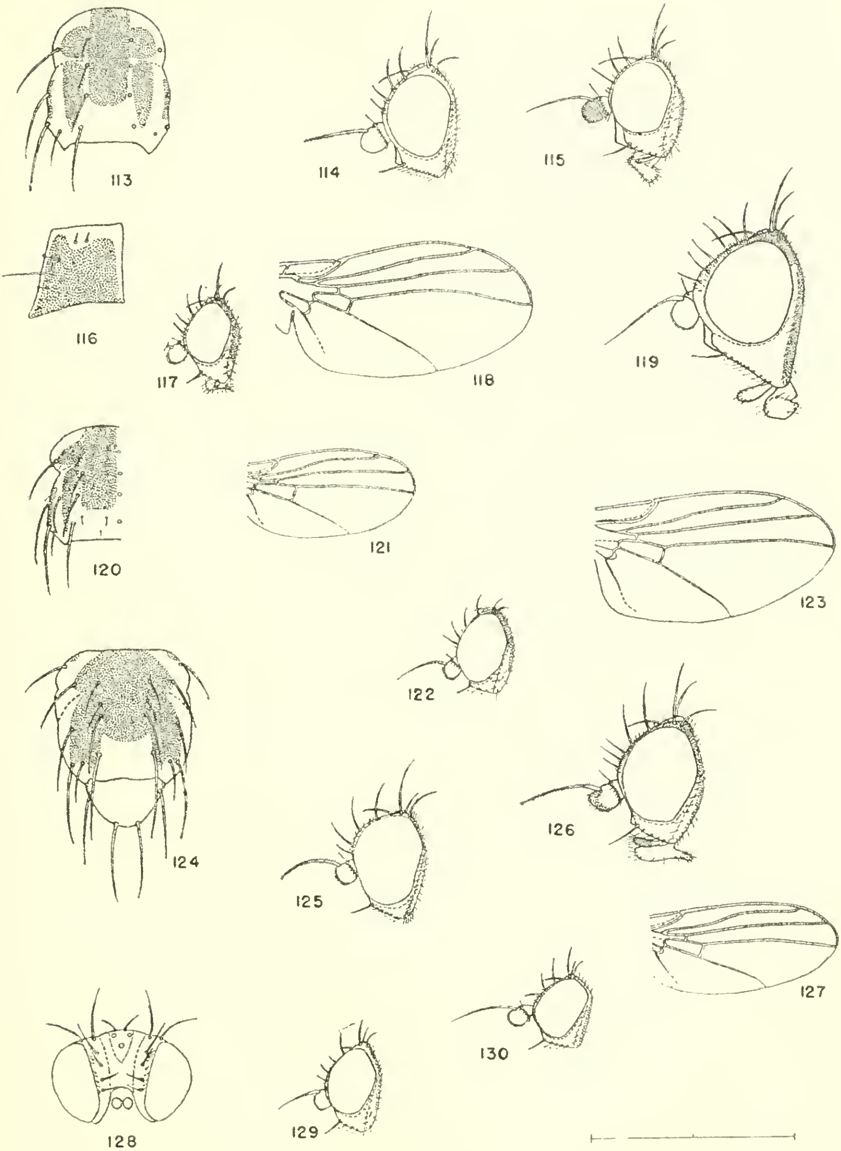
Fig. 95.—Mesonotum of holotype ♀ of *Cerodontha dorsalis* (Loew).
Fig. 96.—Head of holotype ♂ of *Liriomyza angulicornis* (Malloch).
Fig. 97.—Anepisternum of same, double size.
Fig. 98.—Head of holotype ♂ of *L. assimilis* (Malloch).
Fig. 99.—Mesonotum of same, right dorsocentrals omitted.
Fig. 100.—Anepisternum of same, double size.
Fig. 101.—Mesonotum of holotype ♀ of *L. borealis* (Malloch).
Fig. 102.—Head of holotype ♂ of *L. commelinae* (Frost), dorsal upper-orbital and both vertical setae missing.
Fig. 103.—Posterior half of mesonotum and scutellum of same.
Fig. 104.—Head of holotype ♀ of *L. deceptiva* (Malloch), front view.
Fig. 105.—Head of same, lateral view.
Fig. 106.—Head of holotype ♀ of *L. discalis* (Malloch).
Fig. 107.—Head of holotype ♂ of *L. felti* (Malloch).
Fig. 108.—Wing of holotype ♀ of *L. fumicosta* (Malloch), part of wing missing as shown.
Fig. 109.—Mesonotum of same, right dorsocentrals omitted.
Fig. 110.—Head of lectotype ♂ of *L. lima* (Melander).
Fig. 111.—Mesonotum of holotype ♂ of *L. marginalis* (Malloch).
Fig. 112.—Head of same.



FIGURES 95–112.—*Cerodontha* and *Liriomyza* species. Explanation on facing page.

Figures 113–130.—*Liriomyza*, *Metopomyza*, *Haplomyza*, and *Xyraeomyia* species. Heads are shown in profile except where noted. The solid line equals 1 mm.

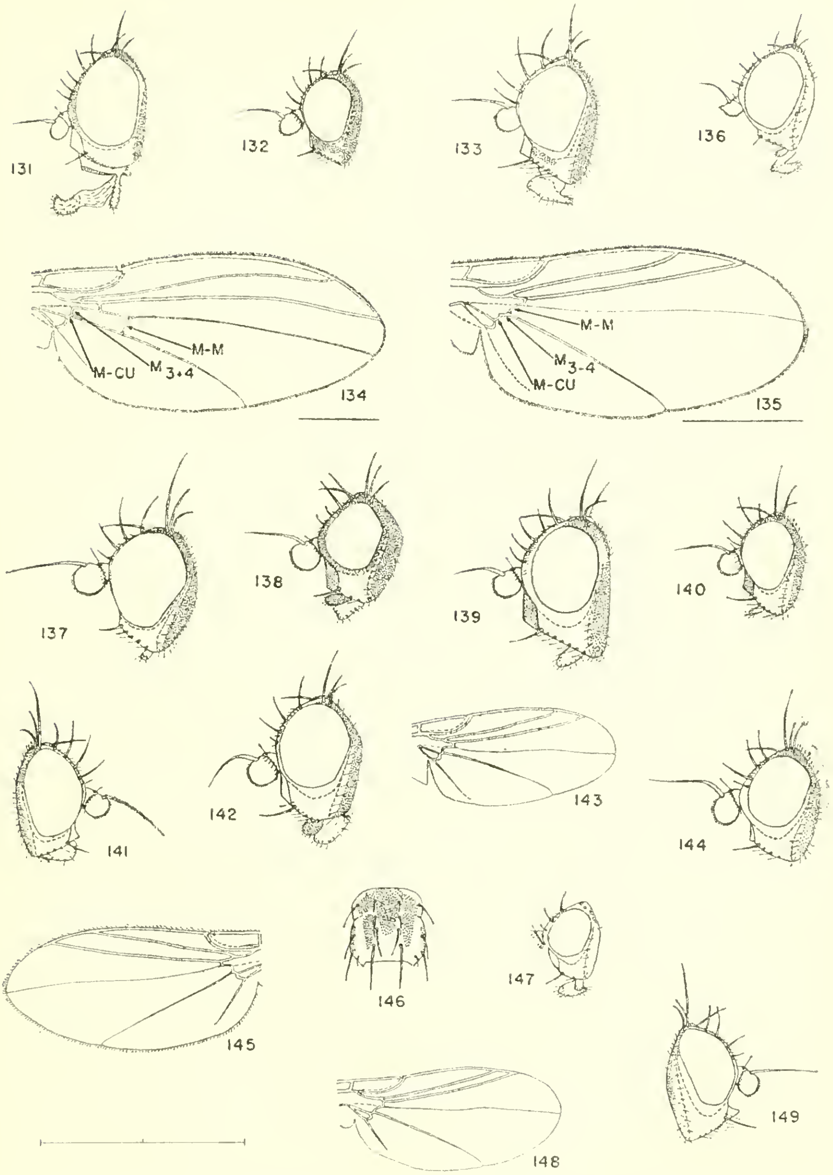
Fig. 113.—Mesonotum of lectotype ♀ of *Liromyza melampyga* (Loew), all setulae and setae on the right side omitted.
Fig. 114.—Head of *L. melampyga* (Loew) (♀, Glen Echo, Md.).
Fig. 115.—Head of lectotype ♂ of *L. pacifica* (Melander).
Fig. 116.—Anepisternum of holotype ♂ of *L. propepusilla* (Frost), double size.
Fig. 117.—Head of same.
Fig. 118.—Wing of same.
Fig. 119.—Head of holotype ♂ of *L. quadrisetosa* (Malloch).
Fig. 120.—Mesonotum of paratype ♀ of *L. reverberata* (Malloch), left half only.
Fig. 121.—Wing of same, one-half size.
Fig. 122.—Head of holotype ♂ of *L. schmidti* (Aldrich), inner vertical seta missing.
Fig. 123.—Wing of same.
Fig. 124.—Mesonotum of lectotype ♂ of *L. sorosis* (Williston), all setulae omitted.
Fig. 125.—Head of same.
Fig. 126.—Head of holotype ♀ of *L. variata* (Malloch).
Fig. 127.—Wing of same, one-half size.
Fig. 128.—Head of *Metopomyza interfrontalis* (Melander) (♀, Hope Valley, Alpine County, Calif.).
Fig. 129.—Head of *Haplomyza togata* (Melander) (♀, Bakersfield, Kern County, Calif., *ex Amaranthus hybridus* L.).
Fig. 130.—Head of paratype ♀ of *Xyraeomyia conjunctimontis* Frick.



FIGURES 113–130.—*Liriomyza*, *Metopomyza*, *Haplomyza*, and *Xyraeomyia* species. Explanation on facing page.

FIGURES 131–149.—*Phytagromyza*, *Pseudonapomyza*, *Napomyza*, and *Phytomyza* species. Heads shown in profile. The solid line equals 1 mm. except where noted.

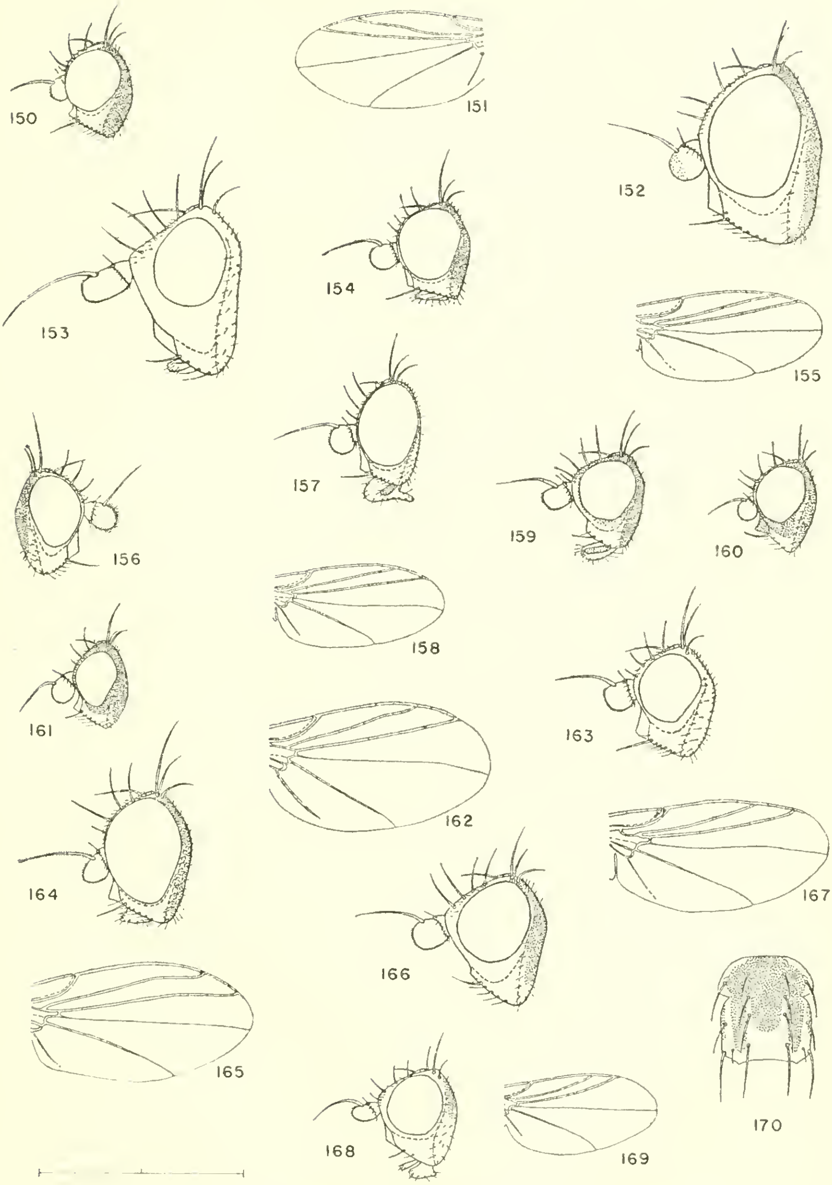
Fig. 131.—Head of *Phytagromyza nitida* (Malloch) (♂, White Heath, Ill.).
Fig. 132.—Head of lectotype ♂ of *P. orbitalis* (Melander).
Fig. 133.—Head of holotype ♂ of *P. plagiata* (Melander).
Fig. 134.—Wing of *P. flavocingulata* (Strobl) (♂, Germany), greatly enlarged, solid line equals 0.5 mm.
Fig. 135.—Wing of *Pseudonapomyza atra* (Meigen) (♂, Germany), greatly enlarged, solid line equals 0.5 mm.
Fig. 136.—Head of holotype ♀ of *P. lacteipennis* (Malloch).
Fig. 137.—Head of holotype ♀ of *Napomyza davisii* (Walton).
Fig. 138.—Head of holotype ♀ of *N. parvicella* (Coquillett).
Fig. 139.—Head of paratype ♂ of *Phytomza affinalis* Frost.
Fig. 140.—Head of holotype ♂ of *P. angelicella* Frost.
Fig. 141.—Head of holotype ♂ of *P. aquilegiana* Frost.
Fig. 142.—Head of holotype ♀ of *P. atripalpis* Aldrich.
Fig. 143.—Wing of same, one-half size.
Fig. 144.—Head of holotype ♀ of *P. auricornis* Frost.
Fig. 145.—Wing of holotype ♂ of *P. centralis* Frost.
Fig. 146.—Mesonotum of holotype ♂ of *P. clemativora* Coquillett.
Fig. 147.—Head of same, third antennal segment and both vertical setae missing.
Fig. 148.—Wing of same.
Fig. 149.—Head of holotype ♀ of *P. delphinii* Frost.



FIGURES 131–149.—*Phytagromyza*, *Pseudonapomyza*, *Napomyza*, and *Phytomyza* species. Explanation on facing page.

Figures 150–170.—*Phytomyza* species. Heads are shown in profile. The solid line equals 1 mm.

Fig. 150.—Head of holotype ♀ of *Phytomyza dura* Curran.
Fig. 151.—Wing of same, one-half size.
Fig. 152.—Head of holotype ♀ of *P. flavinervis* Frost.
Fig. 153.—Head of lectotype ♂ of *P. genalis* Melander.
Fig. 154.—Head of lectotype ♀ of *P. ilicicola* Loew.
Fig. 155.—Wing of same, one-half size.
Fig. 156.—Head of paratype ♂ of *P. lactuca* Frost.
Fig. 157.—Head of lectotype ♀ of *P. loewii* Hendel.
Fig. 158.—Wing of same, one-half size.
Fig. 159.—Head of holotype ♀ of *P. marginalis* Frost.
Fig. 160.—Head of holotype ♂ of *P. melanella* Frost.
Fig. 161.—Head of *P. minuscula* Goureau (lectotype ♂ of *P. nitida* Melander)
Fig. 162.—Wing of holotype ♀ of *P. nervosa* Loew, one-half size.
Fig. 163.—Head of holotype ♂ of *P. nigrinervis* Frost.
Fig. 164.—Head of paratype ♀ of *P. plumiseta* Frost.
Fig. 165.—Wing of same, one-half size.
Fig. 166.—Head of holotype ♀ of *P. subtenella* Frost.
Fig. 167.—Wing of same, one-half size.
Fig. 168.—Head of holotype ♂ of *P. trivittata* Frost.
Fig. 169.—Wing of same, one-half size.
Fig. 170.—Mesonotum of same.



Figures 150–170.—*Phytomyza* species. Explanation on facing page.

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A REVISION OF THE BUTTERFLY GENERA THEOCHILA AND TATOCHILA (LEPIDOPTERA : PIERIDAE)

By José Herrera and William D. Field

This is the second in a series of four papers treating the "Tatocheilae-Phulia" complex of genera. In this paper is offered a treatment of the 14 species included in the genera *Theochila* Field and *Tatochila* Butler. Because these genera have recently been defined by the junior author (Proc. U. S. Nat. Mus., vol. 108, No. 3396, pp. 103–131, 1958), they are not further described here.

Both genera are Neotropical in distribution, *Theochila* being found in the southern nontropical parts of Brazil, in Paraguay, and in eastern Argentina and *Tatochila* being distributed from Colombia and Bolivia south through Tierra del Fuego in the tundra, temperate forests, and scrub areas.

This study is based upon 620 specimens gathered from the collections of the U. S. National Museum; Museo Nacional de Historia Natural, Santiago, Chile; Instituto Pedagógico, Universidad de Chile, at Santiago; Museu Nacional, Rio de Janeiro, Brazil; Fundación Miguel Lillo, Tucumán, Argentina; Cornell University, Ithaca, N. Y.; American Museum of Natural History, New York City; Chicago Museum of Natural History; and British Museum (Natural History), London. Thanks for the loan of this material are due to the officials of all of these museums and most especially to Dr. Kenneth J. Hayward of the museum in Tucumán, Mr. D. S. Fletcher of the British

Museum, and Dr. Emilo Ureta-R. of the Museo Nacional de Historia Natural, Santiago, Chile.

All specific and subspecific descriptions were prepared to supplement the illustrations and should be studied with that in mind.

The descriptions of the following new subspecies were prepared by William D. Field and are credited solely to him: *Tatochila theodice staudingeri* and *T. microdice fueguensis.*

Genus *Theochila* Field

Theochila Field, Proc. U. S. Nat. Mus., vol. 108, p. 106, 1958.

Type: *Pieris maenacte* Boisduval=*Theochila maenacte* (Boisduval), by original designation.

This genus with characters as given in the original description. Only one species is included and it is here rather provisionally considered to consist of two subspecies. Its position until the present time has always been a matter of much speculation and doubt. It has, in a single decade, been placed in four different genera by four different authors.

Theochila maenacte maenacte (Boisduval)

Pieris maenacte Boisduval, Histoire naturelle des insectes, Species général des Lépidoptères, vol. 1, p. 517, 1836.—Doubleday, *in* Doubleday and Westwood, The genera of diurnal Lepidoptera, vol. 1, p. 48, 1847.

Pieris menacte Boisduval, Blanchard *nec* Boisduval (a misspelling), *in* Gay, Historia física y política de Chile, Zoologia, vol. 7, pp. 10, 11, 1852.—Butler, Proc. Zool. Soc. London (1872), p. 41, 1872.—Burmeister, Description physique de la République Argentine . . . , vol. 5, pt. 1, p. 87, 1878; Atlas, sec. 5, pt. 2, p. 13, pl. 4, fig. 10, 1879–1880.—Herrich-Schaffer, Corresp.-Blatt Zool. mineral. Ver. Regensburg, vol. 21, No. 10, p. 126, 1867.—Gosse, Entomologist, vol. 13, p. 195, September 1880.—Mabilde, Guia practica para os principantes colleccionadores de insectos, p. 56, 1896.—Röber, *in* Seitz, Gross-Schmetterlinge der Erde, vol. 5, p. 58, pl. 19, figs. b1, b2, Sept. 26, 1908.—Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, p. 403, Mar. 10, 1915.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, p. 473, Nov. 10, 1916.—Giacomelli, Physis, vol. 3, No. 15, p. 379, 1917.—Köhler, Zeitschr. Wiss. Insekt.-Biol., vol. 18, pt. 12, suppl., p. 15, Dec. 15, 1923.—Drosihn, Ent. Rundschau, vol. 50, suppl., p. 81, pl. 20, fig. m, 1933.—Breyer, Verhandlungen VII Internationalen Kongress für Entomologie, vol. 1 (for 1938), pp. 34, February 1939.—Ureta, Rev. Chilena Hist. Nat., vol. 43 (for 1939), pp. 227, 228, 1940.

Pieris automata Berg, Mabilde *nec* Berg (a misindentification), Guia practica para os principantes colleccionadores de insectos, p. 55, pl. 2, fig. 5, 1896.

Tatochila menacte (Boisduval), Bartlett-Calvert *nec* Boisduval (a misspelling), Rev. Chilena Hist. Nat., vol. 2, No. 7, p. 98, July 1898.—Klots, Ent. Americana, new ser., vol. 12, No. 4, p. 218, December 1931.

Pieris itaticayae Foetterle, Jörgensen *nec* Foetterle (a misidentification and misspelling), Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, p. 473, Nov. 10, 1916.—Röber, *in* Seitz, Gross-Schmetterlinge der Erde, vol. 5, p. 1016, Jan. 21, 1924.

Ascia (*Ganyra*) *menacte* (Boisduval), Talbot *nec* Boisduval (a misspelling), *in* Strand, Lepidopterorum catalogus, pars 66, p. 635, 1935.

Pieris phileta itaticayae Foetterle, Breyer *nec* Foetterle (a misidentification and misspelling), Verhandlungen VII Internationalen Kongress für Entomologie, p. 34, February 1939.

Synchloë maenacte (Boisduval), D'Almeida, Arq. Zool. Estado de São Paulo, vol. 2, p. 300, Jan. 3, 1941.

Ascia maenacte (Boisduval), Talbot, *in* Strand, Lepidopterorum catalogus, pars 66, p. 211, 1935.—Hayward, Acta Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 97, Oct. 25, 1951.

Theochila maenacte (Boisduval), Field, Proc. U. S. Nat. Mus., vol. 108, p. 106, figs. 1, 9, 17, 25, 34, 1958.

VENATION: As illustrated (fig. 55).

LEGS: With paronychium, claw, and pulvillus as illustrated (fig. 69).

MALE: Plate 1, figure 1. Head with an orange margin behind eyes and with outer face of palpus white to pale yellow. Wings white above, usually with apex of forewing, costal margin and distal portions of radial veins dark fuscous in color. Extreme bases of both wings above irrorated with dark fuscous scales, especially along base of cubitus in the hindwing. Hindwing and apex of forewing below white with a faint yellowish cast, remainder of forewing white. There is a faint orange spot in extreme base of hindwing below and many specimens have the veins on this surface faintly outlined with fuscous, especially along the base of cubitus.

Length of forewing, 23–28 mm. (average 25.5 mm.).

Male genitalia as illustrated (figs. 27, 41). No differences were found between the genitalia of typical *T. maenacte* and its subspecies *T. maenacte itatiayae*. The genitalia of four males were studied.

FEMALE: Plate 1, figure 1a. Head as in the male. Wings above white with veins heavily outlined with fuscous and with dark apical area of forewing more extensive than in the male. Wings below as in the male, with ground color more yellow and with fuscous along the veins more distinct.

Length of forewing, 23–28 mm. (average, 25.5 mm.).

Female genitalia as illustrated (fig. 83), with anterior lobe of inner genital plate large, subtriangular, and having its ventral margin triundulate. As in the male, no differences were observed between the two subspecies. The genitalia of six females were studied.

TYPE LOCALITY: "Paraguay, Republique Argentina"=Paraguay.

LOCATION OF TYPE: British Museum (Natural History).

ADDITIONAL TYPE DATA: Described from a number of male specimens (number not specifically stated) in the Boisduval collection. Of these, only a single specimen is in the British Museum (Natural History), and we consider this to be the holotype.

METHOD OF IDENTIFICATION: By means of characters mentioned in the original description that are quite adequate for the identification of this name.

SYNONYMICAL NOTES: As shown in the references above, a number of workers have misspelled the name by dropping the first "a."

MISIDENTIFICATIONS: Jörgensen (1916), Röber (1924), and Breyer (1939) have all confused some specimens of *T. maenacte* with *T. maenacte itatiayae* and, in addition, have misspelled the latter. Mabilde (1896) has mistakenly identified this species as *Pieris automata* Berg.

DISTRIBUTION: Province of Buenos Aires in Argentina north into Paraguay and northwest into the states of Santa Catarina and Paraná in Brazil.

ARGENTINA: *Province of Buenos Aires*, Buenos Aires. PARAGUAY: no specific record. BRAZIL: *State of Santa Catarina*, Joinville; *State of Paraná*, Castro.

MATERIAL STUDIED: 7 males, 12 females.

***Theochila maenacte itatiayae* (Foetterle)**

Pieris itatiayae Foetterle, Rev. Mus. Paulista, vol. 5, pp. 624–627, pl. 16, fig. 5, 1902.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, p. 473, Nov. 10, 1916.—Giacomelli, Physis, vol. 3, No. 15, p. 379, 1917.—Zikán, Ent. Rundschau, vol. 45, p. 7, Jan. 15, 1928.

Pieris itaticayae Foetterle, Röber *nec* Foetterle (a misspelling), *in* Seitz, Gross-Schmetterlinge der Erde, vol. 5, p. 60, pl. 19, fig. d1, 1908; ibid, vol. 5, p. 1016, Jan. 21, 1924.

Synchloë maenacte itatiayae (Foetterle), D'Almeida, Arq. Zool. Estado de São Paulo, vol. 2, p. 300, pl. 1, figs. 1, 5, Jan. 3, 1941.

Leptophobia itaticayae Foetterle, Talbot *nec* Foetterle (a misspelling), *in* Strand, Lepidopterorum catalogus, pars 66, p. 52, 1935.

VENATION: Not illustrated, not different from typical *maenacte*.

LEGS: With paronychium, claw, and pulvillus not illustrated, not different from the typical subspecies.

MALE: Plate 1, figure 2. This subspecies is quite similar to typical *T. maenacte*, differing chiefly in having the fuscous on apex of forewing covering a considerably larger area and usually with dark scaling along veins on hindwing below slightly more distinct.

Length of forewing, 22–28 mm. (average, 25 mm.).

Male genitalia not illustrated, not different from the genitalia of typical *T. maenacte*. The genitalia of four males were studied.

FEMALE: Plate 1, figure 2a. Palpi as in the male but all five females available for study lacked the orange scaling behind the eyes (in four of these the heads were in poor shape). Wings similar to females of *T. maenacte maenacte* with fuscous on apical area more extensive and forming a more solid band. Wings below not distinguishable from the typical subspecies.

Length of forewing, 23–27 mm. (average 25 mm.).

Female genitalia not illustrated and not different from the typical subspecies. The genitalia of three females were studied.

VARIATION: One male (of a series of four) and one female (of a series of seven) labeled "Castro, State of Paraná, Brazil" are like *T. maenacte itatiayae*, while the remaining specimens from this locality are clearly *T. maenacte maenacte*. If these two specimens are correctly labeled (which we have reason to doubt) we will have to accept the fact that either the two subspecies overlap in distribution or that they are found a very short distance from each other although perhaps under different ecological conditions. For the time being this pair is classified as *itatiayae*, but Castro is not included as a locality for that subspecies.

TYPE LOCALITY: "Itatiaya, a partir de 1700 metros para cima," Brazil. The Itatiaya Mountains in the Serra do Mar chain, located in the region where the three states of Minas Gerais, Rio de Janeiro, and São Paulo join.

LOCATION OF TYPES: In the collection of José G. Foetterle, which according to Horn and Kahle (Ent. Beih. Berlin-Dahlem, vol. 2, p. 78, 1935) is in the Natural History Museum in Vienna, Austria.

ADDITIONAL TYPE DATA: Described from four males and one female, of which Foetterle considered one male and one female as "types" (=cotypes).

METHOD OF IDENTIFICATION: Identified by comparison of topotypical material with the original description and with the excellent original figure (in color).

SYNONYMICAL NOTES: There are no synonyms; however both Röber and Talbot, as shown in the references, have misspelled the name by adding a "e" between the second "i" and the second "a."

DISTRIBUTION: Only known from in and around the Itatiaya Mountains in the Serra do Mar chain of eastern Brazil.

BRAZIL: *State of Minas Gerais*, Passa Quatro (1,600 m., March, April, November), Virginia (1,500 m., January), Caldas (July); *State of Rio de Janeiro*, Itatiaya (February–April, August, October).

MATERIAL STUDIED: 14 males, 6 females.

Genus *Tatochila* Butler

Tatochila Butler, Cist. Ent., vol. 1, pp. 38, 51–52, 56, Sept. 12, 1870; Proc. Zool. Soc. London (1872), p. 67, Jan. 16, 1872.—Reed, Anal. Univ. Chile, vol. 49, p. 665, September 1877; Una Monografia de los Mariposas Chilenas, p. 20, 1877.—Butler, Trans. Ent. Soc. London (1881), pp. 472–474, December 1881.—Bartlett-Calvert, Anal. Univ. Chile, vol. 69, p. 314, March 1886.—Schatz, *in* Staudinger and Schatz, Exotische Schmetterlinge, Theil 2, p. 61, 1892.—Berg, Anal. Mus. Nac. Buenos Aires, vol. 4, pp. 217–255, figs. 1–5, Nov. 18, 1895.—Bartlett-Calvert, Rev. Chilena Hist. Nat., vol. 2, p. 98, 1898.—Elwes, Trans. Ent. Soc. London (1903), pp. 292–293, October 1903.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, pp. 55–57, pl. 18, 1908.—Dixey, Proc. Ent. Soc. London (1909), p. cxxxv, Mar. 30, 1910.—Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 403–415, Mar. 10, 1915; Rev. Chilena Hist. Nat., vol. 20, pp. 41–57, 3 pls., June 30, 1916.—Jörgensen, Anal. Mus. Nac. Hist. Buenos Aires, vol. 28, pp. 430, 433–470, figs. 3–7, Nov. 10, 1916.—Giacomelli, Physis, vol. 3, pp. 371–378, 1917.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, pp. 1015–1016, Jan. 21, 1924.—Klots, Ent. Americana, new ser., vol. 12, No. 3, pp. 154, 161, December 1931; No. 4, pp. 217–218, 230, pl. 12, fig. 87, March 1932.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, pp. 57–59, Oct. 24, 1932; pars 66, p. 626, Aug. 30, 1935.—Ureta, Bol. Mus. Nac. Hist. Nat., vol. 16, p. 123, 1937; Rev. Chilena Hist. Nat., vol. 41, pp. 239–283, pls. 11, 13, figs. 33–39, 1938.—Breyer, Verhandlungen VII Internationalen Kongress für Entomologie, vol. 1 (for 1938), pp. 28–33, 1938.—Apolinar, Rev. Acad. Colombiana Cienc. Exact. Fís. Nat., vol. 4, p. 349, 1941.—D'Almeida, Pap. Avulsos Dep. Zool., Sec. Agr. Brazil, vol. 3, p. 103, June 4, 1943.—Bryk, Ark. f. Zool., vol. 36a, pp. 5–7, pl. 1, figs. 2, 9, Nov. 6, 1944.—Hayward, Acta Zool. Lilloana, vol. 9, pp. 91–94, Oct. 25, 1951.—Field, Proc. U. S. Nat. Mus., vol. 108, pp. 108–110, 1958.

Tatocheila Butler, Scudder *nec* Butler (a misspelling), Proc. Amer. Acad. Arts Sci., vol. 10, p. 276, 1875.—D'Almeida, Pap. Avulsos Dep. Zool., Sec Agr. Brazil, vol. 3, p. 102, June 4, 1943.

Synchloë Hübner, D'Almeida *nec* Hübner (falsely states that *Synchloë* was originally monotypic and makes a pseudotype of *S. autodice* Hübner), Arq. Zool. Estado de São Paulo, vol. 2, p. 299, Jan. 3, 1941; Pap. Avulsos Dep. Zool., Sec. Agr. Brazil, vol. 3, p. 102, June 4, 1943.

TYPE: *Synchloë autodice* Hübner=*Tatochila autodice* (Hübner). Type by reason of original designation and also by being sole included species.

Since this genus has just recently been redefined (Field, Proc. U. S. Nat. Mus., vol. 108, pp. 108–110, 1958), there is no need for discussion of its characters here.

The 13 species included in this genus are divided into five species groups on the basis of the type of aedeagus and differences in the wing patterns. It was not found necessary to include genitalia characters in the key.

Key to the species and subspecies of *Tatochila*

1. Hindwing below with a distinct white spot covering the lower discocellular vein and a considerable area of white along both sides of this vein (Groups B and C) 2
   Hindwing below lacking this white spot and with lower discocellular vein outlined with black; or if white spot is present, it is restricted to the vein only (Groups A, D, E) 19
2. Hindwing below with interspace $Sc+R_1$ containing a small oval or irregularly shaped spot or streak in the middle (Group B) 3
   Hindwing below with interspace Sc+R, lacking this spot (Group C) . . 5

3\. Males 4
Females 6

4\. Hindwing above lacking distinct, black, marginal, wedge-shaped markings on ends of veins and lacking the distinct sagittate, submarginal, and intervenal black spots . . . . . . **T. autodice** (p. 481)
Hindwing above with distinct, black marginal, wedge-shaped markings on ends of veins and with distinct sagittate, submarginal and intervenal black spots . . . . . . **T. blanchardii** . . . 5

5\. Hindwing below with ground color very pale yellow or white washed with yellow . . . . . . **T. blanchardii blanchardii** (p. 484)
Hindwing below with ground color distinctly yellow.
T. blanchardii ernestae (p. 486)

6\. Hindwing above with ground color white, sometimes slightly tinged with yellow; apex of forewing with wedge-shaped marks extending inward only to submarginal black spots . . . . . . **T. autodice** (p. 481)
Hindwing above with ground color distinctly yellow; apex of forewing with wedge-shaped marks extending inward to the cell.
T. blanchardii . . . 7

7\. Apex of forewing and hindwing below, light yellow (central Chile, Province of Coquimbo south to Temuco).
T. blanchardii blanchardii (p. 484)
Apex of forewing and hindwing below, dark yellow (northern Chile (Province of Tarapaca), southern Peru, and Bolivia (Department of Potosí)).
T. blanchardii ernestae (p. 486)

8\. Males 9
Females 14

9\. Hindwing above entirely white 10
Hindwing above with considerable black scaling on or near the ends of the veins 13

10\. Scales behind eyes orange; hindwing below mainly white.
T. vanvolxemi (p. 495)
Scales behind eyes white to pale yellow; hindwing below mainly yellow . 11

11\. Marginal wedge-shaped spots of forewing distinctly divided in middle by white scaling on veins . . . . . . **T. mercedes** (p. 497)
Marginal wedge-shaped spots of forewing solid 12

12\. Forewing averaging about 22 mm. in length; with dark markings and discocellular bar on forewing reduced and with white spot over lower discocellular vein on hindwing underneath small.
T. microdice fueguensis (p. 490)
Forewing averaging about 24 mm. in length; with dark markings and discocellular bar on forewing more extensive and with white spot over lower discocellular vein on hindwing underneath larger.
T. microdice microdice (p. 488)

13\. Hindwing below with a series of distinct, submarginal, sagittate markings.
T. microdice macrodice (p. 492)
Hindwing below lacking this series of sagittate markings.
T. microdice arctodice (p. 494)

14\. Scales behind eyes distinctly orange 17
Scales behind eyes white to pale yellow 15

15\. Ground color of wings above distinctly yellow.
T. microdice fueguensis (p. 490)
Ground color of wings above white, sometimes with a faint yellow cast . 16

16. Hindwing above with dark scaling along veins restricted to the outer margin. **T. mercedes** (p. 497)

Hindwing above with dark scaling along entire length of veins. **T. microdice microdice** (p. 488)

17. Dark scaling along either side of veins on hindwing not covering the veins. **T. vanvolxemi** (p. 495)

Dark scaling covering the veins 18

18. Hindwing below with a distinct series of fuscous, submarginal, sagittate markings; with white striping on veins narrow, usually covering only the veins . . . . **T. microdice macrodice** (p. 492)

Hindwing below with fuscous, sagittate markings obsolete, sometimes entirely replaced with faint red spots; with white striping on veins broader, usually covering slightly more than the veins. **T. microdice arctodice** (p. 494)

19. Ground color of hindwing white washed with yellow; submarginal sagittate markings on both pair of wings underneath extending to at least below vein Cu_2 . . . . **T. theodice** and its subspecies (p. 475)

Ground color of hindwing underneath distinctly yellow; submarginal sagittate markings usually absent from both pairs of wings underneath or, if present, very faint and not extending below vein Cu_2 (Groups D, E) 20

20. Palpi with outer surface orange . . . . **T. orthodice** (p. 504)

Palpi with outer surface yellow or white 21

21. Scales behind eyes orange 22

Scales behind eyes white 24

22. Outer edge of forewing entirely black with marginal wedge-shaped markings solidly colored; hindwing below with distinct orange streaks in base of wing below cell and on outer half of wing between veins 25

Outer edge of forewing white except for the wedge-shaped markings, at least some of which are divided in the middle by white along the veins; hindwing below with orange restricted to coastal margin. **T. inversa** (p. 501)

23. Hindwing below with large orange streak covering upper half of cell; forewing above with a submarginal series of connected sagittate markings. **T. xanthodice** (p. 511)

Hindwing below with this area yellow; forewing above lacking sagittate markings . . . . **T. homoeodice** (p. 503)

24. Hindwing and apex of forewing below with long orange streaks between the veins extending from near the cell to the outer margin; veins on hindwing narrowly covered with dull white 25

Hindwing and apex of forewing below lacking these orange streaks; veins on hindwing broadly covered with silvery white . . **T. distincta** (p. 513)

25. Outer margin of hindwing above and below bordered by a distinct but narrow black line . . . . **T. sagittata** (p. 506)

Outer margin of hindwing below with this black line lacking or represented only by short indistinct bars at the ends of the veins. **T. stigmadice** (p. 507)

GROUP A. THE THEODICE GROUP

In this group the distal end of the aedeagus is deeply incised on its ventral side only, forming a large triangular-shaped lobe on its right side.

Hindwings above with solid-colored wedge-shaped markings along the outer margins and usually with a submarginal series of sagittate markings. Hindwings below with white ground color; with a submarginal series of sagittate markings; with narrow orange streaks through the middle of the interspaces from the outer margin to the cell and lacking a white spot that in some other groups covers the lower discocellular vein.

A single species that divides into three subspecies comprises this group.

Tatochila theodice theodice (Boisduval)

Pieris theodice Boisduval, Voyage de découvertes de l'*Astrolabe*, pt. 1, Lépidoptères, p. 51, 1832; Histoire naturelle des insectes, Species général des Lépidoptères, vol. 1, pp. 540, 541, 1836.—Doubleday, *in* Doubleday and Westwood, The genera of diurnal Lepidoptera, vol. 1, p. 51, 1847.—Blanchard, *in* Gay, Historia Física y Política de Chile, Zoologia, vol. 7, p. 12 (description of female *theodice* only, which actually is male *theodice*), 1852.—Lucas, Rev. Mag. Zool., ser. 2, vol. 4, p. 337, July 1852.—Herrich-Schäffer, Corresp. Blatt Zool.-Min. Ver. Regensburg, vol. 21, No. 10, p. 125, 1867.—Kirby, A synonymic catalogue of diurnal Lepidoptera, p. 450, 1871.—Berg, Actas Acad. Nac. Cienc., Córdoba, Argentine Rep., vol. 1, p. 66, 1875.

Pieris demodice Blanchard, *in* Gay, Historia de física y politica de Chile, Zoologia, vol. 7, pp. 13–14, 1852.—Kirby, A synonymic catalogue of diurnal Lepidoptera, p. 451, 1871.—Berg, Bull. Soc. Imp. Nat. Moscou, 1875, No. 4, pp. 195, 196, 1876.—Burmeister, Description physíque de la République Argentine . . . vol. 5, pt. 1, p. 89, 1878.—Staudinger, *in* Staudinger and Schatz, Exotische Schmetterlinge, vol. 1, p. 31, vol. 2, pl. 18, fig. a1, 1888.

Tatochila theodice Boisduval, Butler, Proc. Zool. Soc. London, 1872, p. 67, Jan. 16, 1872.—Reed, Anal. Univ. Chile, vol. 51, pp. 668–669, 1877.—Dixey, Proc. Ent. Soc. London, 1909, p. cxxxiv, Mar. 30, 1910.—Klots, Ent. Americana, new ser., vol. 12, No. 4, p. 218, March 1932.—Ureta, Rev. Chilena Hist. Nat., vol. 38, p. 78, 1934.—Breyer, Verhandlungen VII Internationalen Kongress für Entomologie, p. 30, February 1939.—Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 92, Oct. 25, 1951.

Tatochila demodice (Blanchard), Butler, Proc. Zool. Soc. London (1872), p. 67, Jan. 16, 1872.—Reed, Anal. Univ. Chile, vol. 51, pp. 666, 667, 1877.—Butler, Trans. Ent. Soc. London (1881), p. 473, December 1881.—Bartlett-Calvert, Anal. Univ. Chile, vol. 69, p. 314, 1886.—Berg, Anal. Mus. Nac. Buenos Aires, vol. 4, pp. 240–245, Nov. 18, 1895.—Bartlett-Calvert, Rev. Chilena Hist. Nat., vol. 2, p. 98, July 1898.—Porter, Rev. Chilena Hist. Nat., vol. 3, p. 36, April 1899.—Elwes, Trans. Ent. Soc. London, 1903, pt. 3, pp. 292–293, pl. 12, figs. 7, 8, October 1903.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, pp. 56, 57, May 25, 1908.—Paravicini, Mitteil. Schweiz. Ent. Ges., vol. 12, pt. 1, p. 22, May 1910.—Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 406, 408, 414, 415, Mar. 10, 1915; Rev. Chilena Hist. Nat., vol. 20, pp. 44, 46, 57, 51, June 30, 1916.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, pp. 443, 462–464, figs. 3, 4, Nov. 10, 1916.—Giacomelli, Physis, vol. 3, p. 376, 1917.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 1015, pl. 194, figs. a2, a3, Jan. 21, 1924.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 58, Oct. 24, 1932.—Breyer, Rev. Soc. Ent.

Argentina, vol. 8, p. 63, 1936; Verhandlungen VII Internationalen Kongress für Entomologie, vol. 1 (1938), p. 30, February 1939.—Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 93, Oct. 25, 1951.

Pieris xanthodice Lucas, Mabille *nec* Lucas (a misidentification, figure only), Mission scientifique du Cap Horn, vol. 6, Zoologie, Insectes, pl. 1, fig. 1, 1888.

Tatochila theodice theodice (Boisduval), Ureta, Rev. Chilena Hist. Nat., vol. 41 (1937), pp. 265–270, fig. 37, Nos. 1–7; pl. 11, figs. 9, 10, 1938; Bol. Mus. Nac. Hist. Nat., vol. 16, p. 123, 1938.

Tatochila theodice flammivolans Bryk, Ark. f. Zool., vol. 36A, pp. 6, 7, Nov. 6, 1944.

Tatochila theodice flammivolans f. *antiquincunx* Bryk, Ark. f. Zool., vol. 36A, p. 7, pl. 1, fig. 9, Nov. 6, 1944.

Tatochila theodice autodice (Boisduval), Forster *nec* Boisduval (in error for *T. theodice theodice*), Veroffentl. Zool. Staatss. München, vol. 3, p. 134, Dec. 1, 1955.

VENATION: As illustrated (fig. 56).

LEGS: With paronychium, claw, and pulvillus as illustrated (fig. 72).

MALE: Plate 1, figures 3, 4. Head with scales behind eyes and with outer faces of palpi white to pale yellowish white. Wings above white with dark markings as illustrated, having the dark scaling along veins more heavy on outer margin, forming inwardly directed wedge-shaped marks. Both wings with a submarginal series of sagittate markings. Forewing with a large discal spot. Wings below with apex of forewing and ground color of hindwing pale yellow to white. Veins white and outlined on both sides with fuscous. Both pair of wings with a submarginal and intervenal row of sagittate markings. Hindwing with a fuscous streak through cell, forked near end of cell, with costal margin ornage-yellow, with a long orange-yellow streak below cell and with long narrow intervenal streaks of the same color on outer margin and directed inward through the sagittate markings, continuing toward the cell.

Length of forewing, 25–30 mm. (average 27.1 mm.).

Male genitalia as illustrated (figs. 29, 42), with characters as described for the group. No differences were observed between the three subspecies. The genitalia of seven males of typical *T. theodice* were studied.

FEMALE: Plate 1, figures 3a, 4a. Head as in the male. Wings above very similar to those of the male, differing in having ground color somewhat yellowish or cream colored and with all dark markings more distinct than in the male. Wings below with ground color as in the male with yellow streaks usually darker and more distinct.

Length of forewing, 25–29 mm. (average, 26.8 mm.).

Female genitalia as illustrated (fig. 86), with posterior lobe of inner genital plate uncinate and with a small basal fingerlike process. Anterior lobe of inner genital plate subtriangular, with posterior and anterior free angles greatly produced and with ventral margin undulate. Ductus bursae with ribbonlike plate large, fused to anterior subtriangular plate and with a pair or more of small irregularly shaped plates anterior to this. As in the male, no differences are displayed between the three subspecies. The genitalia of six females were studied.

Seasonal variation: In the spring and sometimes in the fall, this Chilean species produces a form that is smaller (♂, 19–25 mm., average 22.6 mm.; ♀, 22–24 mm., average 22.8 mm.) with all markings correspondingly reduced in size (pl. 1, figs. 4, 4a).

Type locality: Herewith restricted to central Chile. A mixup over the type locality is the reason for the restriction. Boisduval, in his original description, cited the type locality as "Bourou" (Buru, an island in Indonesia). Later, he (1836) corrected this to Payta, Peru. However, this locality is also in error as no species found in Peru fits either the original description or his subsequent description, while the species here discussed from central Chile and southward does agree with his descriptions.

Additional type data and location of types: *T. theodice* was originally described from the female sex, the number of specimens not being given. The type should have gone to the British Museum from the Oberthür collection. Mr. D. S. Fletcher of that museum writes that the type is not in the collection there. He states further that there is a Boisduval specimen labeled "type" by some subsequent worker but that it is certainly not the type, "for even if Boisduval were to mistake his sexes" (the specimen in question is a male) he would never mistake pure white for "white, a little yellowish." Mr. Jean Bourgogne of the Paris Museum searched the collections there and reported that the type of *theodice* is not present. The type is apparently lost.

Method of identification: Based upon the original and subsequent descriptions of Boisduval which positively fix the name *theodice* to the species here described. A neotype designation is not needed.

Synonymical notes: The data for the names listed in the above synonymy are as follows:

Pieris demodice Blanchard, 1852. Type locality, "Provincias del Norte," Chile (this should be interpreted as the north-central provinces, south of Antofagasta). Described from an unspecified number of specimens of both sexes. There are one male and three females, cotypes, in the Paris Museum. A lectotype is not designated. The original description can apply only to *T. theodice*.

Tatochila theodice flammivolans Bryk, 1944. Type locality, "Peninsula Llao Llao" on Lago Nahuel Huapí, Territory of Río Negro, Argentina. Described from holotype male, allotype female, and 20 male and 5 female paratypes. Type in Naturhistoriska Riksmuseet, Stockholm. Specimens from Villa Angostura and Lago Nahuel Huapí, Province of Neuquen (near the type locality) have been studied and found to agree with the original illustration and description of *flammivolans*. This material is typical *theodice*.

Tatochila theodice flammivolans form *antiquincunx* Bryk, 1944. Type locality as given under *flammivolans*. Described from a single male, the holotype. Type in Naturhistoriska Riksmuseet, Stockholm. This is merely an individual variant.

MISIDENTIFICATIONS: Mabille (1888) figures this species under the name *Pieris xanthodice* Lucas. Förster lists this species under the name *Tatochila theodice autodice* (Boisduval), an obvious mistake for *Tatochila theodice theodice*.

DISTRIBUTION: In Chile from the Province of Aconcagua south at least through the Province of Malleco. In Argentina in the western portions of the Province of Neuquen and the Territory of Río Negro.

CHILE: *Province of Aconcagua*, Los Andes (April); *Province of Valparaiso*, Valparaiso; *Province of Santiago*, Peñalolen (March), Cumbre, Santiago (January), El Manzano (December), Macul (February), El Canelo (February, October), Lo Valdés Cordillera (March); *Province of Talca*, Los Nieves (November); *Province of Chillan*, El Roble (January); *Province of Malleco*, Victoria. ARGENTINA: *Province of Neuquen*, Parque Nacional de Lanin, Lago Hermosa (November), Villa Angostura (December), Pucará (December), Hua Hun (December); *Territory of Río Negro*, El Tronador (February).

MATERIAL STUDIED: 22 males, 10 females.

Tatochila theodice gymnodice Staudinger

Pieris theodice Boisduval, Mabille, *nec* Boisduval, Mission Scientifique du Cap Horn, 1882–1883, vol. 6, Zoologie. Insectes, p. 7, pl. 1, fig. 1 (sic fig. 2), 1888.

Tatochila theodice gymnodice Staudinger, Lepidopteren, *in* Ergebnisse der Hamburger Magalhaensische Sammelreise, vol. 2, art. 6, p. 13, 1898.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 56, May 25, 1908.—Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 406, 412, 413, Mar. 10, 1915; Rev. Chilena Hist. Nat., vol. 20, p. 56, June 30, 1916.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, p. 456, Nov. 10, 1916.—Giacomelli, Physis, vol. 3, p. 375, 1917.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 58, Oct. 24, 1932.—Ureta, Rev. Chilena Hist. Nat., vol. 41 (for 1937), pp. 270–272, pl. 12, fig. 6, 1938, Bol. Mus. Nac. Hist. Nat., vol. 16, p. 123, 1938.

Tatochila demodice argyrodice Staudinger, Elwes *nec* Staudinger (a misidentification), Trans. Ent. Soc. London (1903), pp. 292, 293, pl. 12, figs. 9, 10, October 1903.

Tatochila theodice gymmodice Staudinger, Giacomelli *nec* Staudinger (a misspelling), Rev. Chilena Hist. Nat., vol. 20, p. 44, June 30, 1916.

Tatochila theodice f. *gymnodice* Staudinger, Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 92, Oct. 25, 1951.

Veins and legs show no subspecific characters.

MALE: Plate 2, figure 5. Head as in typical *theodice*. Wings similar to typical *theodice*, smaller with black bar at end of cell on upperside of forewing considerably narrower and with orange-yellow markings below considerably paler.

Length of forewing, 23–24 mm. (average, 23.5 mm.).

Male genitalia not illustrated and not different from the typical subspecies. Five males dissected and studied.

FEMALE: Plate 2, figure 52a. Head as in the male. Wings smaller than in typical *theodice* with black bar at end of cell on upperside of forewing narrower and with ground color considerably more suffused with fuscous in basal half of both wings above. Orange-yellow markings below considerably paler than in the typical subspecies.

Length of forewing, 19–24 mm. (average, 22.5 mm.).

Female genitalia not illustrated and not different from the typical subspecies. Four females were dissected and studied.

TYPE LOCALITY: Near "Punta-Arenas"=Punta Arenas, Department of Punta Arenas, Province of Magallanes, Chile.

LOCATION OF TYPE: In the "Zoologisches Museum der Humboldt-Universität, Berlin."

METHOD OF IDENTIFICATION: By a study of the original description and comparison with topotypical material. The name *gymnodice* is based upon a pair of rather rare individual variants lacking most of the yellow between the sagittate markings and veins of the hindwings below. In spite of this individual variation the population here described deserves recognition.

SYNONYMICAL NOTES: Giacomelli (1916) misspelled the name as *gymmodice*.

MISIDENTIFICATIONS: Mabille (1888) confuses this population with typical *theodice*. Elwes (1903) designates this population as *argyrodice*.

DISTRIBUTION: The extreme southern parts of Argentina and Chile north of the Magellan Straits and in the northern part of Tierra del Fuego.

CHILE: *Territory of Magallanes, Department of Punta Arenas*, Punta Arenas (January, February); *Department of Ultima Esperanza*, Puerto Prat (January, February), Puerto Bories (February), Gregory Bay, Dos Lagunas (February); *Department of Tierra del Fuego*, Porvenir (February). ARGENTINA: *Territory of Santa Cruz*, Río Túnel.

MATERIAL STUDIED: 11 males, 10 females.

Tatochila theodice staudingeri Field, new subspecies

Tatochila theodice Boisduval, Staudinger *nec* Boisduval (a misidentification), Lepidopteren, *in* Hamburger Magalhaensische Sammelreise, vol. 2, art. 6, pp. 10–14, 1898.

Veins and legs display no subspecific characters.

MALE: Plate 2, figure 6. Head with scales behind eyes and with outer faces of palpi white to pale yellow, rarely pale orange. Wings above similar to *T. theodice gymnodice*, having the black bar at end of cell on upperside of forewing narrower than in typical *theodice*.

Below it differs from both of these subspecies in the greater amount of dark scaling along the veins with the resulting stripes twice the width they are in the other subspecies.

Length of forewing, 21–26 mm. (average, 24.1 mm.).

Male genitalia not illustrated and not different from the other two subspecies. Two males were dissected and studied.

Female: Plate 2, figure 6a. Head as in the male. Wings above as in *gymnodice* but even more heavily suffused with fuscous. Undersurfaces as in the male with a greater amount of dark scaling along the veins.

Length of forewing, 22–26 mm. (average, 23.4 mm.).

Female genitalia not illustrated and not different from the other subspecies. One female dissected and studied.

Type locality: Puerto Harberton, Territory of Tierra del Fuego, Argentina.

Additional type data: Described from the holotype, male (locality as given above, Dec. 1, 1948, Olrog and Budin); allotype, female (same data, ♀ genitalia preparation, W. D. F.-J. H. No. 399). Paratypes: 4♀♀, same data; 1 ♂, same locality and collectors, Dec. 18, 1948; 2 ♂♂, same locality and collectors, Nov. 26, 1948; 1 ♀, Ushuaia, Territory of Tierra del Fuego, Argentina, Dec. 12, 1948, Olrog and Bodin); and 1 ♂, Río Douglas, Isla Navarino, Department of Tierra del Fuego, Province of Magallanes, Chile, Dec. 28, 1948, Olrog and Bodin.

Location of types: Holotype, allotype, four male and five female paratypes in Fundación Miguel Lillo, Universidad Nacional de Tucumán, Tucumán, Argentina. One pair of paratypes in U. S. National Museum.

Distribution: Extreme southern part of the island of Tierra del Fuego and on the island of Navarino. Specific records as given under additional type data above.

Material studied: 6 males, 6 females.

Group B. The Autodice Group

In this group the aedeagus is sinuous and is incised at the distal end on its left side, with an upwardly directed rounded lobe below the incision on this side and two distal teeth dorsad of this incision.

Hindwings above with marginal wedge-shaped markings absent or, if present, divided by the white veins and with submarginal series of sagittate markings present or absent. Hindwing below with ground color yellow or white suffused with yellow; with a submarginal series of sagittate markings; without orange streaks in middle of interspaces; possessing a white spot over the lower discocellular vein and adjacent area. This is the only group possessing an oval or irregularly shaped fuscous spot or streak in middle of interspace $Sc+R_1$ on undersurface of hindwing.

This group contains two species, one of which is divided into two subspecies.

Tatochila autodice (Hübner)

Synchloë autodice Hübner, Zuträge sur Sammlung exotischer Schmetterlinge, vol. 1, p. 26, 1818; Sammlung exotischer Schmetterlinge, vol. 2, pl. [227], 4 figs., [between Jan. 1, 1825, and Aug. 26, 1825].—D'Almeida, Arq. Zool. Estado de São-Paulo, vol. 2, p. 299, pl. 1, figs. 2, 4, Jan. 3, 1941.—Breyer, Rev. Soc. Ent. Argentina, vol. 12, p. 310, February 1945.—Zischka, Folia Universitaria, Cochabamba, Bolivia, vol. 1, p. 28, December 1947.

Pieris autodice (Hübner), Boisduval, Histoire naturelle des insectes, species général des Lépidoptères, vol. 1, pp. 539, 540, 1836.—Doubleday, List of the specimens of lepidopterous insects in the collection of the British Museum, pt. 1, p. 33, 1844; *in* Doubleday and Westwood, The genera of diurnal Lepidoptera, vol. 1, p. 51, 1847.—Herrich-Schäffer, Corresp.-Blatt Zool.-min. Ver. Regensburg, vol. 21, p. 125, 1867.—Kirby, A synonymic catalogue of diurnal Lepidoptera, p. 450, 1871.—Capronnier, Ann. Soc. Ent. Belgique, vol. 17, fasc. 1, p. 11, 1874.—Berg, Act. Acad. Nac. Cienc. Córdoba, Argentine Rep., vol. 1, p. 65, 66, 1875; Bull. Soc. Imp. Nat. Moscou (1875), pp. 193–195, 1876.—Burmeister, Description physique de la République Argentine . . ., vol. 5, pt. 1, p. 88, 1878.—Gosse, Entomologist, vol. 13, p. 195, September 1880.—Weymer and Maassen, W. Reiss und A. Stübel Reisen in Süd-Amerika, Lepidopteren . . ., p. 93, 1890.

Tatochila autodyce (Hübner), Butler *nec* Hübner (a misspelling), Cist. Ent., vol. 1, p. 51, Sept. 12, 1870.

Pontia mercedis Eschscholtz, Kirby *nec* Eschscholtz (in synomyny of *T. autodice* Hübner), A synonymic catalogue of diurnal Lepidoptera, p. 450, 1871.—Butler, Trans. Ent. Soc. London (1881), p. 473, December 1881.—Weymer and Maassen, W. Reiss und A. Stübel Reisen in Süd-Amerika, Lepidopteren. . . , p. 93, 1890.—Berg, Anal. Mus. Nac. Buenos Aires, vol. 4, p. 222, Nov. 18, 1895.

Tatochila autodice (Hübner), Butler, Proc. Zool. Soc. London (1872), p. 67, Jan. 16, 1872; Trans. Ent. Soc. London (1881), p. 473, December 1881.—Berg, Anal. Mus. Nac. Buenos Aires, vol. 4, pp. 219, 222–226, Nov. 18, 1895.—Bartlett-Calvert, Rev. Chilena Hist. Nat., vol. 2, p. 98, July 1898.—Porter, Rev. Chilena Hist. Nat., vol. 3, p. 36, April 1899.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 56, pl. 18, figs. b1–b3, May 25, 1908.—Dixey, Proc. Ent. Soc. London (1909), p. cxxxiv, Mar. 30, 1910.—Paravicini, Mitteil. Schweiz. Ent. Ges., vol. 12, heft 1, p. 21, May 1910.—Giacomelli, Anal. Soc. Cient. Argentina, vol. 78, p. 174, August 1914; Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 406–408, 410, 412, 413, Mar. 10, 1915; Rev. Chilena Hist. Nat., vol. 20, pp. 44, 45, 46–49, 53, pl. 1, figs. 1, 2, June 30, 1916.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires. vol. 28, p. 430, 443, 444–446, Nov. 10, 1916.—Giacomelli, Physis, vol. 3, p, 373, 1917.—Köhler, Zeitschr. Wiss. Insektenbiol., vol. 18, Sonderbeilage, p. 14, Dec. 15, 1923.—Klots, Ent. Americana, new ser., vol. 12, No. 4, p. 218, pl. 12, fig. 87, March 1932.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 57, Oct. 24, 1932; *in* Strand, Lepidopterorum catalogus, pars 66, Pieridae III, p. 626, Aug. 30, 1935.—Ureta, Rev. Chilena Hist. Nat., vol. 41 (for 1937), pp. 254–259, fig. 35; pl. 11, figs. 5, 6, 1938; Bol.

Mus. Nac. Hist. Nat., vol. 16, p. 123, 1938.—Breyer, Verhandlungen VII Internationalen Kongress für Entomologie, vol. 1 (for 1938), pp. 30–31, February 1939.—Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 91, Oct. 25, 1951.—Zischka, Fol. Univ., Univ. Cochabamba, Bolivia, vol. 5, p. 18, October 1951.—Forster, Veröffentl. Zool. Staatss. München, vol. 3, p. 134, Dec. 1, 1955.

Pieris mercedis (Eschscholtz), Berg *nec* Eschscholtz (in synonymy of *T. autodice* (Hübner)), Bull. Soc. Imp. Nat. Moscou (1875), p. 193, 1876.—Burmeister, Description physique de la République Argentine . . . , vol. 5, pt. 1, p. 88, 1878.

Pieris polydice Blanchard, Butler *nec* Blanchard (in synonymy of *T. autodice* (Hübner)), Trans. Ent. Soc. London (1881), p. 473, December 1881.

Hesperocharis marchalii Guérin, Mabilde *nec* Guérin (a misidentification), Guia practica para os principantes colleccionadores de insectos, p. 52, pl. 2, figs. 1a–c, 1896.

Tatochila autodice f. *flava* Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 7, pp. 135, 136, 1949.

Tatochila autodice ab. *flava* Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 91, Oct. 25, 1951.

VENATION: As illustrated (fig. 57).

LEGS: With paronychium, claw, and pulvillus as illustrated (fig. 71).

MALE: Plate 2, figures 7, 7b. Head with palpi white on the sides; scales behind eyes orange, darker above than below. Wings with markings dark brown to black in color. Ground color on upper surfaces and on disc and base of forewing below white. Below on hindwing and apex of forewing very pale yellow or white washed with yellow. Hindwing below with costal margin and extreme base orange and with a white spot over the lower discocellular vein and adjacent area. *T. autodice* differs from *blanchardii* chiefly by having the hindwing above entirely without markings or, if marked, with very faint spots at the ends of veins only and by usually having the black bar at end of cell, isolated from the costal margin.

Length of forewing, 20–30 mm. (average, 26.1 mm.).

Male genitalia as illustrated (figs. 28, 43). Very close to *blanchardii*, differing chiefly in having the aedeagus slightly less sinuate. The genitalia of seven males were studied.

FEMALE: Plate 2, figure 7a. Head as in the male. Wings with markings dark brown to black. Ground color on upper surfaces white, sometimes pale yellowish on hindwing. Wings below colored as in the male. This sex differs from the male chiefly in having all dark markings on upper surfaces larger and more distinct. From females of *blanchardii* it differs in having wedge-shaped marks on apex of forewing above extending inward only to the submarginal black spots and also in having the ground color of this surface of the hindwing white, sometimes with a faint yellowish tinge but not distinctly yellow as in that species.

Length of forewing, 21–30 mm. (average, 26.1 mm.).

Female genitalia as illustrated (fig. 84), with anterior lobe of inner genital plate gradually produced ventrally. Ductus bursae with a narrow ribbon-like plate on ventral surface opposite opening of ductus seminalis and with a small triangular plate just anterior to this. The genitalia of eight females were studied.

TYPE LOCALITY: "Aus Paraguan, vom Platastrome her." Probably near Buenos Aires, Argentina. In the latter part of the 18th century the region including the Río de la Plata was known for a time as Paraguay and this included Buenos Aires.

ADDITIONAL TYPE DATA: Originally described from the male sex, the number of specimens not stated, sent to Hübner by a Mr. Berg.

LOCATION OF TYPE: Believed to be in the Hübner collection in the Naturhistorisches Museum, Vienna, Austria.

METHOD OF IDENTIFICATION: By means of the very excellent original colored figure.

SYNONYMICAL NOTES:

Tatochila autodice f. *flava* Hayward, 1949. Type locality, "La Rioja." Described from a single female specimen, the holotype, deposited in the Museo Argentino de Ciencias Naturales de Buenos Aires. This name is listed as a synonym since it represents an individual variant.

Butler (1870) has misspelled this specific name as *autodyce*.

MISIDENTIFICATIONS: Kirby (1871) and others confused *mercedis* Eschscholtz with *autodice*. Butler (1881) has confused *polydice* Blanchard with *autodice*. Mabilde (1896) illustrates this species under the name *Hesperocharis marchalii* Guérin.

DISTRIBUTION: Bolivia and southern Brazil south into the territory of Río Negro, Argentina.

BOLIVIA: *Department of Cochabámba,* Cochabámba (March, August). BRAZIL: *State of Minas Gerais,* Punta Grosa (this record seems doubtful); *State of Rio Grande do Sul,* Pelotas (December). PARAGUAY: No specific locality. URUGUAY: *Department of Montevideo,* Montevideo. ARGENTINA: *Province of Jujuy,* Jujuy (May); *Province of Salta,* Cafayate (March), Salta (March, July); *Province of Tucumán,* Tucumán (January, April, June, October), San Genero (April, May), Valle Tafi (April), Quebrada Lulas (February); *Province of La Rioja,* La Rioja, Valle Ana (April); *Province of Córdoba,* Córdoba (February), Sauce (March), Capilla del Monte (February); *Province of Santa Fé,* Hovencia (July), Albarellos, Santa Felicia; *Province of Entre Rios,* Nuñez; *Province of Buenos Aires,* Buenos Aires (March, December); Bahia Blanca (November), Diadema (October); *Neuquén Territory,* Neuquén (November); *Río Negro Territory,* Río Negro (April), Río Colorado.

FOOD PLANTS: *Brassica oleracea* L., *Alysson maritimum* L., *Medicago sativa* L., *Cestrum parqui* L'Her., *Lepidium ruderale* L., *Cestrum pseudoquina* Mar.

MATERIAL STUDIED: 51 males, 55 females.

Tatochila blanchardii blanchardii Butler

Pieris autodice (Hübner), Blanchard *nec* Hübner (a misidentification), *in* Gay, Historia física y política de Chile, Zoologia, vol. 7, p. 11, 1852.

Pieris theodice Boisduval, Blanchard *nec* Boisduval (a misidentification), *in* Gay, Historia física y política de Chile, Zoologia, vol. 7, atlas, plate 1, figs. 2a, 2b (male), 1852.—Berg, Anal. Mus. Nac. Buenos Aires, vol. 4, pp. 227–231, fig. 1, Nov. 18, 1895.

Tatochila blanchardii Butler, Trans. Ent. Soc. London (1881), pp. 472, 473, 483, pl. 21, fig. 15, December 1881.—Bartlett-Calvert, Anal. Univ. Chile, sec. 1, Mem. Cient. Lit., vol. 69, p. 314, 1886.—Berg, Anal. Mus. Nac. Buenos Aires, vol. 4, p. 227, Nov. 18, 1895.—Bartlett-Calvert, Rev. Chilena Hist. Nat., vol. 2, p. 98, July 1898.—Porter, Rev. Chilena Hist. Nat., vol. 3, p. 36, April 1899.—Ureta, Rev. Chilena Hist. Nat., vol. 41 (for 1937), p. 181, 1938, Rev. Chilena Hist. Nat., vol. 41 (for 1937), pp. 259–265, fig. 36, pl. 11, figs. 7, 8, 1938; Bol. Mus. Nac. Hist. Nat., vol. 16, p. 123, 1938; Rev. Chilena Hist. Nat., vol. 42 (for 1938), p. 297, 1939.—Breyer, Verhandlungen VII Internationalen Kongress für Entomologie, vol. 1 (for 1938), p. 31, February 1939.—Ureta, Rev. Chilena Hist. Nat., vol. 43 (for 1939), pp. 254, 255, 1940.—Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 92, Oct. 25, 1951.

Tatochila theodice (Boisduval), Elwes *nec* Boisduval (a misidentification), Trans. Ent. Soc. London (1903), p. 293, October 1903.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 56, pl. 18, figs. c1–c3, May 25, 1908.—Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 406, 407, 412, 413, Mar. 10, 1915; Rev. Chilena Hist. Nat., vol. 20, pp. 43, 44, 45, 49–51, 56, pl. 1, figs. 3, 4, June 30, 1916.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, pp. 443, 454–456, Nov. 10, 1916.—Giacomelli, Physis, vol. 3, p. 375, 1917.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 57, Oct. 24, 1932.

Tatochila blanchardii ab. *izquierdoi* Ureta, Rev. Chilena Hist. Nat., vol. 41 (for 1937), pp. 263–265, fig. 36, No. 8, 1938; Bol. Mus. Nac. Hist. Nat., vol. 16, p. 123, 1938.

Tatochila blanchardii blanchardii Butler, Herrera, Rev. Chilena Ent., vol. 3 (for 1953), p. 144, 1954.

VENATION: As illustrated (fig. 58).

LEGS: With paronychium, claw, and pulvillus as illustrated (fig. 70).

MALE: Plate 3, figure 9. Head with palpi white to pale yellow on the sides. Scales behind eyes yellow to white above, orange below. Wings with dark markings black to dark brown. Ground color on upper surfaces and on disc and base of forewing below white. Pale greenish yellow on hindwing and apex of forewing below. Hindwing below with costal margin and extreme base somewhat darker yellow or pale orange and with a white spot over the lower discocellular vein and adjacent area. *T. blanchardii* differs from *autodice* in having marginal wedge-shaped spots and a submarginal series of black spots on the hindwings above, thus greatly resembling females of *autodice*. It also frequently differs from *autodice* by having the black bar at end of cell on forewing above extending to the costal margin.

Length of forewing, 22–29 mm. (average, 26.8 mm.).

Male genitalia as illustrated (figs. 30, 44).

Close to *autodice*, having a slightly more sinuous aedeagus. No differences were observed between the two subspecies of *blanchardii*. The genitalia of six males were studied.

FEMALE: Plate 2, figure 8; plate 3, figure 9a. Head as in the male. Wings with dark markings black to dark brown. Ground color of forewing above pale yellow to white, usually paler in base of wing. Ground color of hindwing above yellow, sometimes cream colored. Wings below colored as in the male. The female differs from the male by the yellowish ground color of the hindwing above and in having all dark markings larger and more distinct, in having the wedge-shaped markings of forewing above extending inward to the cell and in having these markings on this surface of the hindwing extending inward to the base along both sides of the veins. From females of *autodice* it differs in having the wedge-shaped markings on forewing above longer (extending inward to the cell) and in having the ground color of hindwing above yellow or cream colored, not white or white with a faint yellowish tinge.

Length of forewing, 24–30 mm. (average, 27 mm.).

Female genitalia as illustrated (fig. 85). With anterior lobe of inner genital plate subtriangular and having its posterior margin slightly undulate and its ventral margin broadly produced near the middle. Ductus bursae with narrow ribbon-like plate opposite opening of ductus seminalis divided into two elements and with a single large subtriangular plate and two small plates anterior to this. The genitalia of six females were studied.

TYPE LOCALITY: "Valparaiso," Province of Valparaiso, Chile.

ADDITIONAL TYPE DATA: Originally described from two specimens, one of each sex (locality as given above; collected by Thomas Edmonds, 1882). The male specimen is hereby designated the lectotype.

LOCATION OF TYPE: Lectotype in the collection of the British Museum (Natural History).

METHOD OF IDENTIFICATION: Photographs of a topotypical male were compared with the lectotype of *blanchardii* by Mr. D. S. Fletcher of the staff of the British Museum and were found by him to represent that species. These photographs are reproduced here as figure 17 on plate 3. Fletcher writes that the dark bar at the end of the cell on the lectotype does not extend to the costal margin. However the size of this bar is somewhat variable.

SYNONYMICAL NOTES:

Tatochila blanchardii ab. *izquierdoi* Ureta, 1937. Type locality, "Chile" (exact data unknown). This was described from a female specimen in the collection of Vicente Izquierdo Phillips. It is an aberrant specimen having a great amount of black suffusion particularly on the upper side of forewing, where from the apex of the cell to the submarginal sagittate markings this wing is almost entirely black.

MISIDENTIFICATIONS: Blanchard (1852) confused this species with *T. autodice* (Hübner) and with *T. theodice* (Boisduval). Elwes (1903) and others have identified this species with *T. theodice*.

DISTRIBUTION: Chile from the Province of Antofagasta south through the Province of Cautin.

CHILE: *Province of Antofagasta,* Antofagasta; *Province of Coquimbo,* El Tofo; *Province of Valparaiso,* Valparaiso; *Province of Santiago,* Pudahuel (October), Macul (March), Peñalolen (October, November), Lo Ovalle (January), Canelo (October); *Province of Talca,* Los Nieves (November), San Cristóbal (January, March); *Province of Cautin,* Temuco (February).

FOOD PLANT: *Tropaeolum.*

MATERIAL STUDIED: 12 males, 13 females.

Tatochila blanchardii ernestae Herrera

Pieris theodice Boisduval, Hopffer *nec* Boisduval (a misidentification), Stettiner Ent. Zeit., vol. 40, p. 83, March 1879.

Tatochila theodice (Boisduval), Dyar *nec* Boisduval (a misidentification), Proc. U. S. Nat. Mus., vol. 45, p. 628, July 22, 1913.

Tatochila blanchardii ernestae Herrera, Rev. Chilena Ent., vol. 3 (for 1953), pp. 140–144, figs. 1–4, figs. A, B, 1954.—Forster, Veröffentl. Zool. Staatss. München, vol. 3, p. 134, Dec. 1, 1955.

Veins and legs show no subspecific characters and are not illustrated.

MALE: Plate 3, figure 10. Head very similar to *T. blanchardii blanchardii* with orange behind eyes slightly more extensive than in that subspecies. Wings above with dark markings slightly more distinct than in typical *blanchardii.* Differing chiefly from that subspecies in having the ground color of hindwing and of apex of forewing on the underside darker yellow with the costal margin and base of hindwing distinctly orange. Differing also in having veins on hindwing below pale purplish gray edged in gray instead of the usual white to gray edged in black that is true of typical *blanchardii.*

Length of forewing, 25–29 mm. (average, 27 mm.).

Male genitalia not illustrated, not different from typical *blanchardii.* The genitalia of five males were studied.

FEMALE: Plate 3, fig. 10a. Head as in the male. Wings above usually with dark markings slightly more distinct than in typical *blanchardii,* otherwise very similar to *blanchardii* on this surface. Wings below with yellow ground color even darker than in the male, tending toward orange, and with veins distinctly purplish gray instead of the usual gray of typical *blanchardii.*

Length of forewing, 26–28 mm. (average, 27 mm.).

Female genitalia not illustrated, not different from typical *blanchardii.* The genitalia of five females were studied.

TYPE LOCALITY: "Miñi-Miñi, 1,650 meters, Province Tarapacá,' Chile.

Additional type data: Described from the holotype, male (locality as given above, Feb. 16, 1948, J. Herrera collection, genitalia No. 750); the allotype, female (locality as given above, Feb. 14, 1948, J. Herrera collection, genitalia No. 743); and from the following paratypes: 40 ♂♂ and 19 ♀♀ from various localities in the Province of Tarapacá (Miñi-Miñi, Iquique, Poroma, Codpa and Putre); 4 ♂♂ and 1 ♀ from various localities in Peru (Department of Lima, Supe; Department of Puno, Puno; Department of Arequipa, Arequipa and Cantas; Department of Tacna, Tarata).

Location of type: Holotype and allotype in the collection of the Instituto Pedagogico, Universidad de Chile. Paratypes in the same collection and in the collections of the U. S. National Museum, Washington, D. C.; American Museum of Natural History, New York City; and the Museo Nacional de Historia Natural Javier Prado, Lima, Peru.

Method of identification: Through study of the holotype, allotype, and paratype series.

Distribution: From the Department of Lima in Peru, south through the Province of Tarapacá in Chile, and east into the Department of Potosí in Bolivia.

Peru: *Department of Lima*, Supe (September, October), Matucana; *Department of Arequipa*, Arequipa, Cantas (2,000 ft., November), Cotahuasi (9,000 ft., October), Chuquibamba (10,000 ft., October), Coropuna (14,500 ft., October); *Department of Puno*, Puno (February, October); *Department of Tacna*, Tarata (February). Bolivia: *Department of Potosí*, Potosí (4,100 m., January). Chile: *Province of Tarapacá*, Miñi-Miñi (1,650 m., February), Iquique (January, February), Poroma (3,000 m., March), Codpa (1,900 m., March), Putre (3,650 m., February).

Material studied: 61 males, 37 females.

Group C. The Microdice Group

In these species the aedeagus is gradually arched with the distal end hoodlike, this appearance caused by a very broad incision; there is a distinct subapical tooth at either side of this hood which is somewhat flattened either dorsoventrally or sometimes laterally.

Hindwings above as in Groups B and D. Hindwing below with white or yellow ground color; with or without a submarginal series of sagittate markings; without orange streaks through middle of interspaces; with a white spot on lower discocellular vein (the chief difference between this group and Groups C and D) or as mentioned above with nearly the entire wing white.

Three species, one of which includes four subspecies, comprise this group.

Tatochila microdice (Blanchard)

For references, see below under *T. microdice microdice.*

This species is divided into four subspecies. The most northern of these is found in Ecuador and southern Colombia and the most southern and probably most distinct is found only on the southern coast of the Island of Tierra del Fuego.

VENATION: As illustrated (fig. 59). There is no difference displayed between the various subspecies.

LEGS: With paronychium, claw, and pulvillus as illustrated (fig. 74). These structures exhibit no subspecific characters.

MALE GENITALIA: As illustrated (figs. 31–31h, 45). Certain figures of *T. microdice microdice* (figs. 31–31b), *T. microdice arctodice* (figs. 31c, 31h), and *T. microdice macrodice* (fig. 31g) are included to show individual variation in the aedeagus. Even though they belong sometimes to different subspecies, the differences displayed are not subspecific. Figure 31 shows perhaps the average for the whole species. In figure 31a the base of the aedeagus is deeply indented ventrally, a character occurring in 3 out of 11 specimens of *T. microdice microdice,* in 5 out of 13 specimens of *T. m. macrodice,* and in 3 out of 8 specimens of *T. m. arctodice.* Figure 31b shows an aedeagus with the base nearly flat, while figures 31, 31d–f illustrate variation in the harpes. Again, these are only individual variations and all types usually are found in all four subspecies. The genitalia of 38 males were studied.

FEMALE GENITALIA: As illustrated (fig. 87), with the anterior lobe of the inner genital plate subtriangular, having its posterior margin strongly toothed and gradually rounded to the ventral margin. Ductus bursae with one or sometimes two very narrow ribbonlike plates opposite opening of ductus seminalis, with the plate anterior to this large and subtriangular or sometimes completely ringing the ductus bursae and fused dorsally; usually with two irregular narrow plates anterior to this. No subspecific characters were found in the female genitalia. The genitalia of 22 females were studied.

Tatochila microdice microdice (Blanchard)

Pieris microdice Blanchard, *in* Gay, Historia física y política de Chile, Zoologia, vol. 7, p. 14, 1852.—Kirby, A synonymic catalogue of diurnal Lepidoptera, p. 451, 1871.—Berg, Bull. Soc. Imp. Nat. Moscou (for 1875), p. 196, 1876.—Burmeister, Description physique de la Republique Argentine . . . , vol. 5, pt. 1, pp. 89, 90, 1878.—Berg, Act. Acad. Nac. Cienc. Córdoba, Argentine Rep., vol. 1, pp. 66, 67, 1875.

Tatochila microdice (Blanchard), Butler, Proc. Zool. Soc. London (1872), p. 67, Jan. 16, 1872.—Reed, Anal. Univ. Chile, vol. 51, p. 669, September 1877.—Bartlett-Calvert, Rev. Chilena Hist. Nat., vol. 2, p. 98, July 1898.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 56, May 25, 1908.—Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 406, 412, 413, Mar. 10, 1915, Rev. Chilena Hist. Nat., vol. 20, pp. 44, 45, 53–54, 57, June 30, 1916.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, pp. 443, 451–452, Nov. 10, 1916.—Talbot, *in* Strand, Lepidopterorum catalogus, pars. 53, Pieridae I, p. 58, Oct. 24, 1932.—Breyer, Verhandlungen VII Internationalen Kongress für Entomologie, vol. 1 (for 1938), p. 29, February 1939.—Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 93, Oct. 25, 1951.

Pieris theodice Boisduval, Mabille *nec* Boisduval (a misidentification, figure only), Mission Scientifique du Cap Horn, 1882–1883, vol. 6, Zoologie, Insectes, pl. 1, fig. 2, 1888.

Tatochila microdice sterodice Staudinger, Lepidopteren, *in* Hamburger Magalhaensische Sammelreise, vol. 2, art. 6, pp. 18, 19, 1898.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 56, May 25, 1908.—Giacomelli, Rev. Chilena Hist. Nat., vol. 20, p. 57, June 30, 1916.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, p. 452, Nov. 10, 1916.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 58, Oct. 24, 1932.

Tatochila sterodice Staudinger, Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 406, 412, 413, Mar. 10, 1915.

Tatochila microdice f. *sterodice* Staudinger, Giacomelli, Physis, vol. 3, p. 374, 1917.—Breyer, Verhandlungen VII Internationalen Kongress für Entomologie, vol. 1 (for 1838), p. 29, February 1939.—Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 93, Oct. 25, 1951.

Tatochila microdice microdice (Blanchard), Ureta, Rev. Chilena Hist. Nat., vol. 41 (for 1937), pp. 272–276, figure 38, Nos. 1–4; pl. 12, figs. 1, 2, 1938; Bol. Mus. Nac. Hist. Nat., vol. 16, p. 123, 1938.

Tatochila microdice allodice Bryk, Ark. f. Zool., vol. 36A, pp. 5–6, pl., fig. 2, Nov. 6, 1944.

MALE: Plate 3, figures 11, 11b. Head with scales behind eyes and outer face of palpus white, very rarely pale yellowish. Wings above quite similar to *T. microdice fueguensis*, new subspecies, with dark markings usually larger, more distinct. Below similar to *T. m. fueguensis* with gray stripes along veins usually slightly broader and with white spot over lower discocellular vein larger and with larger wing expanse than in that subspecies.

Length of forewing, 21–27 mm. (average, 24.1 mm.).

FEMALE: Plate 3, figures 11a, 11c. Head with scales behind eyes and outer face of palpus white, very rarely pale yellowish. Wings above with ground color usually white, sometimes pale yellowish white, particularly on the hindwing. Dark markings much more extensive than in the male. Veins, especially on the hindwing, are white entirely outlined along both sides with dark brown or black. Wings above similar to the male, ground color slightly darker yellow. Differing from *T. microdice fueguensis* particularly in the paler yellow ground color of wings above and on base and disc of forewing below and in the large white spot on the lower discocellular vein on underside of hindwing. Differing from all the subspecies in having veins on the uppersurfaces white.

Length of forewing, 22–25 mm. (average, 23.5 mm.).

Type locality: "Estrecho de Magallanes al havre Pulket"=Harbor of Pecket, Province of Magallanes, Chile.

Additional type data and location of type: Described from specimens of both sexes (number of specimens not stated) said to be in the Boisduval collection. Not in that collection in the British Museum and not located in the Paris Museum.

Method of identification: By reference to the original description, which is adequate to distinguish this species from the only other species of the genus known to occur in the province of Magallanes (i. e., *T. theodice gymnodice* Staudinger).

Synonymical notes: The data for the names listed in the above synonymy are as follows:

Tatochila microdice sterodice Staudinger, 1899. Type locality, "Rio Grande," Territory of Tierra del Fuego, Argentina. Described from one pair (locality as given above) and one female ("Punta Arenas," Province of Magallanes, Chile). According to Dr. E. M. Hering of the Zoologisches Museum der Humboldt-Universität, Berlin, these cotypes were returned to the Hamburg Museum and were destroyed during World War II. This name, based upon scantily marked specimens, is clearly a synonym of *microdice*.

Tatochila microdice allodice Bryk, 1944. Type locality, "Peninsula Llau Llau, N. of Puerto Nuevo" (near Nahuel Huapí, Territory of Río Negro, Argentina). Described from a single female in the collection of the Naturhistoriska Riksmuseet, Stockholm. The holotype, illustrated by Bryk, matches perfectly specimens of typical *microdice* studied from the Province of Magallanes, Chile.

Misidentifications: Mabille (1888) figures this species under the name *Pieris theodice* Boisduval.

Distribution: Southern Argentina (Territory of Santa Cruz) and southern Chile (Province of Magallanes) into the island of Tierra del Fuego.

Argentina: *Territory of Santa Cruz*, Glen Kross, San Julian. Chile: *Province of Magallanes, Department of Punta Arenas*, Punta Arenas (January); *Department of Ultima Esperanza*, Puerto Prat (January–March), Natales (March), Puerto Consuelo (March), Puerto Bories (January), Dos Lagunas (February); *Department of Tierra del Fuego*, Porvenir (February).

Material studied: 16 males, 7 females.

Tatochila microdice fueguensis Field, new subspecies

Tatochila microdice (Blanchard), Staudinger nec Blanchard (a misidentification), Lepidopteren, *in* Ergebinisse der Hamburger Magalhaensische Sammelreise, vol. 2, art. 6, pp. 17–23, 1898.

Male: Plate 4, figure 12. Head with scales behind eyes and with outer face of palpus white. Wings white above with markings dark brown to black in color. Similar to *T. m. microdice* but with these markings usually more restricted. Below with ground color of hindwing and of apex of forewing pale yellow; with costal margin of hindwing pale orange and with base and disc of forewing white.

Veins on hindwing dirty white outlined on both sides by gray with a white spot over the lower discocellular vein and adjacent area. Differing chiefly from *T. m. microdice* in having these gray stripes along the veins usually more narrow and with the white spot over lower discocellular vein smaller and in the smaller wing expanse.

Length of forewing, 20–30 mm. (average, 22.2 mm.).

Female: Plate 4, figure 12a. Head with scales behind eyes and with outer face of palpus pale yellow. Wings quite different from those of the male, having the ground color above dark yellow and with dark brown stripes along veins. Other dark markings dark brown in color and more extensive than in the male. Ground color of wings below darker yellow than in the male with base and disc of forewing on this surface yellowish white rather than pure white and with a series of large but faint submarginal sagittate markings on this wing extending to below vein Cu_2. White spot on lower discocellular vein of hindwing small (as in the male) and with orange along costal margin of hindwing below more distinct than in the male. In addition there is a faint streak of orange below cell and another below vein Cu_2. *T. m. fueguensis* differs from the other subspecies, in the female sex particularly, in the ground color of the wings above and on the base and disc of the forewing below. In addition it differs from *T. m. macrodice* and *T. m. arctodice* in the color of the scales behind the eyes and of outer face of palpus. As is true of the males, the females have the smallest wing expanse of any of the other subspecies.

Length of forewing, 20–22 mm. (average 21.3 mm.).

Type locality: Puerto Harberton, Territory of Tierra del Fuego, Argentina.

Additional type data: Described from the holotype, male (locality as given above; Nov. 26, 1948, Olrog and Budin, ♂ genitalia preparation W. D. F.-J. H. 3919); allotype, female (Ushuaia, Territory of Tierra del Fuego, Argentina; Dec. 15, 1948, Olrog and Budin; ♀ genitalia preparation W. D. F.-J. H. 3929); and paratypes as follows: 2 ♂♂ and 2 ♀♀, same locality as holotype, Nov. 26 and Dec. 1, 1948, Olrog and Budin (♂ genitalia preparations W. D. F.-J. H. 3920 and 3922; ♀ genitalia preparations W. D. F.-J. H. 3923 and 3925); 2 ♂♂, same locality as the allotype, Dec. 11, 1948, Olrog and Budin (genitalia preparations W. D. F.-J. H. 3918 and 3921).

Location of types: Holotype, allotype, and two male paratypes in the collection of the Fundación Miguel Lillo, Universidad Nacional de Tucumán, Tucumán, Argentina. One pair of paratypes in the U. S. National Museum and one pair of paratypes in the collection of Alberto Breyer, Buenos Aires, Argentina.

Misidentification: Staudinger (1899) describes this subspecies from material collected at Ushuaia, Tierra del Fuego, mistakenly calling it *microdice.*

Distribution: As indicated above, this subspecies is known only from the extreme southern part of the island of Tierra del Fuego.

Material studied: 5 males, 3 females.

Tatochila microdice macrodice Staudinger

Pieris xanthodice Lucas, Hopffer *nec* Lucas (a misidentification), Stettiner Ent. Zeit., vol. 4, p. 83, March 1879.—Weymer and Maassen *nec* Lucas (misidentification), W. Reiss und A. Stübel Reisen in Süd-Amerika, Lepidopteren . . ., pp. 36, 43, 48, 71, 1890.—Staudinger, Ent. Zeitschr. "Iris," Dresden, vol. 5, pt. 2, p. 273, December 1892.

Pieris microdice Blanchard, Weymer and Maassen *nec* Blanchard (a misidentification), W. Reiss und A. Stübel Reisen in Süd-Amerika, Lepidopteren . . ., p. 97, 1890.—Staudinger, Ent. Zeitschr. "Iris," Dresden, vol. 7, pp. 61, 62, July 14, 1894.

Tatochila microdice macrodice Staudinger, Lepidopteren, *in* Hamburger Magalhaensische Sammelreise, vol. 2, art. 6, pp. 21–23, 1898.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 56, pl. 18, figs. C5, C6, D1, May 25, 1908.—Paravicini, Mitt. Schweizerschen Ent. Ges., vol. 12, p. 22, May 1910.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 58, Oct. 24, 1932.—Ureta, Bol. Mus. Nac. Hist. Nat., vol. 23, pp. 52, 54, pl. 1, fig. 3, 1947.—Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 93, Oct. 25, 1951.—Zischka, Fol. Univ., Univ. Cochabamba, Bolivia, vol. 5, p. 18, October 1951.

Tatochila macrodice Staudinger, Dyar, Proc. U. S. Nat. Mus., vol. 45, p. 628, July 22, 1913.—Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 406, 408, 409, 412, 413, Mar. 10, 1915; Rev. Chilena Hist. Nat., vol. 20, pp. 53, 54, 57, pl. 2, figs. 3, 4, June 30, 1916.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, pp. 443, 449–451, Nov. 10, 1916.—Giacomelli, Physis, vol. 3, pp. 373–374, 1917.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 1015, Jan. 21, 1924.—Breyer, Verhandlungen VII Internationalen Kongress für Entomologie, vol. 1 (for 1938), p. 29, February 1939.—Förster, Veröffentl. Zool. Staatss. München, vol. 3, p. 134, Dec. 1, 1955.

Tatochila microdice Blanchard, Köhler *nec* Blanchard (a misidentification) Zeitschr. Wiss. Insektenbiol., vol. 18, Sonderbeilage, p. 14, Dec. 15, 1923.—Förster, Veroffent. Zool. Staatss. München, vol. 3, p. 134, Dec. 1, 1955.

Synchlöe macrodice (Staudinger), Zischka, Fol. Univ., Univ. Cochabamba, Bolivia, vol. 1, p. 28, December 1947.

Length of forewing, 21–27 mm. (average, 25 mm.).

Type locality and additional type data: Described from about 50 males and 20 females (presumably all cotypes) from "Huallatani," Department of Cochabamba, from near "La Paz," and from "Illimani," Department of La Paz, Bolivia. Two male cotypes from near "La Paz" were sent to us for study. Of these, the one from Achacachi, La Paz, Bolivia, collected on Sept. 18, 1893, by Garlepp, is hereby designated the lectotype.

MALE: Plate 4, figure 13. Head with scales behind eyes and with outer face of palpus yellow to orange. Wings above somewhat as in typical *microdice* but with all dark markings much larger and with a series of dark wedge-shaped markings at end of veins. Usually with a series of submarginal intervenal dark markings on the hindwing. Wings below with ground color of hindwing and of apex of forewing darker yellow than in *T. microdice fueguensis* or *T. microdice microdice* and with the costal margin of hindwing darker orange than in those subspecies. Hindwing below with a distinct submarginal series of sagittate intervenal markings, and, as is true of *T. m. microdice,* there is a large white spot over the lower discocellular vein. This subspecies differs from *T. m. microdice* and from *T. m. fueguensis* also in having the series of dark submarginal sagittate markings on the underside of forewing very much larger and extending below vein Cu^1.

Length of forewing, 22–28 mm. (average, 25.2 mm.).

FEMALE: Plate 4, figure 13a. Head with scales behind eyes orange and with outer face of palpus yellow to orange. Wings above similar to female *T. m. microdice* except that the dark markings are much more extensive and the veins on the hindwing are entirely dark brown or occasionally with small streaks of white but never white throughout their entire length. Wings below with ground color darker yellow than in the males and with orange along costal margin of hindwing darker. Similar to undersurface of female *T. m. microdice,* with veins on hindwings more of a silvery white with yellow ground color deeper and with dark markings of forewing larger, more distinct. Most similar to *T. m. arctodice* but with a distinct series of fuscous, submarginal sagittate markings and with white stripes on veins narrow, usually covering only the veins.

LOCATION OF TYPE: Lectotype in the Zoologisches Museum der Humboldt-Universität, Berlin.

METHOD OF IDENTIFICATION: By study of the lectotype, designated above, and by comparison with the carefully prepared original description.

MISIDENTIFICATIONS: Hopffer (1879) and others identified this population as *Pieris xanthodice* Lucas.

Weymer and Maasen (1890) and others identified this subspecies as *Pieris microdice* Blanchard.

DISTRIBUTION: Southern Peru and extreme northern Chile east into Bolivia and south as far as the Province of Mendoza in Argentina.

PERU: *Department of Puno,* Oroya (May), Puno (3,800–4,200 m., January); *Department of Arequipa,* Arequipa, Chuquibamba (10,000 ft., October), Cotahuasi (9,000 ft., October). BOLIVIA: *Department of La Paz,* Guaqui (3,820 m., February), Obrajes (January), Sicasica (October); *Department of Potosí,* Potosí (4,000–5,000 m., January). CHILE: *Province of Tarapacá,* Parinacota (4,500 m., February), Putre (3,650 m. and 2,800 m., February), Lorancahua, two (2,800 m. February). ARGENTINA: *Province of Catamarca*, El Candado (March); *Province of Mendoza*, Funes (January).

MATERIAL STUDIED: 18 males, 7 females.

Tatochila microdice arctodice Staudinger

Tatochila microdice arctodice Staudinger, Lepidopteren, *in* Hamburger Magalhaensische Sammelreise, vol. 2, art. 6, pp. 19–21, 1898.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 56, May 25, 1908.—Giacomelli, Rev. Chilena Hist. Nat., vol. 20, p. 57, June 30, 1916.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, pp. 452–453, Nov. 10, 1916.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 58, Oct. 24, 1932.

Tatochila xanthodice Lucas, Röber *nec* Lucas (a misidentification of male), *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 56, pl. 18, fig. d4, May 25, 1908.

Tatochila arctodice Staudinger, Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 406, 411, 414, 415, Mar. 10, 1915.—Campos-R., Rev. Col. Nac. Vicente Rocafuerte, vol. 9, p. 80, 1927.—Apolinar, Rev. Acad. Colombiana Cienc. Exact. Fís. Nat., vol. 4, p. 349, December 1941.—Brown, Colorado Coll. Pub., gen. ser., No. 233, p. 20, May 1942.

Tatochila microdice f. *arctodice* Staudinger, Giacomelli, Physis, vol. 3, p. 374, 1917.

MALE: Plate 4, figure 14. Head as in *T. microdice macrodice*. Wings above and below very similar to that subspecies, differing only in lacking the submarginal series of dark sagittate markings between veins on both surfaces of hindwings and in having the wedge-shaped marks at end of veins on upper surface of hindwing greatly reduced. These markings are sometimes represented only by faint linear bars.

Length of forewing, 22–28 mm. (average, 25.8 mm.).

FEMALE: Plate 4, figure 14a. Head with scales behind eyes orange and with outer face of palpus yellow to orange. Wings above quite unlike the male, most like female of *T. m. macrodice*, usually with dark color even more extensive, sometimes almost obliterating the ground color. A few females occur with this dark coloring almost absent on the hindwing except around the outer margin. Wings below quite similar to *T. m. macrodice* but with fuscous submarginal sagittate markings obsolescent, the fuscous sometimes replaced with faint red and with white stripes along veins broader, usually covering slightly more than the veins.

Length of forewing, 22–29 mm. (average, 25.4 mm.).

TYPE LOCALITY AND ADDITIONAL TYPE DATA: Described from two males and one female from the Cauca Valley, Colombia; from one female, Río Dagua, Department of Valle, Colombia; from one male and one female, Macachi, Province of Pichinchá, Ecuador (3,000 m.); and from one male, Loja, Province of Loja, Ecuador. There is no lectotype.

LOCATION OF TYPES: Cotypes in Zoologischen Museum der Humboldt-Universität, Berlin.

METHOD OF IDENTIFICATION: By reference to the original description, which is quite adequate, and by study of a male cotype from Ecuador.

MISIDENTIFICATION: Röber (1908) illustrates a male of this species as *T. xanthodice* (Lucas).

DISTRIBUTION: From the Andes in Colombia south into the Department of Junín in Peru.

COLOMBIA: See above under "Type locality." ECUADOR: *Province of Imbabura,* Ibarra (7,000 ft.); *Province of Tungurahua,* Banõs (6,400 ft., January, February); *Province of Cañar,* Azogues, Biblián; *Province of Azuay,* Tarqui; *Province of Loja,* Loja. PERU: *Department of Cajamarca,* Calendín (2,625, m.); *Department of Junín,* Mancará (as Manchara, 7,000 ft., September).

MATERIAL STUDIED: 15 males, 15 females.

Tatochila vanvolxemii (Capronnier)

Pieris van volxemii Capronnier, Ann. Soc. Ent. Belgique, vol. 17, p. 11, pl. 1, fig. 1, 1874.—Kirby, A synonymic catalogue of diurnal Lepidoptera, suppl., p. 793, 1877.—Burmeister, Description physique de la République Argentine . . . , vol. 5, pt. 1, p. 86, 1878.

Pieris achamantis Berg, Act. Acad. Nac. Cienc. Córdoba, Argentine Rep., vol. 1, pp. 67–68, 1875; Bull. Soc. Imp. Nat. Moscou, 1875, pp. 196–198, 1876.—Kirby, A synonymic catalogue of diurnal Lepidoptera, suppl., p. 792, 1877.—Berg, Anal. Soc. Cient. Argentina, vol. 4, pp. 87, 88, July 1877.—Burmeister, Description physique de la République Argentine, vol. 5, pt. 1, pp. 86, 87, 1878.—Harold, Stettiner Ent. Zeit., vol. 40, p. 237, June 1879.—Berg, Anal. Mus. Nac. Buenos Aires, vol. 4, p. 236, Nov. 18, 1895.

Pieris volxemi Capronnier, Harold *nec* Capronnier (an improper emendation), Stettiner Ent. Zeit., vol. 40, p. 237, June 1879.

Tatochila volxemi (Capronnier), Berg *nec* Capronnier, Anal. Mus. Nac. Buenos Aires, vol. 4, pp. 236–240, fig. 2, Nov. 18, 1895.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 55, pl. 18, figs. a5, a6, May 25, 1908.—Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 406, 407, 412, 413, Mar. 10, 1915; Rev. Chilena Hist. Nat., vol. 20, pp. 44, 45, 46, 51, 52, 56, pl. 2, figs. 1, 2, June 30, 1916.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, p. 443, 447, 448, Nov. 10, 1916.—Giacomelli, Physis, vol. 3, p. 373, 1917.—Köhler, Zeitschr. Wiss. Insektenbiol., vol. 18, Sonderbeilage, p. 14, Dec. 15, 1923.—Klots, Ent. Americana, new ser., vol. 12, No. 4, p. 218, March 1932.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 57, Oct. 24, 1932.—Breyer, Rev. Soc. Ent. Argentina, vol. 8, p. 63, 1936; Verhandlungen VII Internationalen Kongress für Entomologie, vol. 1 (for 1938), pp. 28, 29, February 1939.—Ureta, Bol. Mus. Nac. Hist. Nat., vol. 26, pp. 161, 162, Mar. 14, 1956.

Tatochila volxemi ♀ var. *fulva* Köhler, Zeitschr. Wiss. Insektenbiol., vol. 18, Sonderbeilage, p. 14, pl. 1, fig. 1, Dec. 15, 1923.—Breyer, Verhandlungen VII Internationalen Kongress für Entomologie, vol. 1 (for 1938), p. 29, February 1939.—Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 92, Oct. 25, 1951.

Tatochila volxemi ♀ forma *obsura* Köhler, Zeitschr. Wiss. Insektenbiol., vol. 18, Sonderbeilage, p. 14, Dec. 15, 1923.

Tatochila vanvolxemii (Capronnier), Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 92, Oct. 25, 1951.

VENATION: As illustrated (fig. 60).

LEGS: With paronychium, claw, and pulvillus as illustrated (fig. 76).

MALE: Plate 4, figures 15, 15a; plate 5, figure 16. Head with outer surfaces of palpi white. Scales behind eyes orange. Forewing above white with dark brown markings as illustrated, usually having a large black discocellular bar. Variable in having a few dark scales along either side of the ends of the veins in the apex of forewing (the usual form) to having a heavy black sagittate, submarginal and subapical band with the markings along the veins extending inward through this band (this form more rare). Hindwings above entirely white. Wings below white with a pale yellow suffusion over hindwing especially in the base and around outer margin of this wing and in apex of forewing. Costal margin of hindwing orange. Veins on hindwing and in apex of forewing white outlined on both sides with faint black lines along outer margin and frequently for considerable distance inward.

Length of forewing, 26.5–32 mm. (average, 29.9 mm.).

Male genitalia as illustrated (figs. 32, 46). Not different from *T. microdice* and illustrated here to show how closely related it is to that species. The genitalia of 15 males were studied.

FEMALE: Plate 5, figures 16a, 16b. Head as in the male with outer surfaces of palpi white and with scales behind eyes orange. Wings above with ground color pure white to dirty white or very pale tan. Rarely pale yellow over much of hindwing and around outer third of forewing. Dark brown to black markings as illustrated, differing greatly from the male, with discocellular bar on forewing usually much larger both above and below and with submarginal row of sagittate markings large, confluent and strongly indicated even on the hindwing. Marginal sagittate markings and the black or brown scaling along veins extending inward to the cell along some veins in forewing and extending almost to the base along some veins in many specimens on the hindwings. Wings below with ground color of hindwing and apex of forewing yellow and with veins in these areas white completely outlined along either side with dark brown. Hindwing with costal margin orange, with a brown bar through middle of cell that is divided by a thin line of white or yellow and with a large white spot over lower discocellular vein. This latter larger than in *mercedis*. Submarginal row of confluent sagittate markings strongly indicated on forewing and also present on hindwing although more weakly indicated.

Length of forewing, 28–32 mm. (average, 29.6 mm.).

Female genitalia not illustrated, not distinguishable from *T. microdice.* The genitalia of six females were studied.

TYPE LOCALITY: "Buenos Aires," Argentina.

ADDITIONAL TYPE DATA: Described from a single male specimen, the holotype (locality as given above, December).

LOCATION OF TYPE: Presumably in the collection of M. C. Van Volxem, the whereabouts of which is unknown.

METHOD OF IDENTIFICATION: By comparison with the original colored figure and description.

SYNONYMICAL NOTES:

Pieris achamantis Berg, 1875. Type locality, "Cerro de Caballada," Territory of Río Negro, Argentina. Described from two specimens collected by Francisco P. Moreno and presumably now in the collections of the Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina. This name is clearly a synonym of *T. vanvolxemii.*

Tatochila volxemi var. *fulva* Köhler, 1923. Described from a single female specimen collected in Tucumán and now in the collection of Alberto Breyer. It represents a slightly melanic individual form in which the submarginal spots on forewing above are confluent and connected to the discocellular spot.

Tatochila volxemi forma *obsura* Köhler, 1923. Described from a female specimen collected in Tucumán and in the collection of Alberto Breyer. It is an individual form similar to *fulva* that has a deeper reddish yellow color (presumably, although not stated, on the undersurface of the hindwing).

MISSPELLINGS: Harold (1879) and others improperly emended the spelling of *P.* or *T. van volxemii* to *P.* or *T. volxemii.* Capronnier very clearly named this species after M. C. Van Volxem. Hayward (1951) was the first to give the proper form of this name.

DISTRIBUTION: Argentina from the Provinces of Tucumán and Buenos Aires south into the Territory of Río Negro.

ARGENTINA: *Province of Tucumán,* Tucumán; *Province of La Rioja,* La Rioja; *Province of Córdoba,* Córdoba; *Province of Mendoza,* Uspallata Mountains (1,850 m., October), Potrerillos (1,500 m., October), Mendoza (May, July); *Province of Buenos Aires,* Médanos (November), Bolívar (December); *Territory of Río Negro,* Río Colorado (October, November), Gómez (December, January), "Chdele" (November). We have seen specimens labeled without specific locality data as coming from both Uruguay and Paraguay. We doubt the authenticity of these labels.

MATERIAL STUDIED: 27 males, 19 females.

Tatochila mercedis (Eschscholtz)

Pontia mercedis Eschscholtz, *in* Kotzebue, Entdeckungs-Reise in die Sud-See und nach der Berings-Strasse, vol. 3, p. 215, pl. 9, figs. 22a, 22b, 1821.—Berg, Anal. Mus. Nac. Buenos Aires, vol. 4, p. 231, Nov. 18, 1895.—Staudinger, Lepidopteren, *in* Hamburger Magalhaensische Sammelreise, vol. 2, art. 6, p. 11, 1898.

Pieris polydice Blanchard, *in* Gay, Historia física y política de Chile, Zoologia, vol. 7, p. 12, 1852.—Kirby, A synonymic catalogue of diurnal Lepidoptera, p. 451, 1871.—Reed, Anal. Univ. Chile, vol. 51, p. 665, September 1877.

Tatochila mercedis (Eschscholtz), Butler, Proc. Zool. Soc. London (1872), p. 67, Jan. 16, 1872.—Reed, Anal. Univ. Chile, vol. 51, pp. 665, 666, September 1877.—Bartlett-Calvert, Anal. Univ. Chile, vol. 69, p. 314, 1886.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 56, pl. 18, figs. b4–b6, May 25, 1908.—Paravicini, Mitteil. Schweizerschen Ent. Ges., vol. 12, pp. 21, 22, May 1910.—Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 405, 406, 408, 412, 413, Mar. 10, 1915; Rev. Chilena Hist. Nat., vol. 20, pp. 44, 45, 51, 55, 56, pl. 1, figs. 5, 6, June 30, 1916.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, pp. 443, 453, 454, Nov. 10, 1916.—Talbot, *in* Strand, Lepidopterorum catalogus, pars. 53, Pieridae I, p. 57, Oct. 24, 1932.—Ureta, Rev. Chilena Hist. Nat., vol. 38, p. 78, 1934; vol. 41, pp. 246–254, figs. 33, 34, pl. 11, figs. 3, 4, 1938; Bol. Mus. Nac. Hist. Nat., vol. 16, p. 123, 1938; Rev. Chilena Hist. Nat., vol. 42, p. 297, 1939.—Breyer, Verhandlungen VII Internationalen Kongrees für Entomologie, vol. 1 (for 1938), p. 29, February 1939.—Ureta, Rev. Chilena Hist. Nat., vol. 44, p. 245, 1941.—Förster, Veröffentl. Zool. Staatss. München, vol. 3, p. 134, Dec. 1, 1955.

Tatochila polydice (Blanchard), Bartlett-Calvert, Anal. Univ. Chile, sec. 1, Mem. Cient. Lit., vol. 69, p. 314, 1886.—Berg, Anal. Mus. Nac. Buenos Aires, vol. 4, pp. 231–236, Nov. 18, 1895.

Tatochila autodice (Hübner), Bartlett-Calvert *nec* Hübner (a misidentification), Anal. Univ. Chile, sec. 1, Mem. Cient. Lit., vol. 69, p. 314, 1886.—Elwes, Trans. Ent. Soc. London (1903), p. 292, pl. 12, figs. 1, 3, 4, October 1903.

Tatochila autodice var.? *microdice* (Blanchard), Elwes *nec* Blanchard (a misidentification, in part.), Trans. Ent. Soc. London (1903), p. 292, pl. 12, fig. 6, October 1903.

Tatochila mercedis ab. *lilac* Ureta, Rev. Chilena Hist. Nat., vol. 41 (for 1937), pp. 250, 251, fig. 33, No. 7, pl. 12, fig. 8, 1938; Bol. Mus. Nac. Hist. Nat., vol. 16, p. 123, 1938; Rev. Chilena Hist. Nat., vol. 42 (for 1938), p. 297, 1939.

Tatochila mercedis ab. *porteri* Ureta, Rev. Chilena Hist. Nat., vol. 41 (for 1937), p. 251, pl. 12, fig. 7, 1938; Bol. Mus. Nac. Hist. Nat., vol. 16, p. 123, 1938; Rev. Chilena Hist. Nat., vol. 42 (for 1938), p. 297, 1939.

Tatochila mercedis ab. *elwesi* Ureta, Rev. Chilena Hist. Nat., vol. 41 (1937), pp. 251, 252, fig. 33, No. 8, 1938; Bol. Mus. Nac. Hist. Nat., vol. 16, p. 123, 1938; Rev. Chilena Hist. Nat., vol. 42 (for 1938), p. 297, 1939.

Synchloë mercedis (Eschscholtz), D'Almeida, Arq. Zool. Estado de São Paulo, vol. 2, p. 299, pl. 1, figs. 3, 6, Jan. 3, 1941.

VENATION: As illustrated (fig. 61).

LEGS: With paronychium, claw, and pulvillus as illustrated (fig. 76).

MALE: Plate 5, figures 17–17c. Head with outer surfaces of palpi white. Scales behind eyes white. Forewings above white with dark brown or black markings as illustrated, having a distinct discocellular bar (this bar also present on the undersurface), a submarginal row of separate sagittate markings and usually a marginal row of double streaks parallel to and lying on either side of the veins, thus differing from *vanvolxemii*. These streaks extend inward to not more than one-half the distance to the submarginal markings. Hindwings above almost always entirely white. In a very few specimens there is some black scaling along the veins at the outer margin and a submarginal series of small sagittate markings. Wings below with hindwing and apex of forewing yellow. Costal margin of hindwing and interspace below cell at base of wing darker yellow to pale orange. Hindwing with cell divided in the middle by a bar of dark brown that is itself divided by a thin line of yellow and with a distinct white spot on lower discocellular vein. Veins on hindwing white entirely outlined on both sides with dark brown, gray, or black. Veins in apex of forewing white to yellow outlined on both sides with this same dark color for a short distance inward but not reaching the submarginal row of sagittate markings. These sagittate markings are almost always present on forewing and hindwing, but on the latter they occasionally may be only weakly indicated.

Length of forewing, 20–29 mm. (average, 26.1 mm.).

Male genitalia as illustrated (figs. 33, 47). Differing from *T. microdice* and *T. vanvolxemii* in having the distal end of the aedeagus compressed entirely laterally instead of approximately dorsoventrally. Thus a lateral view of the aedeagus of *mercedis* has the nearly exact appearance of a ventral view of the other two species. The genitalia of 11 males were studied.

Female: Plate 5, figures 18–18b. Head as in the male with outer surfaces of palpi white and scales behind eyes white. Wings above with ground color white, sometimes suffused with pale yellow, especially on the hindwing. Dark brown to black markings as illustrated, much more extensive than in the male and similar to female *vanvolxemii*. However, on the forewing the discocellular bar is much more narrow, the submarginal sagittate markings on both wings are smaller, separate and not nearly so confluent, and more sharply sagittate along the outer edges than in *vanvolxemii*. Wings below with ground color of hindwing and of apex of forewing more distinctly yellow than in *vanvolxemii*. Hindwing with cell divided in the middle by a bar of dark brown that is itself divided by a thin line of yellow, and with costal margin and sometimes interspace below cell at the base darker yellow to pale orange. Hindwing with a distinct white spot on lower discocellular vein and with veins white outlined along either side by dark brown or black clear to the base. Veins along outer margin of forewing white bordered by dark brown or black about one-half the distance toward the submarginal sagittate markings and thus differing from *vanvolxemii* where these markings extend clear through the submarginal band at least along some of the veins. Discocellular dark brown bar on forewing much narrower than in *vanvolxemii* and submarginal sagittate markings on both wings entirely separate and much smaller than in that species

Length of forewing, 22–30 mm. (average, 25.3 mm.).

Female genitalia as illustrated (fig. 88), with anterior lobe of inner genital plate having posterior margin smooth with its posterior free angle produced and finger-like and with ventral margin broadly produced near middle. Plate opposite opening of ductus seminalis very large and broad with the plate just anterior to this large and completely ringing the ductus bursae. The genitalia of eight females were studied.

Type locality: "Talcaguano"=Talcahuano, Province of Concepción, Chile.

Additional type data: The sex and the number of specimens are not given in the original description; however, the illustrations and description apply only to the female.

Location of type: According to Horn and Kahle (Ent. Beih. Berlin-Dahlem, vol. 2, p. 69, 1935) the material described from Kotzebue's journey was shared in part by the "Museum Dorpat" (Eesti Rahva Museum, Tartu, Esthonia), and in part by C. G. Mannerheim (material now in the Zoological Museum of Helsingfors).

Method of identification: By comparison with the excellent, colored, original figures of both surfaces of the female and the original description.

Synonymical notes:

Pieris polydice Blanchard, 1852, described from both sexes (number of specimens not indicated) taken in the vicinity of Concepción, Chile, is clearly a synonym of *T. mercedis.* This type material, in the Museum National D'Historie Naturelle, Paris, consists of one male (cotype) in bad condition, presented by Gay in 1843, and two males and one female (cotypes) in good condition, purchased from Madame Lorquin in 1851.

Tatochila mercedis ab. *lilae* Ureta, 1937. This was described from a single female taken at Vicuna, Province of Coquimbo, Chile, in which the ground color is yellowish with violet reflections. It is clearly an individual variant and is therefore listed as a synonym. The type is in the collection of Dr. Emilio Ureta-R.

Tatochila mercedis ab. *porteri* Ureta, 1937. This was described from a single male taken at Santiago, Chile. It is an individual variant of the male sex in which the maculation of the wings above to some extent resembles that of *T. vanvolxemii* and in which nearly all black scaling along the veins underneath is absent. Being an individual variant, it is here listed as a synonym. The holotype is in the collection of Dr. Emilio Ureta-R.

Tatochila mercedis ab. *elwesi* Ureta, 1937, described from two females taken at El Pangue, Department of Elqui, Province of Coquimbo, Chile, is an individual variant of the female sex in which the ground color is bright yellow with a somewhat greenish tinge and in which nearly all black scaling along the veins below is absent. The type is in the collection of Dr. Emilio Ureta-R.

Misidentifications: Bartlett-Calvert (1886) refers to this species under the name *T. autodice* (Hübner). Elwes (1903) illustrates a female of this species as *P. microdice* Blanchard.

Distribution: Chile from the Province of Atacama south into the Province of Llanquihue and east into the extreme western part of the Territory of Río Negro in Argentina.

Chile: *Province of Atacama,* Copiapó: *Province of Coquimbo,* Vicuña (February); *Province of Valparaiso,* La Campana (March), Quillota (March), Valparaiso (March), Papudo (January); *Province of Santiago,* La Florida (April), San Cristóbal (March), Peñalolen (February, March), Criadas (October), Macul (February–April), Lo Ovalle (November), Romeral (December), Canelo (October), Santiago (February), El Volcán; *Province of Concepción,* Talcahuano; *Province of Malleco,* Angel (March), Victoria; *Province of Cautin,* Temuco (February); *Province of Llanquihue,* Frutillar (February). Argentina: *Territory of Río Negro,* Bariloche (November).

Food plants: *Brassica campestris* L. and *Raphanus sativus* L.

Material studied: 29 males, 21 females.

Group D. The Orthodice Group

In this group the aedeagus (in lateral view) is gradually arched and usually much narrower just before the middle than at the distal end. The distal end of the aedeagus is entirely excised on its right side and deeply incised on its left side. There is a small tooth above this incision and frequently one below it.

Hindwings above with marginal wedge-shaped markings absent, although the veins are sometimes black along the outer margin; without a submarginal row of sagittate markings, or if present, greatly reduced. Hindwing below with ground color yellow and with submarginal series of sagittate markings usually absent or, if present, very faintly represented. The orange streaks through middle of the interspaces are either present or absent. Usually the white spot on lower discocellular vein is absent, if present the white is confined to the vein.

This group contains five species.

Tatochila inversa Hayward

Tatochila inversa Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 7, pp. 136, 137, 1949; vol. 9, p. 94, Oct. 25, 1951.

Venation: As illustrated (fig. 62).

Legs: With paronychium, claw, and pulvillus as illustrated (fig. 73).

Male: Plate 6, figure 19. Head with outer surfaces of palpi white. Scales behind eyes orange. Wings with dark markings dark brown to black, ground color on uppersurfaces and on disc and base of forewing below white, ground color of hindwing below and of apex of forewing below yellow with costal margin and extreme base of hindwing orange and with veins silvery white outlined heavily with gray. Lower discocellular vein white. This species is similar to *homoeodice* and *orthodice* in lacking the black scaling on veins of upper surface of hindwing and differs from these species in having a very strong discocellular black bar on upperside of forewing. Like *homoeodice* it differs from *orthodice* in having lateral surface of palpi white to pale yellow not orange. It is easily separated from *homoeodice* in its lack of orange between the veins and below the cell on the undersurfaces of hindwing and from *orthodice* in lacking orange in upper half of cell on this wing.

Length of forewing, 27–28 mm.

Male genitalia as illustrated (figs. 34, 48), with aedeagus in lateral view having central part relatively more slender than in the other species of Group D and with dorsal and ventral margins of this central portion more nearly parallel than in the other species of this group except *orthodice.* From *orthodice* it differs, in addition to the slenderness, in having a narrower and shorter distal incision on the left side. The genitalia of both of the known males were studied.

Female: Plate 6, figure 19a. Head with outer surfaces of palpi pale yellow. Scales behind eyes orange. Forewing above white with dark brown markings on forewing as illustrated, being very extensive with an especially large discocellular bar and large submarginal dark band. Hindwing above differing from all other species in Group D in having a clear yellow ground color. Veins white with dark brown scaling as illustrated. Wings below not differing from the male except with dark brown scaling along veins stronger, with discocellular bar of forewing more distinct and with the submarginal series of sagittate markings on this wing clearly indicated.

Length of forewing, 27.5 mm.

Female genitalia as illustrated (fig. 90), with anterior lobe of inner genital plate nearly subcircular, having a small lobelet at either end of ventral margin. The ribbon-like plate on ventral surface of ductus bursae is situated opposite and posterior to the opening of the ductus seminalis. Ductus bursae with two large plates, one ventral and one dorsal and anterior to the opening of ductus seminalis. Only a single specimen, the holotype, was available for dissection and study.

Type locality: "Quebrada Carapunco, Department de Tafí, Provincia de Tucumán," Argentina.

Additional type data: Described from a single female, the holotype (2,500 m., November 1932).

Location of type: In the collection of the Instituto Miguel Lillo, Tucumán, Argentina.

Method of identification: By a study of the holotype.

Additional remarks: The two known males, although from quite a distant locality, Cuzco, Peru, are here associated with the female holotype because of their great similarity in color and pattern. One of these males has the forewing with outer margin more straight and an even larger discocellular bar than in the one illustrated (fig. 19) and with a row of large submarginal dark spots present. Otherwise it is quite similar to the one illustrated and has identical genitalia. It is possible that *inversa* may be a synonym of *homoeodice;* however, scarcity of material prevents that conclusion at this time.

DISTRIBUTION: This species is too rare for any general statement on distribution.

PERU: *Department of Cuzco,* Ollantaitambo (9,200 ft., March), Callanga (1,500 m.). ARGENTINA: *Province of Tucumán,* Quebrada Carapunco (2,500 m., November).

MATERIAL STUDIED: 2 males, 1 female.

Tatochila homoeodice Paravicini

Tatochila homoeodice Paravicini, Mitteil. Schweizerschen Ges., vol. 12, Heft 1, p. 23, May 1910.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae 1, p. 59, Oct. 24, 1932.

VENATION: As illustrated (fig. 63).

LEGS: With paronychium, claw, and pulvillus as illustrated (fig. 77).

MALE: Plate 6, figure 21. Head with outer surfaces of palpi yellowish white. Scales behind eyes orange. Wings with dark markings dark brown, ground color of upper surfaces and on disc and base of apex of forewing underneath yellow. Hindwing with costal margin and intervenal area below cell orange and with faint orange streaks between veins along outer half of this wing. Veins on this surface white broadly outlined by dark gray. Similar to *T. orthodice,* differing chiefly in having the ground color below a much darker yellow and in having all markings much stronger. This is true of these markings on apex of forewing above also. From *sagittata* and *stigmadice* it is easily distinguished by lacking all the black markings on the uppersurface of the hindwing.

Length of forewing, 25 mm.

Male genitalia as illustrated (figs. 35, 49), with aedeagus more swollen before distal end than in *inversa* and *orthodice* and differing from *sagittata* chiefly in having a small but distinct, ventrally placed subapical tooth in addition to the dorsally placed subapical tooth. The genitalia of only a single male was available for study.

FEMALE: Unknown.

TYPE LOCALITY: "Huancabamba," Department of Piura, "Peru."

ADDITIONAL TYPE DATA: Described from three males, one labeled type (= holotype, locality as given above and without further data) and one labeled paratype (data as in the holotype, ♂ genitalia preparation W. D. F. No. 5338) by Paravicini. The whereabouts of the second paratype is unknown.

Location of type: In the collection of the British Museum (Natural History).

Method of identification: Through a study of the paratype which was compared with the holotype by Mr. D. S. Fletcher.

Distribution: Known only from the type locality.

Material studied: 1 male.

Tatochila orthodice (Weymer)

Pieris orthodice Weymer, *in* Weymer and Maassen, W. Reiss und A. Stübel Reisen in Süd-Amerika, Lepidopteren . . ., pp. 99, 124, pl. 3, fig. 20, 1890.—Staudinger, Ent. Zeitschr. "Iris," Dresden, vol. 7, p. 62, July 14, 1894.

Tatochila xanthodice (Lucas), Berg *nec* Lucas (a misidentification of male), Anal. Mus. Nac. Buenos Aires, vol. 4, pp. 249–252, fig. 4, Nov. 18, 1895

Tatochila orthodice Weymer, Berg, Anal. Mus. Nac. Buenos Aires, vol. 4, pp. 253, 254, Nov. 18, 1895.—Rebel, Weymer, and Stichel, Berliner Ent. Zeitschr., vol. 46, p. 291, September 1901.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 57, pl. 18, figs. e4, e5, May 25, 1908.—Paravicini, Mitteil. Schweizerschen Ges., vol. 12, p. 23, May 1910.—Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 406, 407, 409, 411, 414, 415, Mar. 10, 1915; Rev. Chilena Hist. Nat., vol. 20, pp. 43, 44, 46, 53, 55, 56, 57, pl. 3, fig. 6, June 30, 1916.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, pp. 430, 443, 456–459, fig. 5, Nov. 10, 1916.—Giacomelli, Physis, vol. 3, pp. 375, 376, 1917.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 1015, Jan. 21, 1924.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 59, Oct. 24, 1932.—Breyer, Verhandlungen VII Internationalen Kongress für Entomologie, vol. 1 (for 1938), p. 32, February 1939.—Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," p. 93, Oct. 25, 1951.—Förster, Veröffentl. Zool. Staatss. München, vol. 3, p. 136, Dec. 1, 1955.—Zischka, Fol. Univ., Univ. Cochabamba, Bolivia, vol. 5, pp. 18, 19, October 1951.

Tatochila orthodice ab. *breyeri* Breyer (Giacomelli MS.), Verhandlungen VII Internationalen Kongress für Entomologie, vol. 1 (for 1938), pp. 32, 33, February 1939.—Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 94, Oct. 25, 1951.

Tatochila orthodice f. *inpunctata* Breyer, Verhandlungen VII Internationalen Kongress für Entomologie, vol. 1 (for 1938), p. 32, February 1939.

Synchlöe orthodice (Weymer), Breyer, Rev. Soc. Ent. vol. 12, p. 310, February 1945.—Zischka, Fol. Univ., Univ. Cochabama, Bolivia, vol. 1, p. 28, December 1947.

Tatochila orthodice f. *impunctata* Breyer, Hayward (a correction for *inpunctata*), Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 94, Oct. 25, 1951.

Venation: As illustrated (fig. 64).

Legs: With paronychium, claw, and pulvillus as illustrated (fig. 78).

Male: Plate 6, figure 20. Head with outer surfaces of palpi orange and thus differing from all other members of Group D. Scales behind eyes orange. Wings above white with dark brown markings on forewing as illustrated, being more reduced than in *inversa* or *homoeodice*, the discocellular bar being represented by a narrow line. As in *inversa* and *homoeodice*, this species differs from *sagittata* and *stigmadice* in lacking all black markings on hindwing. Wings below very similar to *homoeodice* and *inversa* with yellow of ground color and black bordering along veins even paler than in those two species and differing from both in having the upper half of hindwing cell orange.

Length of forewing, 22–29 mm. (average, 25.4 mm.).

Male genitalia as illustrated (figs. 36, 49). Aedeagus in lateral view similar to *inversa*, being thicker throughout and differing also in having a broader and deeper distal incision on its left side. The genitalia of six males were studied.

FEMALE: Plate 6, figure 20a. Head as in the male with outer surfaces of palpi orange and thus differing from all other females in Group D. Scales behind eyes orange. Forewing above white, sometimes slightly creamy, with dark brown markings on forewings, as illustrated, being much more extensive than in the male but much less so than in the female of *inversa*, the discocellular bar and submarginal row of spots being greatly reduced. Hindwing above with ground color white, sometimes slightly cream colored with veins white and bordered by pale brown. Wings below quite like the male, differing from *inversa* in having yellow of ground color paler, and like *stigmadice* in having upper half of cell orange. It differs from *stigmadice* in lacking the distinct dark brown stripes along the veins especially on the base and disc of forewing and in lacking the clearly defined orange lines between the veins on the hindwing and on apex of forewing.

Length of forewing, 21.5–26 mm. (average, 24.3 mm.).

Female genitalia as illustrated (fig. 89), with anterior lobe of inner genital plate subtriangular and with both the posterior and the ventral margin of this plate serrate. Ductus bursae with the ribbonlike plate on ventral surface opposite the opening of ductus seminalis divided and with a semicrescentic plate just anterior to this. The genitalia of four females were studied.

TYPE LOCALITY: "Cotana," Department of La Paz, Bolivia.

ADDITIONAL TYPE DATA: Described from five males, cotypes (locality as given above, 1,200–2,200 m., December).

LOCATION OF TYPES: In the Zoologisches Museum der Humboldt-Universität, Berlin. According to Dr. E. M. Hering of that institution, there are only two males remaining in the collection. A third male was destroyed during World War II. Two males are unaccounted for. A lectotype is not designated.

METHOD OF IDENTIFICATION: By a study of one of the two remaining cotypes and by comparison with the excellent original colored figure and description.

SYNONYMICAL NOTES:

Tatochila orthodice ab. *breyeri* Breyer, 1939. This was described from a single melanistic female taken at Río Ochuna, Province of Tucumán, Argentina. The type is in the collection of Alberto Breyer, Buenos Aires, Argentina.

Tatochila orthodice f. *inpunctata* Breyer, 1939 (corrected to *impunctata* by Hayward, 1951). This was described from a single specimen (sex not indicated) taken at Río Cochuna, Province of Tucumán, in which the discocellular bar on uppersurface of forewing is absent. The type is in the collection of Alberto Breyer, Buenos Aires, Argentina.

MISIDENTIFICATIONS: Berg (1895) refers to a male of this species as *Tatochila xanthodice* (Lucas).

DISTRIBUTION: From the Cordillera near La Paz in Bolivia south into the Province of Catamarca in Argentina.

BOLIVIA: *Department of La Paz*, Province of Nor Yungas, Yanacachi (January); *Department of Santa Cruz*, Province of Balle Grande, Semaipata (1,500–2,500 m., March). ARGENTINA: *Province of Jujuy*, Laguinillas (October); *Province of Salta*, Salta (December), San Lorenzo (April); *Province of Tucumán*, Quebrada Carapunco (November), Quebrada de Lules (January), El Nogalar (September), Río Ochuna, Villa Nougues (January); *Province of Catamarca*, Esquina Grande (November), El Candado (December).

MATERIAL STUDIED: 37 males, 12 females.

***Tatochila sagittata* Röber**

Tatochila demodice sagittata Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 57, pl. 18, fig. e1, May 25, 1908.—Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 406, 408, 414, 415, Mar. 10, 1915; Rev. Chilena Hist. Nat., vol. 20, p. 55, pl. 3, fig. 1, June 30, 1916.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 58, Oct. 24, 1932.

Tatochila stigmadice sagittata Röber, Paravicini, Mitteil. Schweizerschen Ent. Ges., vol. 12, p. 22, May 1910.

Tatochila sagittata Röber, Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, pp. 443, 464, 465, Nov. 10, 1916.—Giacomelli, Physis, vol. 3, p. 377, 1917.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 1015, Jan. 21, 1924.—Förster, Veröffentl. Zool. Staatss. München, vol. 3, p. 135, Dec. 1, 1955.

Tatochila joergenseni Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, pp. 1015, 1016, pl. 194, fig. a4, Jan. 11, 1924.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 59, Oct. 24, 1932.

VENATION: As illustrated (fig. 65).

LEGS: With paronychium, claw, and pulvillus as illustrated (fig. 79).

MALE: Plate 6, figures 22–22b. Head with outer surfaces of palpi white. Scales behind eyes white. Wings with dark markings dark brown to black. Ground color on uppersurfaces and on disc and base of forewing below white. Hindwing and apex of forewing below yellow with costal margin and extreme base of hindwing orange and with intervenal orange streaks. Veins on undersurface of hindwing gray, heavily outlined by dark brown. Similar to *orthodice* and *stigmadice*, differing chiefly in having the margins of hindwing above and below bordered by a distinct but narrow black line and in usually having a submarginal series of dark brown or black sagittate markings on both wings (on both surfaces) and, in addition, differing from *orthodice* in having outer surface of palpi white not orange.

Length of forewing, 24–28 mm. (average, 27 mm.).

Male genitalia as illustrated (figs. 37, 51). Distal portion of aedeagus more swollen than in orthodice, with incision on left side deeper and placed distinctly above the middle and differing from *homoeodice* in lacking the distal and subapical ventral tooth found in that species. From *inversa* it differs in not being constricted in front of the dorsolateral tooth (ventral view). The genitalia of 10 males were studied.

FEMALE: Unknown.

TYPE LOCALITY: "Huancabamba," Department of Piura, "Peru."

ADDITIONAL TYPE DATA: Described from male specimens (number not stated) taken at 3,000 m. According to Dr. E. M. Hering of the Zoologisches Museum, Humboldt-Universität, Berlin, there is in the Röber collection a single male. We consider this to be the holotype.

LOCATION OF TYPE: In the Röber collection, formerly in Dresden and now in the Berlin Museum, as stated above.

METHOD OF IDENTIFICATION: By comparison with the excellent original figure.

SYNONYMICAL NOTES:

Tatochila joergenseni Röber, 1924. Type locality, "Ecuador." Described from a single male, the holotype, in the Röber collection. This name falls to *sagittata* Röber as a synonym since it is only an individual variant. It differs from typical *sagittata* only in lacking the submarginal sagittate markings on upper side of hindwing.

DISTRIBUTION: The Andes from southern Colombia south to central Peru.

COLOMBIA: *Province of Cauca,* Popayán. PERU: *Department of Piura* (6,000–10,000 ft.); *Department of Cajamarca,* Celendin (2,625 m.); *Department of Junín,* Huancayo (3,500 m.).

MATERIAL STUDIED: 11 males.

Tatochila stigmadice (Staudinger)

Pieris stigmadice Staudinger, Ent. Zeitschr. "Iris," Dresden, vol. 7, pp. 62, 63, July 14, 1894.

Tatochila xanthodice (Lucas), Berg *nec* Lucas (a misidentification of female), Anal. Mus. Nac. Buenos Aires, vol. 4, pp. 249–252, fig. 5, Nov. 18, 1895.

Tatochila stigmadice (Staudinger), Berg, Anal. Mus. Nac. Buenos Aires, vol. 4, pp. 254, 255, Nov. 18, 1895.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 57, May 25, 1908.—Dixey, Proc. Ent. Soc. London, (1909)

p. cxxxiv, Mar. 30, 1910.—Paravicini, Mitteil. Schweizerschen Ent. Ges., vol. 12, p. 22, May 1910.—Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 406, 407, 409, 414, 415, Mar. 10, 1915; Rev. Chilena Hist. Nat., vol. 20, pp. 44, 55, 56, 57, pl. 3, fig. 4, June 30, 1916.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, pp. 430, 443, 467, Nov. 10, 1916.—Giacomelli, Physis, vol. 3, pp. 377, 378, 1917.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 1016, pl. 194, fig. a6, Jan. 21, 1924.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 58, Oct. 24, 1932.—Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 94, Oct. 25, 1951.—Förster, Veröffentl. Zool. Staatss. München, vol. 3, p. 135, Dec. 1, 1955.—Zischka, Fol. Univ., Univ. Cochabamba, Bolivia, vol. 5, p. 18, October 1951.

Tatochila stigmadice f. *immaculata* Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 57, pl. 18, figs. e2, e3, May 25, 1908.—Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 406, 407, 409, 410, 414, 415, Mar. 10, 1915; Rev. Chilena Hist. Nat., vol. 20, p. 55, pl. 3, fig. 3, June 30, 1916.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, pp. 430, 469, Nov. 10, 1916.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 1016, Jan. 21, 1924.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 59, Oct. 24, 1932.—Breyer, Verhandlungen VII Internationalen Kongress für Entomologie, vol. 1 (for 1938), p. 31, February 1939.—Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 94, Oct. 25, 1951.—Zischka, Fol. Univ., Univ. Cochabamba, Bolivia, vol. 5, p. 18, October 1951.

Tatochila stigmadice f. *inmaculata* Röber, Giacomelli *nec* Röber (a misspelling), Rev. Chilena Hist. Nat., vol. 20, pp. 46, 57, June 30, 1916.

Tatochila stiginadice (Staudinger), Giacomelli *nec* Staudinger (a misspelling), Rev. Chilena Hist. Nat., vol. 20, p. 55, June 30, 1916.

Tatochila stigmadice f. *punctata* Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, pp. 430, 467, 468, Nov. 10, 1916.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 1016, Jan. 21, 1924.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 59, Oct. 24, 1932.—Breyer, Verhandlungen VII Kongress für Entomologie, vol. 1 (for 1938), p. 31, February 1939.

Tatochila stigmadice ab. *nigra* Breyer (Giacomelli MS), Verhandlungen VII Internationalen Kongress für Entomologie, vol. 1 (for 1938), pp. 31, 32, February 1939.—Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 94, Oct. 25, 1951.

Synchlöe stigamdice (Staudinger), Zischka *nec* Staudinger (a misspelling), Fol. Univ., Univ. Cochabamba, Bolivia, vol. 1, p. 28, December 1947.

Tatochila stigmadice ab. *punctata* Jörgensen, Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 94, Oct. 25, 1951.

Tatochila stigmadice immaculata Röber, Zischka, Fol. Univ., Univ. Cochabamba, Bolivia, vol. 5, p. 18, October 1951.

VENATION: As illustrated (fig. 66).

LEGS: With paronychium, claw, and pulvillus as illustrated (fig. 80).

MALE: Plate 6, figure 23; plate 7, figure 24. Head with outer surfaces of palpi white. Scales behind eyes white, thus differing from *inversa*, *orthodice*, and *homoeodice*. Wings above with dark brown markings as illustrated, having dark scaling more extensive than in *orthodice*, especially on the hindwing where the outer parts of the veins are covered with dark brown. Wings below with ground color of hindwing and apex of forewing pale yellow as in orthodice. Similar to *orthodice*, *homoeodice*, and *inversa* in having veins on these areas more narrowly covered with white and more narrowly bordered with dark brown and unlike these species in having clearly defined orange lines between the veins on these areas. Like *orthodice* and differing from *inversa* and *homoeodice* in having orange on upper half of cell of hindwing below.

Length of forewing, 23–27 mm. (average, 25.1 mm.).

Male genitalia as illustrated (figs. 38, 52). Distal end of aedeagus more slender than in any of the other species and with ventral lobe formed by the lateral incision smaller and less produced, thus somewhat similar to the *autodice* group from which it differs otherwise in being gradually arched, not sinuous. The genitalia of 12 males were studied.

FEMALE: Plate 7, figures 24a–24c. Head with outer surfaces of palpi white. Scales behind eyes white, thus differing from females of *inversa* and *orthodice*. Wings above white, sometimes slightly creamy with dark brown markings as illustrated, being very much more extensive than in the male of this species and in other females of this group, having the veins on both wings entirely and extensively covered with dark brown clear to their bases and with the submarginal row of sagittate markings very distinct even on the hindwing. Wings below quite like the male, except with veins on base and disc of forewing very distinctly outlined by dark brown, differing from *inversa* and *orthodice* females in this character as well as in having clearly defined orange lines between all of the veins on the hindwing and on apex of forewing. The upper half of cell on hindwing is orange, thus differing from *inversa*.

Length of forewing, 22–26 mm. (average, 23.6 mm.).

Female genitalia as illustrated (fig. 91), having anterior lobe of inner genital plate with anterior margin serrate and with ventral margin triundulate. Ductus bursae almost entirely sclerotized. The genitalia of five females were studied.

TYPE LOCALITY: "Cocapata," Department of Cochabamba, Bolivia.

ADDITIONAL TYPE DATA AND LOCATION OF TYPE: Described from seven males, cotypes (locality as given above); of these, five now remain in the Zoologisches Museum der Humboldt-Universität, Berlin. One of these was sent to us for study and it is hereby designated as the lectotype.

METHOD OF IDENTIFICATION: By a study of the lectotype.

SYNONYMICAL NOTES:

Tatochila stigmadice f. *immaculata* Röber, 1908. This was described from the male sex from Province of Tucumán, Argentina. The type is in the Röber collection of the Zoologisches Museum, Humboldt-Universität, Berlin. The original description and colored figure show that it is an unnecessary name, representing an individual variant in which the submarginal spots are absent on both surfaces of both wings.

Tatochila stigmadice f. ♂ *punctata* Jorgensen, 1916. This was described from a number of specimens from various localities in the Provinces of Salta, Tucumán, and Catamarca, Argentina. Type in the collection of the Museo Argentino de Ciencias Naturales of Buenos Aires. A study of a paratype in the collection of the U. S. National Museum and of the carefully prepared original description show this name to apply (indeed as described) to a fairly common individual variant of the male sex in which there is a submarginal series of small spots on the upper surfaces of the hindwings. The name is neither desirable nor necessary and falls to *stigmadice*.

Tatochila stigmadice ab. *nigra* Breyer, 1939. This was described from a single specimen (sex not stated) taken in Tucumán, Argentina. It is a large and dark individual variant and does not need a name. The type is in the collection of Alberto Breyer, Buenos Aires, Argentina.

The name *stigmadice* has been misspelled as *stiginadice* by Giacomelli (1916) and as *stigamdice* by Zischka (1947).

MISIDENTIFICATIONS: Berg (1895) refers to a female of this species as *Tatochila xanthodice* (Lucas).

DISTRIBUTION: Bolivia, from Department of Cochabamba and the southern part of Department of La Paz, south into the Province of Córdoba, Argentina.

BOLIVIA: *Department of Cochabamba*, Cochabamba (2,600 m., March); *Department of La Paz*, Sicasica (October). ARGENTINA: *Province of Juyjuy*, Juyjuy; *Province of Salta*, Salta (December); *Province of Catamarca*, Las Faldas, Esquina Grande (April, November, December), El Suncho (May), El Candado (February); *Province of Tucumán*, Siambón (March, May, October), Villa Nougues (November), Tafi (February), Tucumán; *Province of La Rioja*, La Rioja; *Province of Córdoba*, Rearte (April).

MATERIAL STUDIED: 29 males, 17 females.

GROUP E. THE XANTHODICE GROUP

In this group the aedeagus is gradually arched and deeply incised at the distal end both dorsally and ventrally, forming large lateral lobes, at least one of which forms a point at the apex. The aedeagus here is thus similar to the aedeagi found in the genera *Hypsochila*, *Phulia*, and *Piercolias*.

Wings above like Groups C and D. Hindwing below with a yellow ground color; without a series of sagittate markings and sometimes with irregular orange spots replacing this series. The white spot sometimes found on the lower discocellular vein is lacking in this group.

This group contains two species.

Tatochila xanthodice (Lucas)

Pieris xanthodice Lucas, Rev. Mag. Zool., ser. 2, vol. 4, pp. 337, 338, July 1852.—Kirby, A synonymic catalogue of diurnal Lepidoptera, p. 450, 1871.—Herrich-Schaffer, Corresp.-Blatt Zool.-Min. Ver. Regensburg, vol. 21, p. 125, 1867.—Whymper, Travels amongst the Great Andes of the Equator, supplementary appendix, p. xi, 1891.—Godman and Salvin, *in* Whymper, ibid., p. 106, 1891.—Campos-R., Rev. Col. Nac. Vicente Rocafuerte, No. 4, p. 42, 1921.

Tatochila xanthodice (Lucas), Butler, Proc. Zool. Soc. London (1872), p. 67, Jan. 16, 1872.—Rebel, Weymer, and Stichel, Berliner Ent. Zeitschr., vol. 46, pp. 290, 291, pl. 4, figs. 1, 2, September 1901.—Elwes, Trans. Ent. Soc. London (1903), p. 293, October 1903.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 56, pl. 18, figs. d5, d6, May 25, 1908.—Dixey, Proc. Ent. Soc. London (1909), p. cxxxiv, Mar. 30, 1910.—Paravicini, Mitteil. Schweizerschen Ent. Ges., vol. 12, p. 23, May 1910.—Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 406, 408, 411, 415, Mar. 10, 1915; Rev. Chilena Hist. Nat., vol. 20, pp. 44, 46, 54, 57, pl. 2, figs. 5, 6, June 30, 1916.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, pp. 443, 460–462, Nov. 10, 1916.—Giacomelli, Physis, vol. 3, p. 376, 1917.—Campos-R., Rev. Col. Nac. Vicente Rocafuerte, vol. 9, pp. 80, 81, 1927.—Klots, Ent. Americana, new ser., vol. 12, No. 4, p. 218, March 1932.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 58, Oct. 24, 1932.—Apolinar, Rev. Acad. Colombiana Cienc. Exact. Fís. Nat., vol. 4, p. 349, December 1941.

Pieris (*Tatochila*) *xanthodice* Lucas, Therese von Bayern, Berliner Ent. Zeitschr., vol. 46, p. 242, September 1901.

Tatochila pyrrhomma Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 56, pl. 18, figs. d2, d3, May 25, 1908.—Paravicini, Mitteil. Schweizerschen Ent. Ges., vol. 12, p. 23, May 1910.—Giacomelli, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 26, pp. 406, 408–413, Mar. 10, 1915; Rev. Chilena Hist. Nat., vol. 20, pp. 44, 52–55, 57, pl. 3, fig. 2, June 30, 1916.—Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, pp. 443, 460, Nov. 10, 1916.—Giacomelli, Physis, vol. 3, p. 376, 1917.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 58, Oct. 24, 1932.

VENATION: As illustrated (fig. 67).

LEGS: With paronychium, claw, and pulvillus as illustrated (fig. 81).

MALE: Plate 7, figures 25, 25a. Head with outer surfaces of palpi white to pale yellow. Scales behind eyes orange. Wings above white, sometimes yellowish with dark brown markings on forewing as illustrated, having the marginal black sagittate markings broad and entirely obscuring the veins and thus differing from *distincta*. Wings below with base and disc of forewing white and with ground color of hindwing and apex of forewing pale yellow, nearly white along outer margins. Veins white outlined with black in these areas. Hindwing with costal margin, upper half of cell and interspace below cell orange.

Differing from *distincta* in having upper half of cell and interspaces below cell orange and in having a submarginal series of orange spots on the hindwing.

Length of forewing, 24–28 mm. (average, 26.6 mm.).

Male genitalia as illustrated (figs. 39, 53). Aedeagus with dorsal and ventral incisions much deeper than in *distincta* and forming two lateral lobes that are not equal in size or shape. Five genitalia preparations were studied.

FEMALE: Plate 7, figure 25b. Head as in the male with outer surfaces of palpi pale yellow and scales behind eyes orange. Wings above as illustrated with ground color yellow and nearly obliterated by the dark brown markings along the veins. Submarginal spots large and confluent with the vein markings. Wings below as in the male.

Length of forewing, 26–28 mm. (average 27 mm.).

Female genitalia as illustrated (fig. 92). The anterior lobe of the inner genital plate is subtriangular, having the posterior margin serratulate and the ventral margin deeply undulate, forming five separate lobelets. Ductus bursae lacks all sclerotization. Two genitalia preparations were studied.

TYPE LOCALITY: The original description specifies Venezuela and Peru. According to Mr. Jean Bourgogne, of the Paris Museum, the two original males are from Colombia and were purchased from a Mr. Parzudaki. A lectotype is not designated.

ADDITIONAL TYPE DATA: Described from two males, cotypes (Colombia, Mr. Parzudaki), and one female, presumed to be a cotype (Peru, from Mr. Becker).

LOCATION OF TYPES: In the Museum National D'Historie Naturelle, Paris.

METHOD OF IDENTIFICATION: Identified by reference to the original description, which fits no other species. *Tatochila microdice arctodice* Staudinger and *T. microdice macrodice* Staudinger, the only other species with which *xanthodice* could logically be confused, lack entirely the submarginal streaks of orange between the veins on hindwings below and never have black marginal lines on the hindwings above. The present species is quite in agreement with the original description, does have these orange streaks, and frequently has this black marginal line.

SYNONYMICAL NOTES:

Tatochila pyrrhomma Röber, 1908. Described from the male sex (number of specimens not stated) from "Huancabamba," Department of Piura, Peru (3,000 m.). Type presumably in the Röber collection. The original description and colored figure accompanying this name show clearly that it is a synonym of *xanthodice*.

Distribution: The Andes of Colombia south through Ecuador into northern Peru.

Colombia: *Department of Santander,* Río Suarez (900–1,000 m., August); *Department of Boyacá,* Arcabuco (2,200–3,000 m., September) Samacá; *Department of Cundinamarca,* San Miguel (3,000 m., August), La Calera (2,800 m., February), Choachi (December), Aguadita (June); *Department of Cauca,* Páramo Malvoza (3,400 m., July). Ecuador: *Province of Tungurahua,* Río Pastaza. Peru: *Department of Cajamarca,* Cajamarca; *Department of Piura,* Huancabamba (3,000 m.).

Material studied: 12 males, 2 females.

Tatochila distincta Jörgensen

Tatochila distincta Jörgensen, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 28, pp. 443, 465–467, figs. 6, 7, Nov. 10, 1916.—Giacomelli, Physis, vol. 3, p. 377, 1917.—Röber, *in* Seitz, Die Gross-Schmetterlinge der Erde, vol. 5, p. 1016, pl. 194, fig. a5, Jan. 21, 1924.—Talbot, *in* Strand, Lepidopterorum catalogus, pars 53, Pieridae I, p. 59, Oct. 24, 1932.—Breyer, Verhandlungen VII Internationalen Kongress für Entomologie, vol. 1 (for 1938), p. 30, February 1939.—Hayward, Act. Zool. Lilloana Inst. "Miguel Lillo," vol. 9, p. 94, Oct. 25, 1951.

Venation: As illustrated (fig. 68).

Legs: With paronychium, claw, and pulvillus as illustrated (fig. 82).

Male: Plate 7, figure 26. Head with outer surfaces of palpi and scales behind eyes white. Forewings above white with dark markings as illustrated, having black marginal sagittate markings much narrower than in *xanthodice* and not covering the white veins along the margin. Submarginal sagittate markings prominent and usually confluent in forewing, absent or sometimes only faintly indicated on hindwing. Hindwing above white sometimes with prominent black scaling along both sides of the veins. Wings below with base and disc of forewing white and with ground color of hindwing and apex of forewing yellow, with veins silvery white outlined with gray in these areas. Orange absent except in base, cell, and along costal margin of hindwing, thus differing from *xanthodice.*

Length of forewing, 22–24 mm. (average, 23 mm.).

Male genitalia as illustrated (figs. 40, 54), with dorsal and ventral incisions much more shallow than in *xanthodice* and forming two lateral lobes that are nearly equal in size and shape. The genitalia of five males were studied.

Female: Plate 7, figure 26a. Head as in the male with outer surfaces of palpi and scales behind eyes white. Wings above as illustrated, with ground color of forewing white and of hindwing white with a yellowish tinge. Dark markings more extensive than in the male, especially on the hindwing where the veins are white completely outlined on both sides by dark brown or black. All dark markings much smaller and more narrow than in females of *xanthodice*, with submarginal sagittate markings of hindwing very indistinct. Wings below as in the male.

Length of forewing, 23–24 mm. (average, 23.5 mm.).

Female genitalia as illustrated (fig. 93), with anterior lobe of inner genital plate subtriangular and with posterior and ventral margins of this lobe slightly irregular and undulate. Ductus bursae with sclerotized ring around area at opening of ductus seminalis. Only one of the two available females was dissected for study.

Type locality: "Cerros de Aconquija," Province of Catamarca, Argentina.

Additional type data: Described from males and females, cotypes (number not specified), from Cerro Negro (3,500 m.), La Ollada (3,100 m.), and Cerro de la Ensenada (3,200 m.), all in the Sierra de Aconquija, Province of Catamarca, Argentina (on the wing in February and March).

Location of types: In the collection of the Museo Argentino de Ciencias Naturales, Buenos Aires. One male cotype (Cerro Negro) and one female cotype (La Ollada) in the collection of the U. S. National Museum. One male cotype (Cerro Negro) in the collection of the British Museum (Natural History).

Method of identification: By a study of the three cotypes available to us for study and of the well-prepared original description and illustrations.

Distribution: Known only from Argentina.

Argentina: *Province of Tucumán*, Casa de Piedra (3,150 m., February), La Ollada (3,100 m.).

[A single specimen in the collection of Cornell University is labeled "Puno Peru, 17.XII.38, Leg. Loukuf." This record is very doubtful and should be further verified before acceptance.]

Material studied: 6 males, 2 females.

U.S. GOVERNMENT PRINTING OFFICE: 1959

Figures 1-93

Figures 27–33, 40 were drawn by Herrera. Figures 34–39, 41–93 were drawn by Field.

Following is an explanation of the symbols used on the drawings:

Male genitalia: *Ae*, aedeagus; *An*, anellus or juxta; *ap*, articulatory process of tegumen; *AT*, anal tube; *clpl*, clasper lobe; *Hp*, harpe; *ip*, inner plate of uncus; *Sac*, saccus; *Subs*, subscaphium; *Teg*, tegumen; *U*, uncus; *Vm*, vinculum.

Female genitalia: *acp*, accessory pouch of bursa copulatrix; *al*, anterior lobe of inner genital plate; *ap*, anterior apophysis; *Bc*, bursa copulatrix; *Db*, ductus bursae; *ds*, ductus seminalis; *fp*, finger-like process of inner genital plate; *igp*, inner genital plate; *Ob*, ostium bursae; *ogp*, outer genital plate; *Ov*, ovipositor; *S*, signum; *tg*, tergite.

Other symbols: *Cl*, claw; *Pr*, paronychium; *Pv*, pulvillus; *h*, humeral vein.

Explanation of Figures 1–4a

The uppersurfaces are shown on the left; the undersurfaces on the right.

Fig. 1.—*Theochila maenacte maenacte* (Boisduval); male from Castro, State of Paraná, Brazil.

Fig. 1a.—*T. maenacte maenacte* (Boisduval); female from same locality.

Fig. 2.—*T. maenacte itatiayae* (Foetterle); male from Itatiaya Mountains, Brazil.

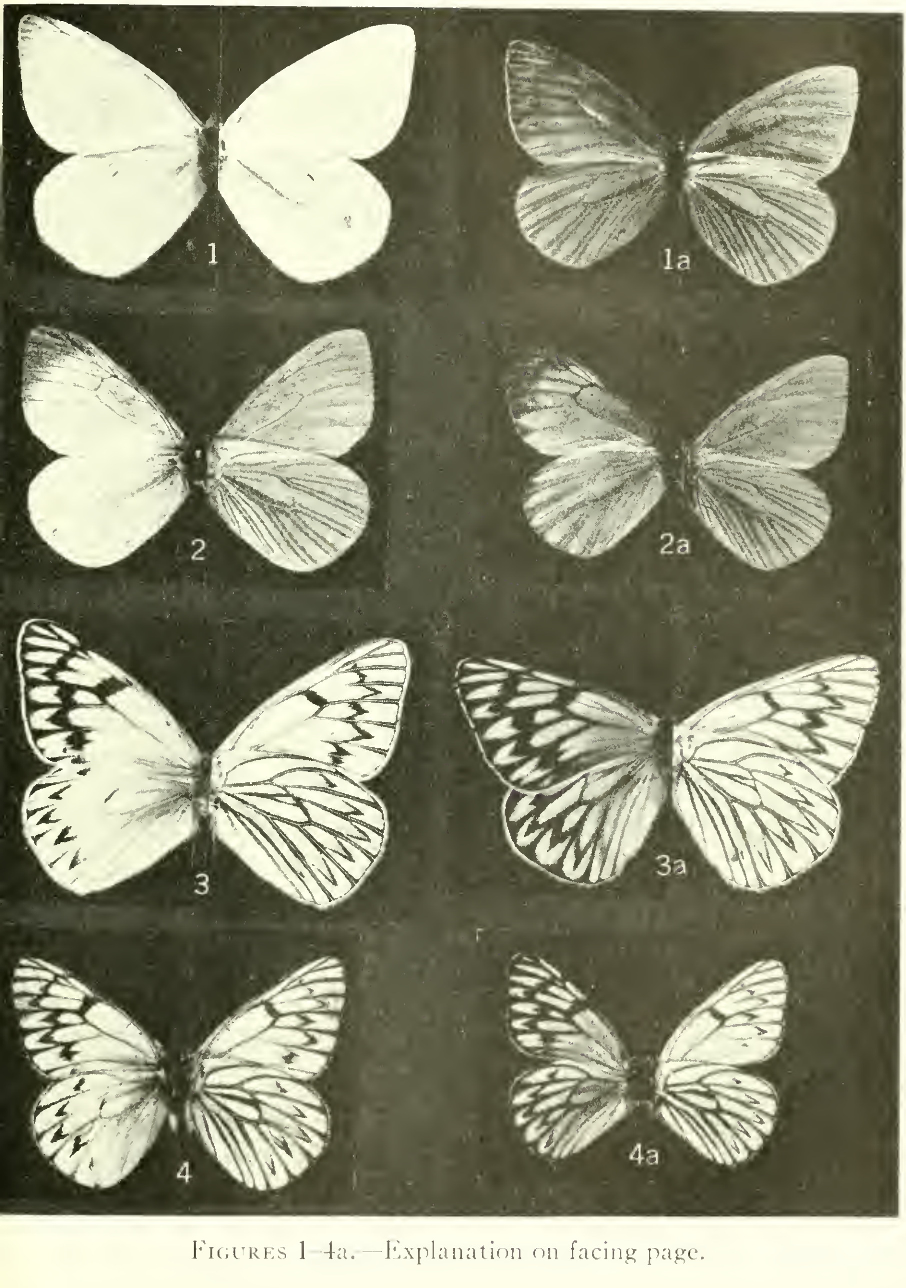
Fig. 2a.—*T. maenacte itatiayae* (Foetterle); female from same locality.

Fig. 3.—*Tatochila theodice theodice* (Boisduval); male, summer form, from El Manzano, Province of Santiago, Chile.

Fig. 3a.—*T. theodice theodice* (Boisduval); female, summer form, from Los Nieves, Province of Talca, Chile.

Fig. 4.—*T. theodice theodice* (Boisduval); male, spring form from El Canelo, Province of Santigo, Chile.

Fig. 4a.—*T. theodice theodice* (Boisduval); female, spring form, from the same locality.



FIGURES 1–4a.—Explanation on facing page.

EXPLANATION OF FIGURES 5–8

The uppersurfaces are shown on the left and the undersurfaces on the right, except in figure 8 which is entirely of the uppersurface.

FIG. 5.—*Tatochila theodice gymnodice* Staudinger; male from Puerto Prat, Territory of Magallanes, Chile.

FIG. 5a.—*T. theodice gymnodice* Staudinger; female from the same locality.

FIG. 6.—*T. theodice staudingeri* Field, new subspecies; holotype male from Puerto Harberton, Tierra del Fuego, Argentina.

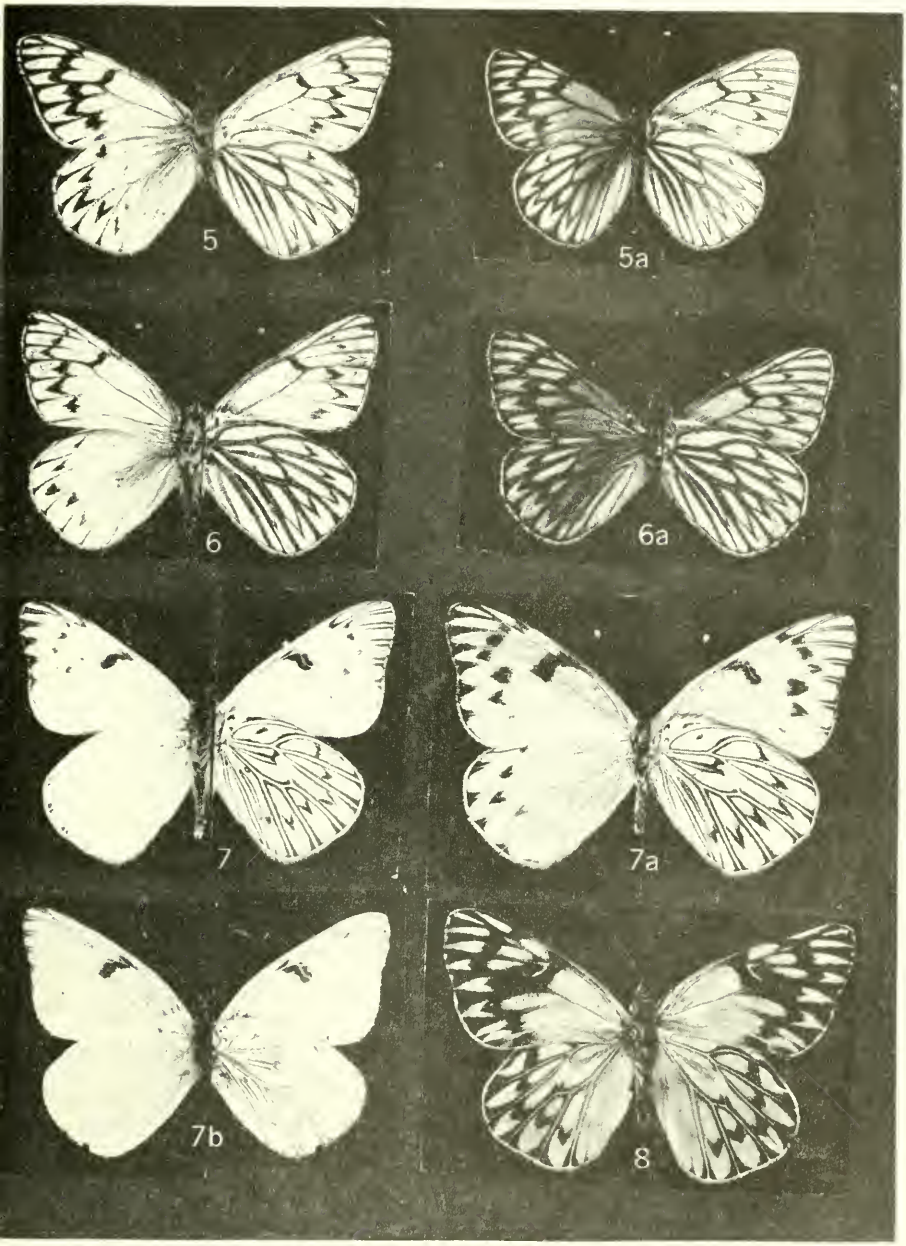
FIG. 6a.—*T. theodice staudingeri* Field, new subspecies; allotype female from the same locality.

FIG. 7.—*T. autodice* (Hübner); typical male, from Cafayate, Province of Salta, Argentina.

FIG. 7a.—*T. autodice* (Hübner); female from same locality.

FIG. 7b.—*T. autodice* (Hübner); an immaculate male form, locality unknown.

FIG. 8.—*T. blanchardii blanchardii* Butler, a heavily marked aberrant female form from Province of Valparaiso, Chile.



FIGURES 5-8.—Explanation on facing page.

EXPLANATION OF FIGURES 9–11c

The uppersurfaces are shown on the left and the undersurfaces on the right, except in figures 9a and 10a where this condition is reversed.

FIG. 9.—*Tatochila blanchardii blanchardii* Butler; male from Province of Valparaiso, Chile.

FIG. 9a.—*T. blanchardii blanchardii* Butler; female from Chile.

FIG. 10.—*T. blanchardii ernestae* Herrera; male from Iquique, Province of Tarapacá, Chile.

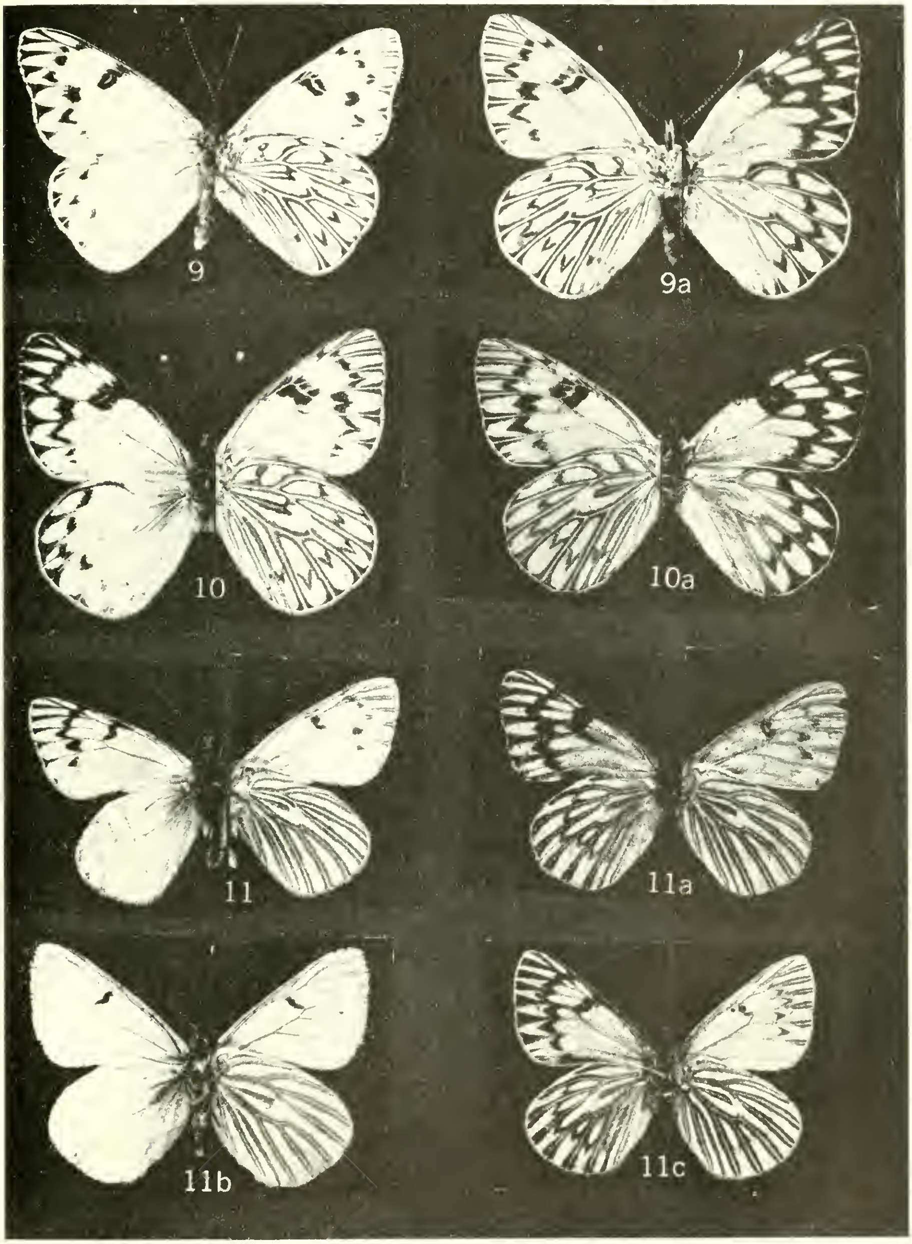
FIG. 10a.—*T. blanchardii ernestae* Herrera; female from the same locality.

FIG. 11.—*T. microdice microdice* (Blanchard); typical male, from Porvenir, Department of Tierra del Fuego, Chile.

FIG. 11a.—*T. microdice microdice* (Blanchard); typical female, from Puerto Prat, Territory of Magallanes, Chile.

FIG. 11b.—*T. microdice microdice* (Blanchard); an immaculate male form from Glen Kross, Territory of Santa Cruz, Argentina.

FIG. 11c.—*T. microdice microdice* (Blanchard); a slightly aberrant female form from the same locality.



Figures 9-11c.—Explanation on facing page.

EXPLANATION OF FIGURES 12–15a

The uppersurfaces are shown on the left and the undersurfaces on the right.

FIG. 12.—*Tatochila microdice fueguensis* Field, new subspecies; holotype male from Puerto Harberton, Tierra del Fuego, Argentina.

FIG. 12a.—*T. microdice fueguensis* Field, new subspecies; allotype female from Ushuaia, Tierra del Fuego, Argentina.

FIG. 13.—*T. microdice macrodice* Staudinger, male from Potosí, Department of Potosí, Bolivia.

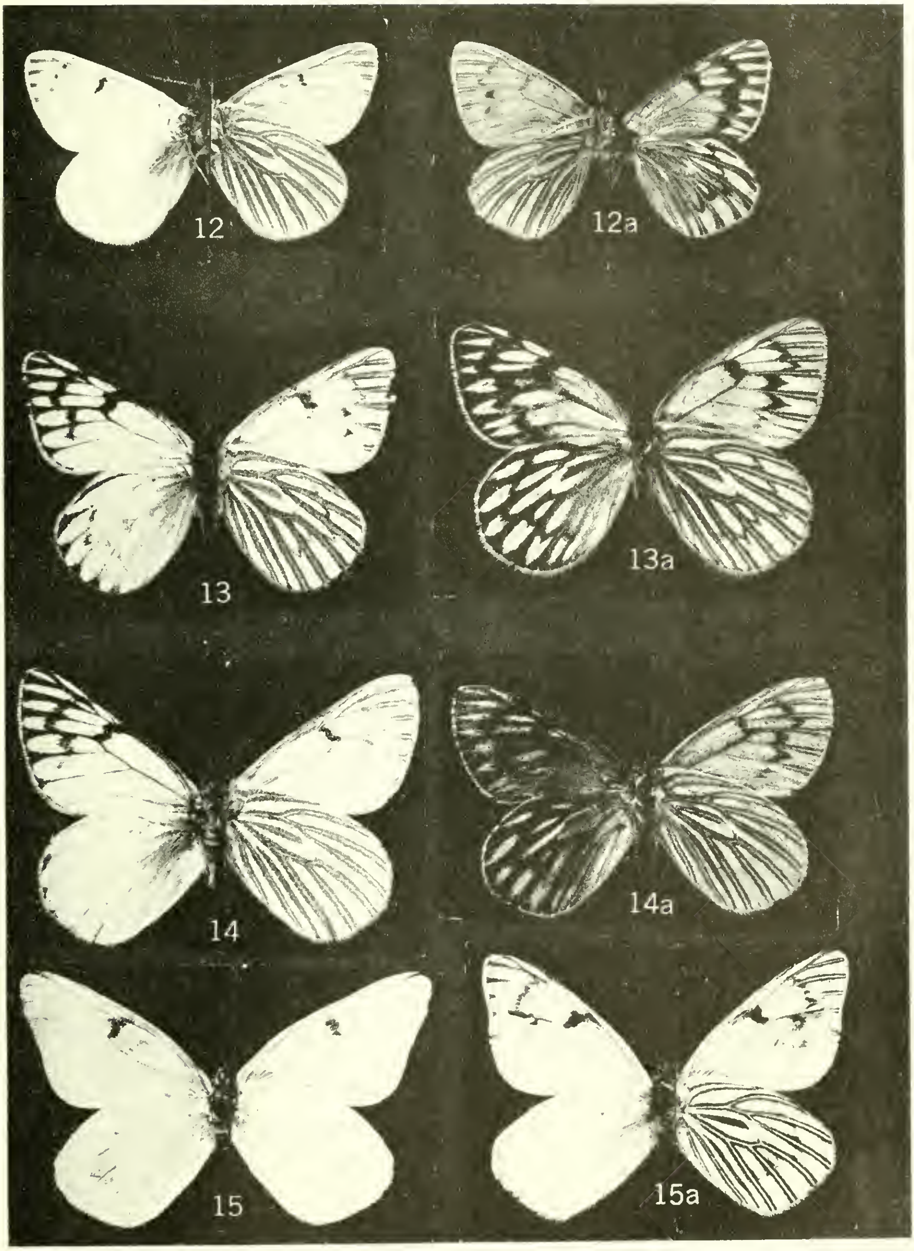
FIG. 13a.—*T. microdice macrodice* Staudinger; female from Bolivia.

FIG. 14.—*T. microdice arctodice* Staudinger; male from Banõs, Province of Tungurahua, Ecuador.

FIG. 14a.—*T. microdice arctodice* Staudinger; female from Ecuador.

FIG. 15.—*T. vanvolxemii* (Capronnier); typical male form, from La Rioja, Province of La Rioja, Argentina.

FIG. 15a.—*T. vanvolxemii* (Capronnier); male, intermediate to *T. microdice macrodice* or hybrid specimen, from Potrerillos, Province of Mendoza, Argentina.



FIGURES 12–15a.—Explanation on facing page.

Explanation of Figures 16–18b

The uppersurfaces are shown on the left and the undersurfaces on the right in figures 16b–18. Only the uppersurfaces are shown in figures 16, 16a, 18a, and 18b.

Fig. 16.—*Tatochila vanvolxemii* (Capronnier); a male form apparently somewhat intermediate to *T. microdice macrodice*, from Río Colorado, Territory of Río Negro, Argentina.

Fig. 16a.—*T. vanvolxemii* (Capronnier); a lightly marked female form from Río Colorado, Territory of Río Negro, Argentina.

Fig. 16b.—*T. vanvolxemii* (Capronnier); typical female form, from Bolívar, Province of Buenos Aires, Argentina.

Fig. 17.—*T. mercedis* (Eschscholtz); an aberrant, nearly immaculate, male form from Romeral, Province of Santiago, Chile.

Fig. 17a.—*T. mercedis* (Eschscholtz); a lightly marked male form from Lo Ovalle, Province of Santiago, Chile.

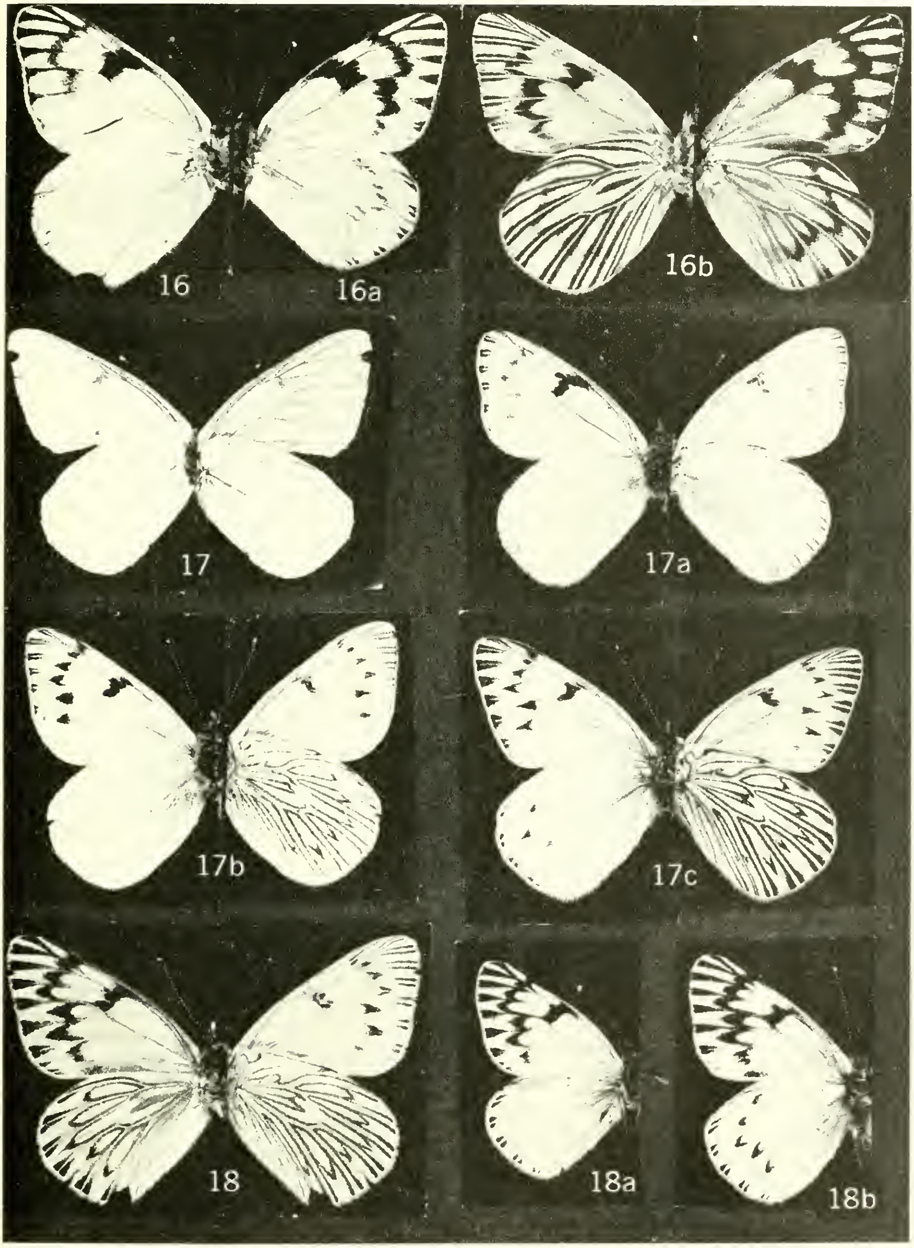
Fig. 17b.—*T. mercedis* (Eschscholtz); typical male form, from Macul, Province of Santiago, Chile.

Fig. 17c.—*T. mercedis* (Eschscholtz); a heavily marked male from Frutillar, Province of Llanquihue, Chile.

Fig. 18.—*T. mercedis* (Eschscholtz); a heavily marked female from the same locality.

Fig. 18a.—*T. mercedis* (Eschscholtz); a lightly marked female form from Santiago, Province of Santiago, Chile.

Fig. 18b.—*T. mercedis* (Eschscholtz); typical female form from Macul. Province of Santiago. Chile.



Figures 16–18b.—Explanation on facing page.

EXPLANATION OF FIGURES 19–23

Figures 22 and 22a show only the uppersurfaces. Figure 21 shows the undersurface on the left and the remainder show the undersurfaces on the right.

FIG. 19.—*Tatochila inversa* Hayward; male from Ollantaitambo, Department of Cuzco, Peru.

FIG. 19a.—*T. inversa* Hayward; holotype female from Quebrada Carapunco, Province of Tucumán, Argentina.

FIG. 20.—*T. orthodice* (Weymer); male from Bolivia.

FIG. 20a.—*T. orthodice* (Weymer); female from Río Ochuna, Province of Tucumán, Argentina.

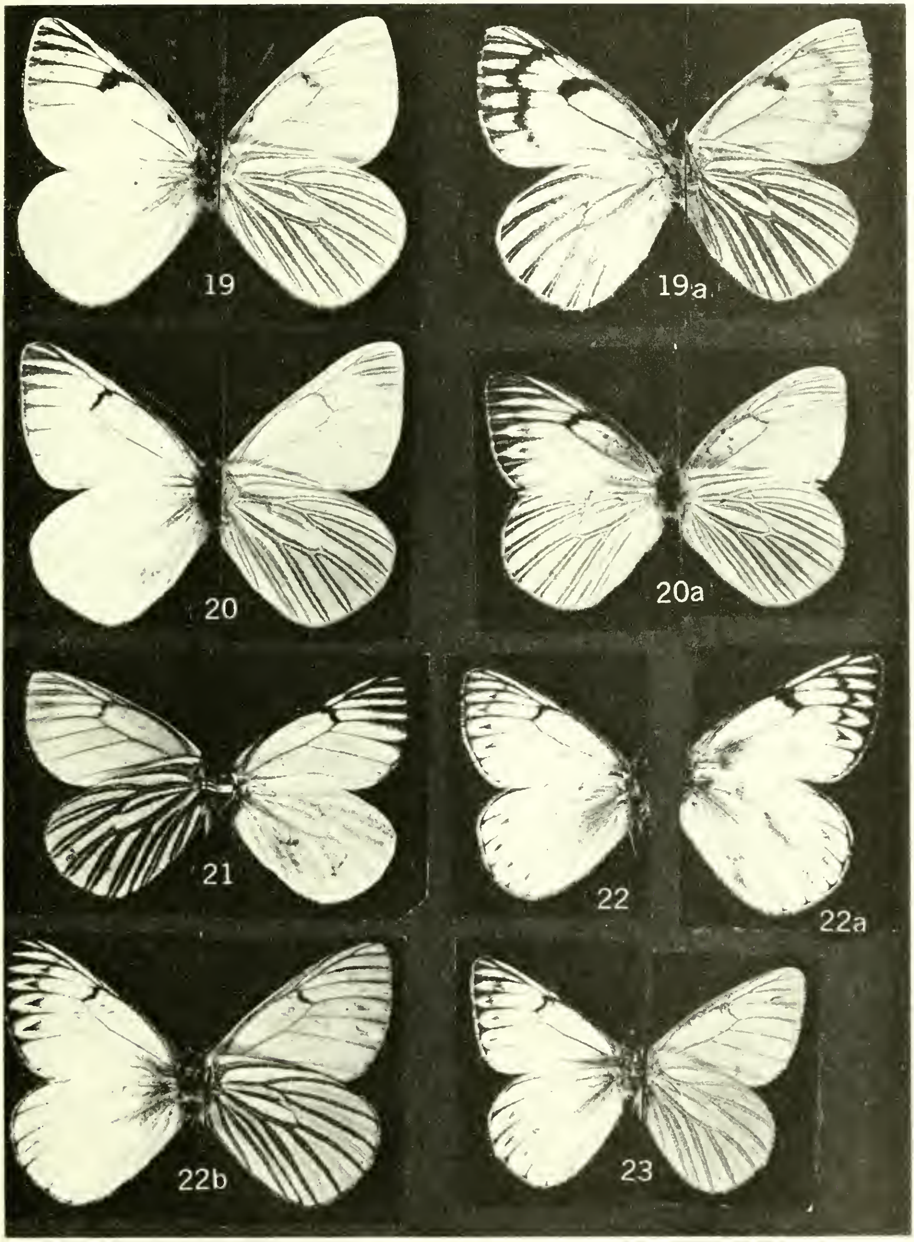
FIG. 21.—*T. homoeodice* Paravicini; paratype male from Huancabamba, Department of Piura, Peru.

FIG. 22.—*T. sagittata* Röber; a lightly marked male form from Popayán, Province of Cauca, Colombia.

FIG. 22a.—*T. sagittata* Röber; a heavily marked male form from Huancayo, Department of Junín, Peru.

FIG. 22b.—*T. sagittata* Röber; typical male form from Celendin, Department of Cajamarca, Peru.

FIG. 23.—*T. stigmadice* (Staudinger); male from Esquina Grande, Province of Catamarca, Argentina.



Figures 19–23.—Explanation on facing page.

EXPLANATION OF FIGURES 24–26a

In figures 24b and 24c only the uppersurfaces are shown. In figures 25b and 26a the undersurfaces are shown on the left. In the remainder of the figures the undersurfaces are shown on the right.

FIG. 24.—*T. stigmadice* (Staudinger); male from Chochabamba, Department of Chochabamba, Bolivia.

FIG. 24a.—*T. stigmadice* (Staudinger); female typical form, from Catamarca, Province of Catamarca, Argentina.

FIG. 24b.—*T. stigmadice* (Staudinger); a heavily marked female form from Esquina Grande, Province of Catamarca, Argentina.

FIG. 24c.—*T. stigmadice* (Staudinger); a lightly marked female form from Catamarca, Province of Catamarca, Argentina.

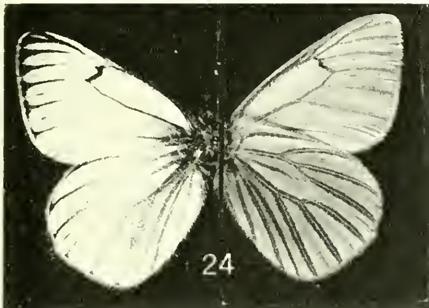
FIG. 25.—*T. xanthodice* (Lucas); a heavily marked male form from Páramo Malvoza, Department of Cauca, Colombia.

FIG. 25a.—*T. xanthodice* (Lucas); typical male form, from San Miguel, Department of Cundinamarca, Colombia.

FIG. 25b.—*T. xanthodice* (Lucas); female from Río Suarez, Department of Santander, Colombia.

FIG. 26.—*T. distincta* Jörgensen; male from Tafi, Province of Tucumán, Argentina.

FIG. 26a.—*T. distincta* Jörgensen; female from La Ollada, Province of Catamarca, Argentina.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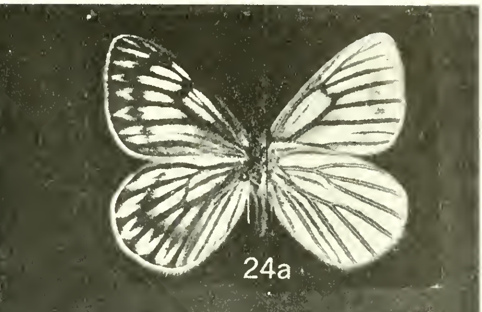
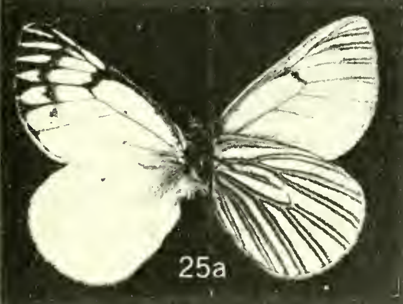

24a


24b

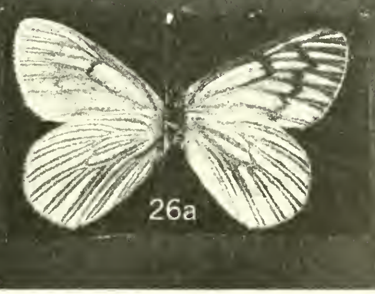

24c


25


25a


25b


26


26a

Figures 24–26a.—Explanation on facing page.

EXPLANATION OF FIGURES 27–30

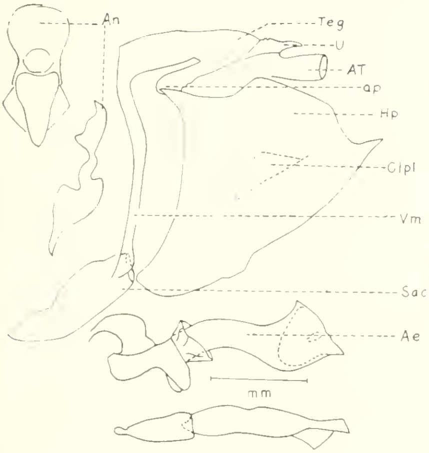
Male genitalia. The aedeagus is shown in ventral view immediately above the name, and the anellus is shown in ventral view in the upper left corner of each of the figures.

FIG. 27.—*Theochila maenacte* (Boisduval); drawn from Preparation W. D. F.–J. H. No. 107.

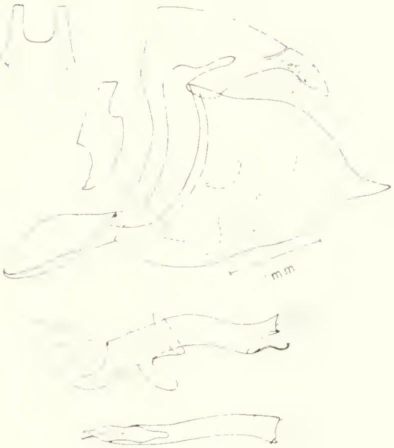
FIG. 28.—*Tatochila autodice* (Hübner); drawn from Preparation W. D. F.–J. H. No. 71.

FIG. 29.—*T. theodice* (Boisduval); drawn from Preparation W. D. F.–J. H. No. 7.

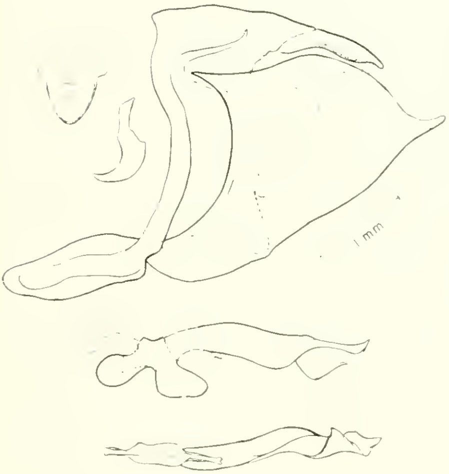
FIG. 30.—*T. blanchardii* Butler; drawn from Preparation W. D. F.–J. H. No. 2.



27. maenacte



28. autodice



29. theodice

30. blanchardii

Figures 27–30.—Explanation on facing page.

EXPLANATION OF FIGURES 31–31h

Male genitalia. In figures 31–31c the aedeagus is shown in ventral view immediately above the name and figure numbers. The remainder of the figures are in lateral view. Figures 31d–31f are of harpes in lateral view. Figures 31g and 31h are of the aedeagi in lateral view. While these figures are drawn from the several subspecies of *T. microdice*, they do not show diagnostic characters; they are included only to show the extent of individual variation within the species.

FIG. 31.—*Tatochila microdice microdice* (Blanchard); drawn from Preparation W. D. F.–J. H. No. 26.

FIG. 31a.—*T. microdice microdice* (Blanchard); drawn from Preparation W. D. F.–J. H. No. 27.

FIG. 31b.—*T. microdice microdice* (Blanchard); drawn from Preparation W. D. F.–J. H. No. 357.

FIG. 31c.—*T. microdice arctodice* Staudinger; drawn from Preparation W. D. F.–J. H. No. 350.

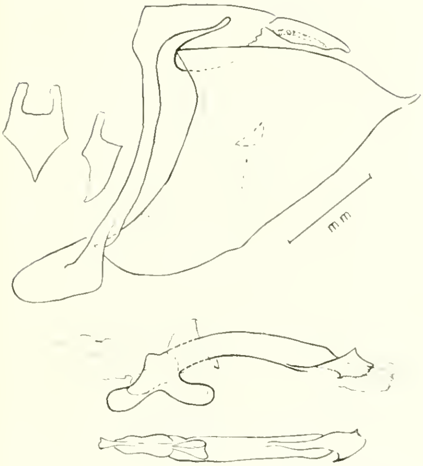
FIG. 31d.—*T. microdice microdice* (Blanchard); drawn from Preparation W. D. F.–J. H. No. 355.

FIG. 31e.—*T. microdice macrodice* Staudinger; drawn from Preparation W. D. F.–J. H. No. 32.

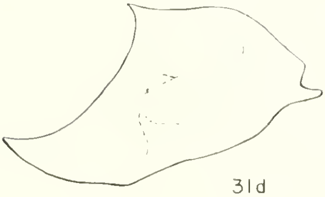
FIG. 31f.—*T. microdice arctodice* Staudinger; drawn from Preparation W. D. F.–J. H. No. 57.

FIG. 31g.—*T. microdice macrodice* Staudinger; drawn from Preparation W. D. F.–J. H. No. 32.

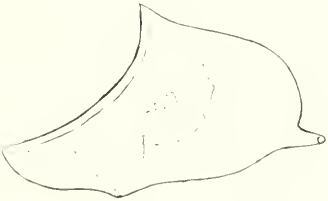
FIG. 31h.—*T. microdice arctodice* Staudinger; drawn from Preparation W. D. F.–J. H. No. 57.



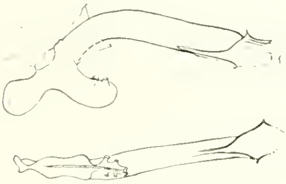
31 microdice



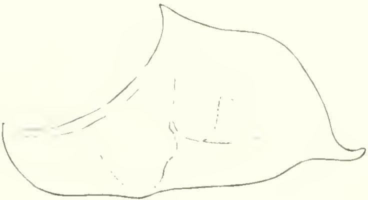
31d



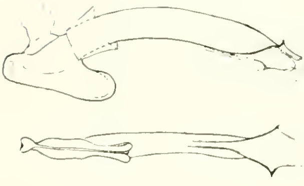
31e



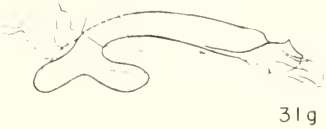
31a



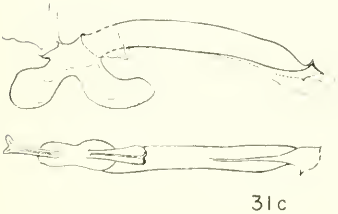
31f



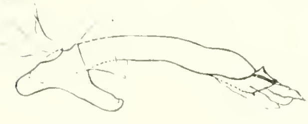
31b



31g



31c



31h

Figures 31–31h.—Explanation on facing page.

Explanation of Figures 32–35

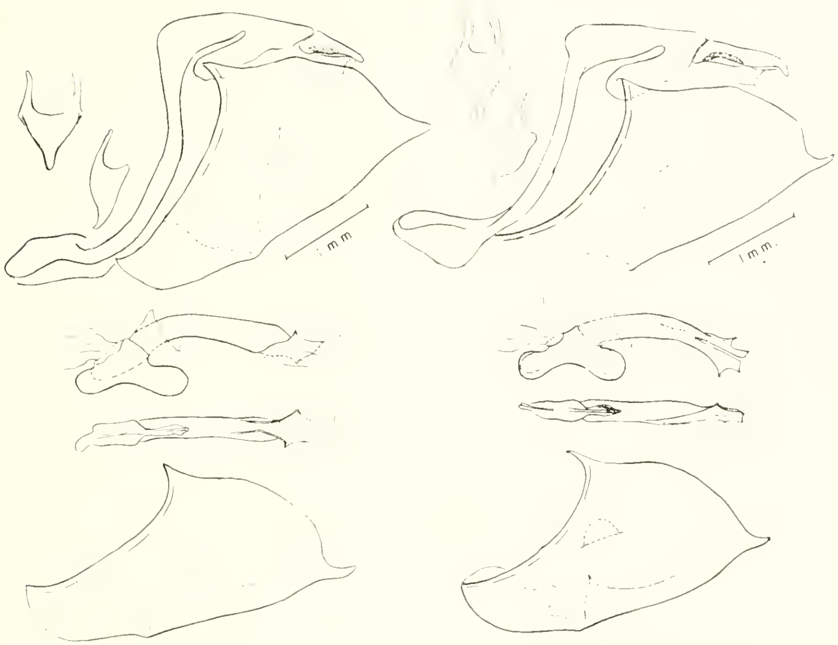
Male genitalia. The aedeagus and anellus are shown in both ventral and lateral views. The other structures are in lateral view. In figures 32 and 33 the harpe of an additional specimen is shown to illustrate individual variation.

Fig. 32.—*Tatochila vanvolxemii* (Capronnier). Aedeagus and anellus drawn from Preparation W. D. F.–J. H. No. 23; lower harpe from Preparation W. D. F.–J. H. No. 72.

Fig. 33.—*T. mercedis* (Eschscholtz). Aedeagus and anellus drawn from Preparation W. D. F.–J. H. No. 17; lower harpe from Preparation W. D. F.–J. H. No. 18.

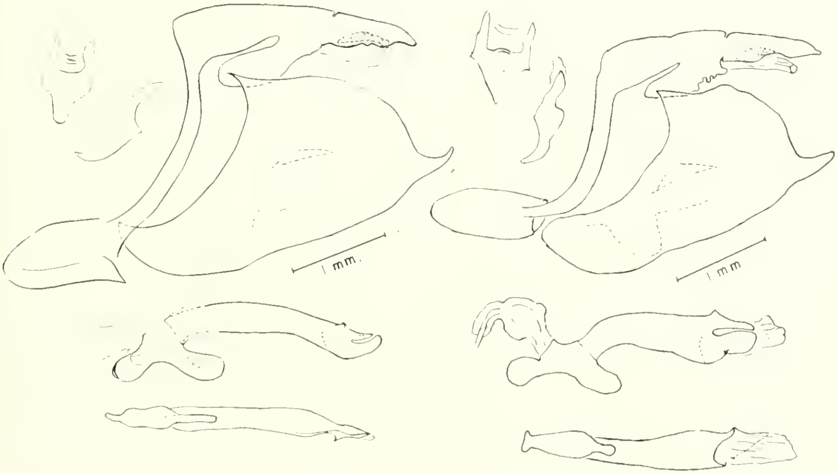
Fig. 34.—*T. inversa* Hayward; drawn from Preparation W. D. F.–J. H. No. 380.

Fig. 35.—*T. homoeodice* Paravicini; drawn from Preparation W. D. F. No. 5338.



32. vanvolxemii

33 mercedis



34. inversa

35. homoeodice

FIGURES 32–35.—Explanation on facing page.

EXPLANATION OF FIGURES 36–39

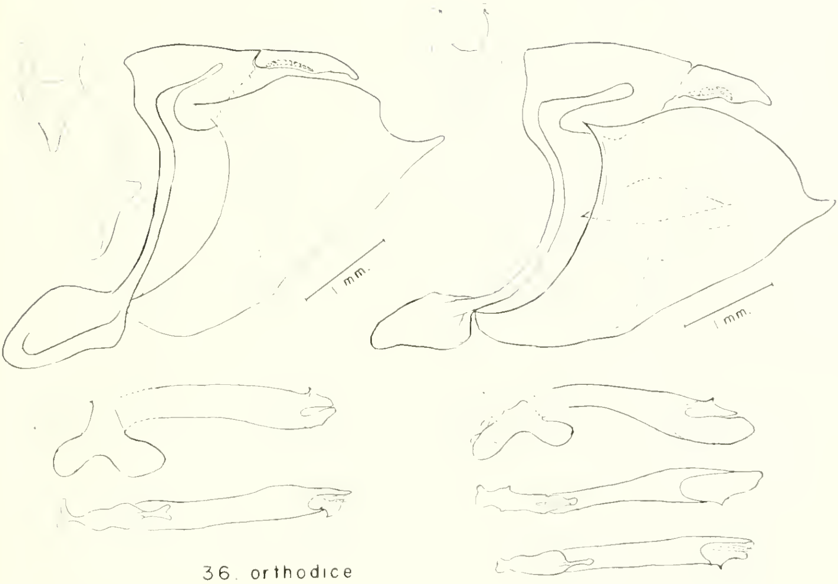
Male genitalia. The aedeagus is shown in ventral and lateral view in each figure. The aedeagus is also shown in dorsal view in figure 38 immediately above the name. In figure 37 the drawing immediately above the name is of a second specimen, to illustrate individual variation.

FIG. 36.—*Tatochila orthodice* (Weymer); drawn from Preparation W. D. F.–J. H. No. 86.

FIG. 37.—*T. sagittata* Röber; drawn from Preparation W. D. F. No. 3914; lower aedeagus drawn from Preparation W. D. F.–J. H. No. 79.

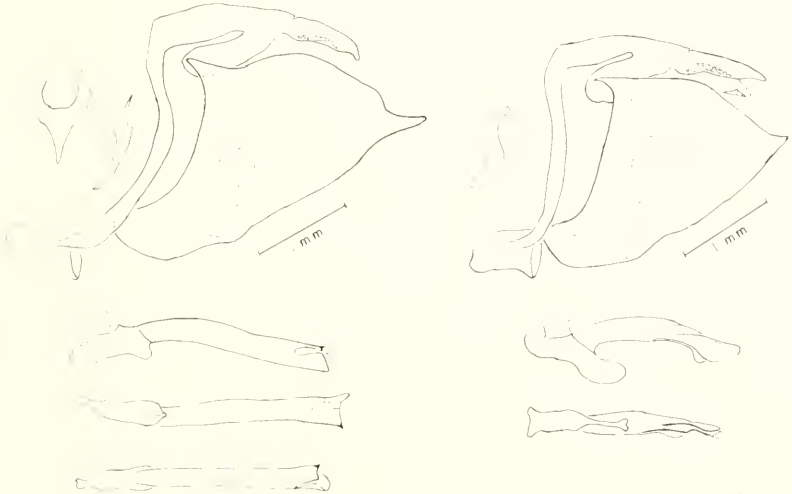
FIG. 38.—*T. stigmadice* (Staudinger); drawn from Preparation W. D. F.–J. H. No. 76.

FIG. 39.—*T. xanthodice* (Lucas); drawn from Preparation W. D. F.–J. H. No. 366.



36. orthodice

37 sagittata



39. xanthodice

38 stigmadice

Figures 36–39.—Explanation on facing page.

EXPLANATION OF FIGURES 40–54

Male genitalia. In figure 40 the drawing of the aedeagus immediately above the name is in ventral view; the remainder in lateral view. Figures 41–54 are of the tegumen and uncus of the various species in ventral view and are drawn to the same scale as figure 41.

FIG. 40.—*Tatochila distincta* Jörgensen; drawn from Preparation W. D. F.–J. H. No. 393.

FIG. 41.—*Theochila maenacte* (Boisduval); drawn from Preparation W. D. F.–J. H. No. 107.

FIG. 42.—*Tatochila theodice* (Boisduval); drawn from Preparation W. D. F.–J. H. No. 7.

FIG. 43.—*T. autodice* (Hübner); drawn from Preparation W. D. F.–J. H. No. 22.

FIG. 44.—*T. blanchardii* Butler; drawn from Preparation W. D. F.–J. H. No. 2.

FIG. 45.—*T. microdice* (Blanchard); drawn from Preparation W. D. F.–J. H. No. 353.

FIG. 46.—*T. vanvolxemii* (Capronnier); drawn from Preparation W. W. D. F.–J. H. No. 74.

FIG. 47.—*T. mercedis* (Eschscholtz); drawn from Preparation W. D. F.–J. H. No. 18.

FIG. 48.—*T. inversa* Hayward; drawn from Preparation W. D. F.–J. H. No. 380.

FIG. 49.—*T. homoeodice* Paravicini; drawn from Preparation W. D. F. No. 5338.

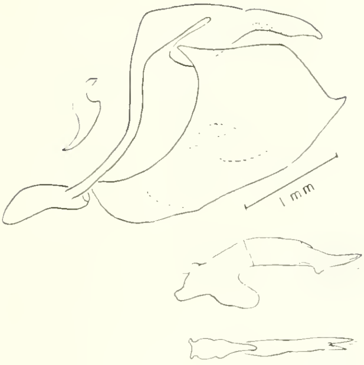
FIG. 50.—*T. orthodice* (Weymer); drawn from Preparation W. D. F.–J. H. No. 86.

FIG. 51.—*Tatochila sagittata* Röber; drawn from Preparation W. D. F.–J. H. No. 384.

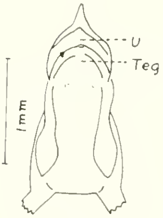
FIG. 52.—*T. stigmadice* (Staudinger): drawn from Preparation W. D. F.–J. H. No. 76.

FIG. 53.—*T. xanthodice* (Lucas); drawn from Preparation W. D. F.–J. H. No. 366.

FIG. 54.—*T. distincta* Jörgensen; drawn from Preparation W. D. F. No. 3948.

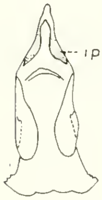


40. distincta

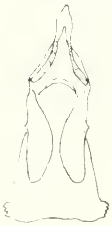


41. maenacte

42. theodice



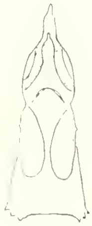
43. autodice



44. blanchardii

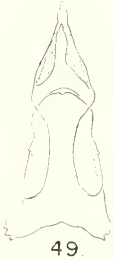
45. micradice

46. vanvolxemii



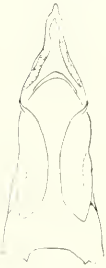
47. mercedis

48. inversa

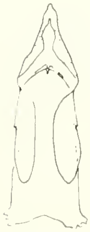


49. homoeodice

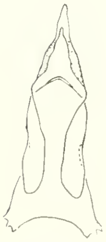
50. orthodice



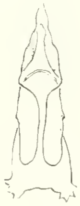
51 sagittata



52. stigmadice



53. xanthodice



54 distincta

Figures 40–54.—Explanation on facing page.

Explanation of Figures 55–63

Wing venation.

Fig. 55.—*Theochila maenacte* (Boisduval); drawn from Preparation W. D. F. No. 1148.

Fig. 56.—*Tatochila theodice* (Boisduval); drawn from Preparation W. D. F. No. 1150.

Fig. 57.—*T. autodice* (Hübner); drawn from Preparation W. D. F. No. 1151.

Fig. 58.—*T. blanchardii* Butler; drawn from Preparation W. D. F. No. 1152.

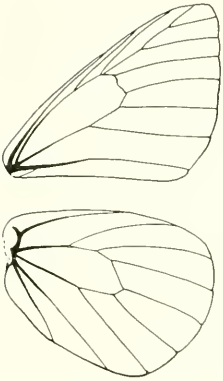
Fig. 59.—*T. microdice* (Blanchard); drawn from Preparation W. D. F. No. 1153.

Fig. 60.—*T. vanvolxemii* (Capronnier); drawn from Preparation W. D.F. No. 1154.

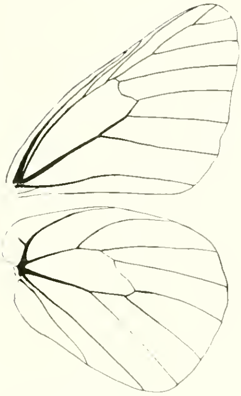
Fig. 61.—*T. mercedis* (Eschscholtz); drawn from Preparation W. D. F. No. 1155.

Fig. 62.—*T. inversa* Hayward; drawn from specimen labeled W. D. F.–J. H. No. 394

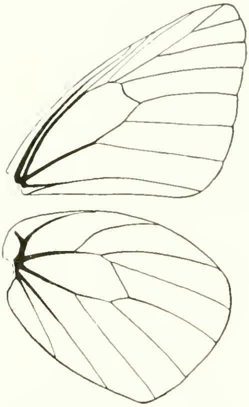
Fig. 63.—*T. homoeodice* Paravicini; drawn from Preparation W. D. F. No. 5338.



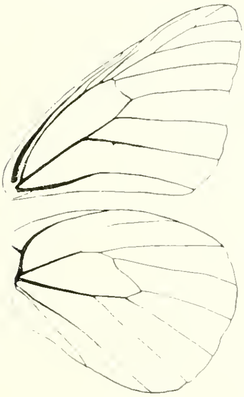
55 moenacte



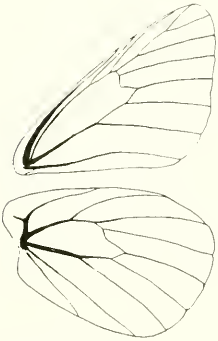
56. theodice



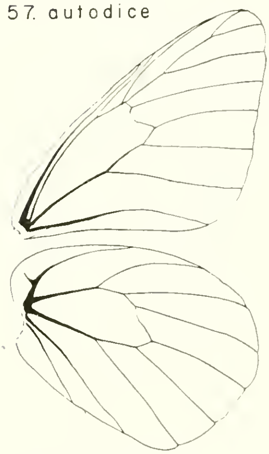
57. autodice



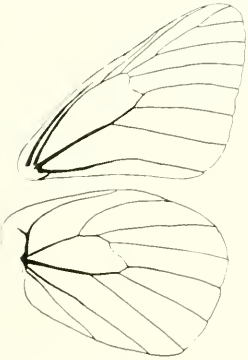
58. blanchardii



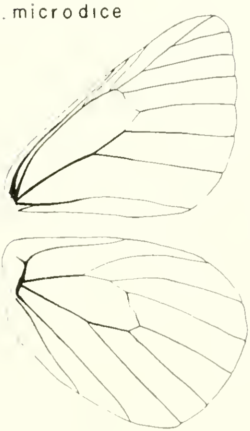
59. microdice



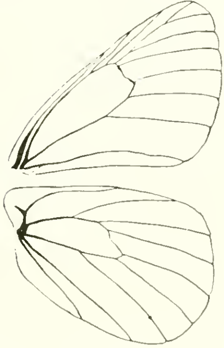
60. vanvolxemii



61. mercedis



62. inversa



63. homoeodice

Figures 55–63.—Explanation on facing page.

EXPLANATION OF FIGURES 64–73

Wing venation (figs. 64-68 and claw and related structures (figs. 69-73).

FIG. 64.—*Tatochila orthodice* (Weymer); drawn from Preparation W. D. F. No. 1156.

FIG. 65.—*T. sagittata* Röber; drawn from Preparation W. D. F. No. 1158.

FIG. 66.—*T. stigmadice* (Staudinger); drawn from Preparation W. D. F. No. 1157.

FIG. 67.—*T. xanthodice* (Lucas); drawn from Preparation W. D. F.–J. H. No. 376.

FIG. 68.—*T. distincta* Jörgensen; drawn from Preparation W. D. F. No. 1161.

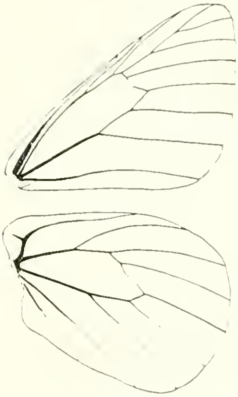
FIG. 69.—*Theochila maenacte* (Boisduval); drawn from Preparation W. D. F. No. 1148.

FIG. 70.—*Tatochila blanchardii* Butler; drawn from Preparation W. D. F. No. 1152.

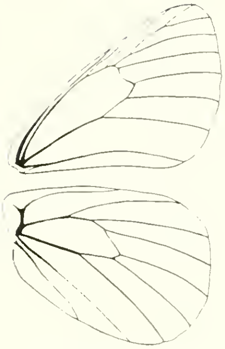
FIG. 71.—*T. autodice* (Hübner); drawn from Preparation W. D. F. No. 1151.

FIG. 72.—*T. theodice* (Boisduval); drawn from Preparation W. D. F. No. 1150.

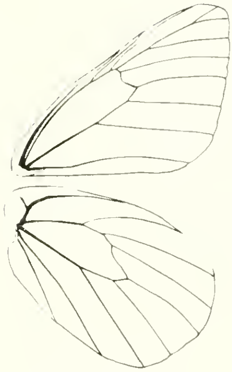
FIG. 73.—*T. inversa* Hayward; drawn from Preparation W. D. F.–J. H. No. 394.



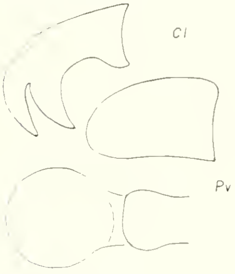
64. orthodice



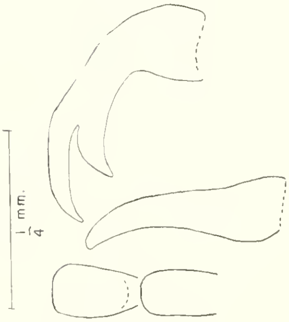
65. sagittata



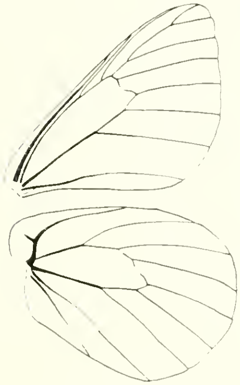
66. stigmadice



69. maenacte

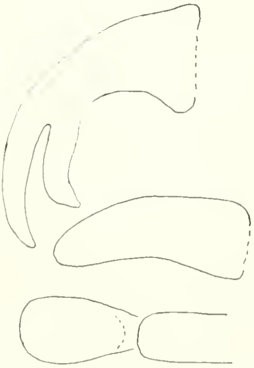


70. blanchardii

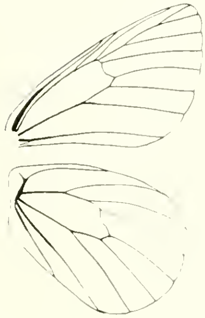


67. xanthodice

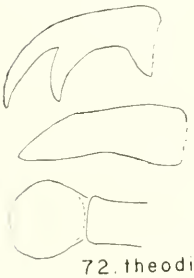
71. autodice



73 inversa



68 distincta



72. theodice

Figures 64-73.—Explanation on facing page.

Explanation of Figures 74–82

Claw and related structures.

Fig. 74.—*Tatochila microdice* (Blanchard); drawn from Preparation W. D. F. No. 1153.

Fig. 75.—*T. vanvolxemii* (Capronnier); drawn from Preparation W. D. F. No. 1154.

Fig. 76.—*T. mercedis* (Eschscholtz); drawn from Preparation W. D. F. No. 1155.

Fig. 77.—*T. homoeodice* Paravicini; drawn from Preparation W. D. F. No. 5338.

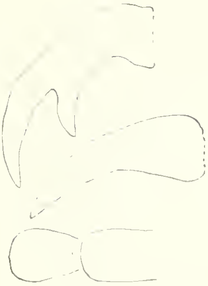
Fig. 78.—*T. orthodice* (Weymer); drawn from Preparation W. D. F. No. 1156.

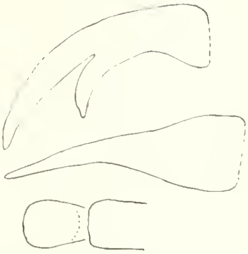
Fig. 79.—*T. sagittata* Röber; drawn from Preparation W. D. F. No. 1158.

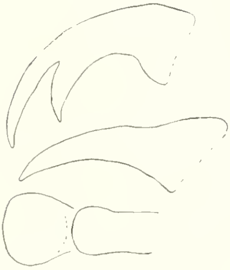
Fig. 80.—*T. stigmadice* (Staudinger); drawn from Preparation W. D. F. No. 1157.

Fig. 81.—*T. xanthodice* (Lucas); drawn from Preparation W. D. F. No. 1163.

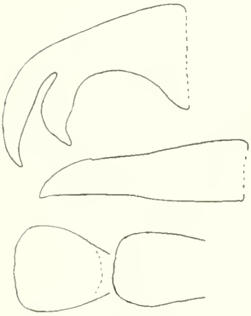
Fig. 82.—*T. distincta* Jörgensen; drawn from Preparation W. D. F. No. 1161.

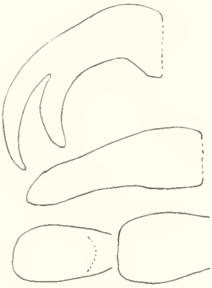

74 microdice

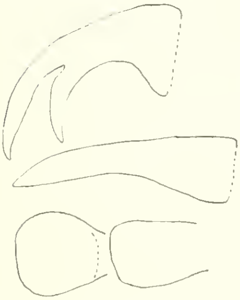

75 vanvolxemii

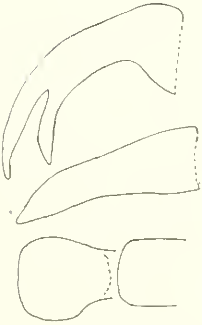

76 mercedis

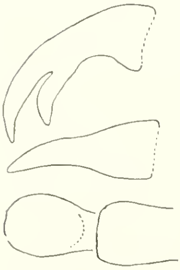

77 homoeodice


78 orthodice


79 sagittata


80 stigmadice


81. xanthodice


82. distincta

Figures 74–82.—Explanation on facing page.

EXPLANATION OF FIGURES 83–87

Female genitalia. All figures are in lateral view except the signum in figure 84, which has been turned to show the dorsal view. Figures 85–87 show only the inner genital plate and ductus bursae.

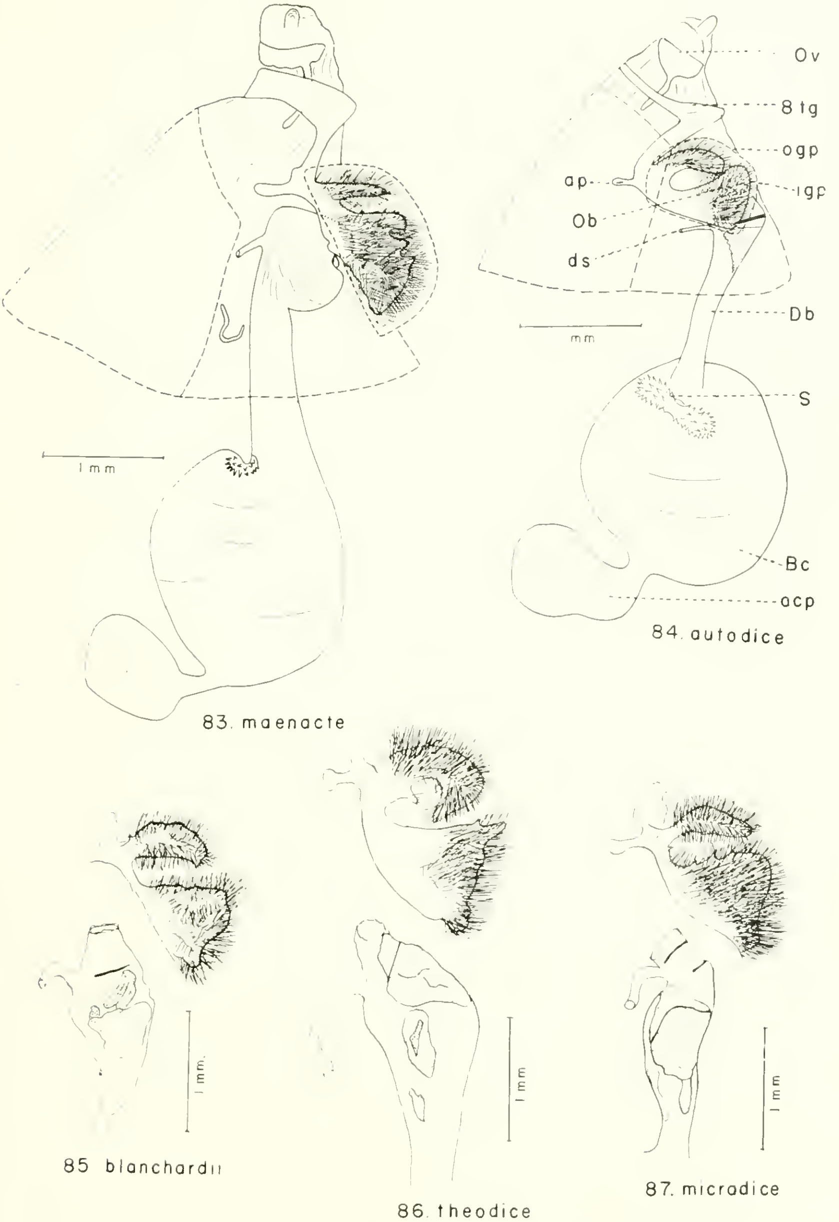
FIG. 83.—*Theochila maenacte* (Boisduval); drawn from Preparation W. D. F. No. 5354.

FIG. 84.—*Tatochila autodice* (Hübner); drawn from Preparation W. D. F.–J. H. No. 91.

FIG. 85.—*T. blanchardii* Butler; drawn from Preparation W. D. F.–J. H. No. 40.

FIG. 86.—*T. theodice* (Boisduval); drawn from Preparation W. D. F.–J. H. No. 47.

FIG. 87.—*T. microdice* (Blanchard); drawn from Preparation W. D. F.–J. H. No. 100.



83. maenacte

84. autodice

85 blanchardii

86. theodice

87. micradice

Figures 83–87.—Explanation on facing page.

EXPLANATION OF FIGURES 88–93

Female genitalia. All figures are of the inner genital plate and ductus bursae in lateral view except in figure 89, where the ductus bursae is shown also in ventral view.

FIG. 88.—*Tatochila mercedis* (Eschscholtz); drawn from Preparation W. D. F.-J. H. No. 92.

FIG. 89.—*T. orthodice* (Weymer); drawn from Preparation W. D. F.-J. H. No. 111.

FIG. 90.—*T. inversa* Hayward; drawn from Preparation W. D. F.-J. H. No. 394.

FIG. 91.—*T. stigmadice* (Staudinger); drawn from Preparation W. D. F.-J. H. No. 87.

FIG. 92.—*T. xanthodice* (Lucas); drawn from Preparation W. D. F.-J. H. No. 60.

FIG. 93.—*T. distincta* Jörgensen; drawn from Preparation W. D. F.-J. H. No. 64.

88. mercedis

89. orthodice

90. inversa

91 stigmadice

92. xanthadice

93. distincta

Figures 88–93.—Explanation on facing page.

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SCARAB BEETLES OF THE GENUS BOTHYNUS IN THE UNITED STATES (COLEOPTERA: SCARABAEIDAE)[1]

By O. L. Cartwright

Since Col. Thomas Casey's (1915) study of the scarab beetles of the genus *Bothynus,* which he placed in *Ligyrus* and *Ligyrodes,* the number of species has varied from the 31 he accepted to only six species accepted by L. W. Saylor in 1946. Casey described species based on minor variations, while Saylor's lumping of so many together under the name *Ligyrus gibbosus* (DeGeer) was based on obvious but superficial similarities. I agree that all of Casey's species are synonyms, but I do not agree with Saylor's placing of them. Two of the LeConte species which Saylor placed in synonymy are perfectly valid.

I have examined the Casey types in the U. S. National Museum and the LeConte types in the Museum of Comparative Zoology at Harvard College. After studying several thousand specimens, my conclusions regarding the species discussed by Dr. LeConte almost exactly 100 years ago are practically identical with the opinions expressed by him. The few species found since Dr. LeConte's day bring the total I recognize from the United States to nine species and one subspecies.

In the following account, changes in the nomenclature of the group are discussed, a key is presented for separation of the species, and for each species are given the synonyms, a complete description, a figure of the male genitalia, location of the type, number of specimens

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examined, and a map showing the distribution in the United States.

Many specimens were borrowed from other museums and private collections to supplement the material in the United States National Museum. I thank sincerely the following who made such loans: (from museum collections) E. B. Britton, British Museum (Natural History); A. E. Brower, State of Maine Forest Service; W. J. Brown, Canadian Department of Agriculture; M. A. Cazier, American Museum of Natural History; Leland Chandler and J. V. Osmun, Purdue University; E. A. Chapin, Museum of Comparative Zoology; Henry Dietrich, Cornell University; S. W. Frost, Pennsylvania State University; Walter B. Jones, Geological Survey of Alabama; Ralph Dury, Cincinnati Museum of Natural History; J. N. Knull, Ohio State University; Hugh B. Leech, California Academy of Sciences; H. O. Lund, University of Georgia; Rene Malaise, Naturhistoriska Riksmuseum; Frances McAlister, Clemson College; A. T. McClay, University of California (Davis, Calif.); H. E. Milliron, University of Delaware; W. D. Newsom, University of Louisiana; L. W. Quate, University of Nebraska; H. J. Reinhard, Agricultural and Mechanical College of Texas; M. W. Sanderson, Illinois Natural History Survey; H. C. Severin, University of South Dakota; A. N. Tissot, Florida Agricultural Experiment Station; H. V. Weems, Jr., Florida State Plant Board; F. G. Werner, University of Arizona; D. L. Wray, North Carolina Department of Agriculture; (from private collections) L. J. Bottimer, J. F. Brimley, H. L. Dozier, H. F. Howden, Gayle Nelson, F. H. Parker, William Rosenberg, and R. B. Selander.

I am especially grateful to Dr. Rene Malaise of the Riksmuseum in Stockholm, to Dr. Bengt-Olof Landin, Universitetets Zoologiska Institution, Lund, and to Dr. E. B. Britton of the British Museum (Natural History) for invaluable help in checking type specimens in their respective museums.

Genus *Bothynus* Hope, 1837

Bothynus Hope, 1837, p. 95.—Burmeister, 1847, p. 115.—LeConte, 1847, p. 86.—Lacordaire, 1856, p. 413.—Prell, 1936, p. 146.

Ligyrus Burmeister, 1847, p. 542.—Casey, 1915, p. 178.—Arrow, 1937, p. 36.—Saylor, 1946, p. 41.

Tomarus Erichson, 1847, p. 95.

Ligyrodes Casey, 1915, p. 178.

Euligyrus Casey, 1915, p. 185.

Grylius Casey, 1915, p. 189.

Anagrylius Casey, 1915, p. 204.

Ligyrellus Casey, 1915, p. 206.

Type of genus: *Geotrupes cuniculus* Fabricius.

The genus *Bothynus* was erected by the Rev. F. W. Hope in 1837 for two species, *Geotrupes cuniculus* Fabricius and *Scarabaeus ascanius*

Kirby. He specifically designated *Geotrupes cuniculus* as type of the genus, gave a description, but did not mention a type locality. Casey (1915) designated *Corynoscelis quadridens* Taschenberg as type of the genus, overlooking Hope's previous designation.

Burmeister (1847) was unable to place *G. cuniculus* Fabricius but thought it was likely a small *Podalgus*.

Lacordaire (1856) stated that Hope had made *Geotrupes cuniculus* Fabricius the type of *Bothynus* but said the species could not be determined, that he did not recognize it any more than did Burmeister, and suggested *S. ascanius* Kirby as the type of the genus.

Bates (1888) did not mention *cuniculus* Fabricius in either *Geotrupes* or *Bothynus* but placed *tumulosus* Burmeister (a synonym) in *Ligyrus*.

Prell (1936) noted that Hope had designated *Geotrupes cuniculus* Fabricius as type of the genus *Bothynus* and that the Fabrician species was identical with *Ligyrus tumulosus* Burmeister. However, he stated that Hope's description of the genus *Bothynus* did not fit this species, that Hope very evidently had before him a species from the group which is limited in distribution to the Continent and which was designated by Burmeister as *Podalgus* (or *Scatophilus*). Prell then decided that *B. cuniculus* Hope, 1837 (not Fabricius 1801), was an undescribed species, the name *Bothynus* Hope, 1837, lost its validity, and that *Bothynus* Burmeister, 1847, with the type species *Geotrupes medon* Germar, 1824 (=*B. ascanius* Burmeister, 1847, nec Kirby, 1818), took its place.

Even though Hope described in his genus *Bothynus* a species which he mistakenly thought was *cuniculus* Fabricius, and which in reality was therefore without a valid name, perhaps not even congeneric with *cuniculus* Fabricius, he nevertheless first specifically stated the type of *Bothynus* to be *Geotrupes cuniculus* Fabricius, and I accept that species as the type. It might be pointed out that it is generally agreed the designation of a species as type of a genus is not to be rejected on the ground that the original author of the generic name misidentified that species.

Since *Bothynus cuniculus* (Fabricius) is congeneric with *Ligyrus gibbosus* (DeGeer), type of the genus *Ligyrus*, all of our species of *Ligyrus* should be placed in *Bothynus*. The name *Scatophilus* Burmeister, 1847, remains available for those species recently assigned to *Bothynus*.

Lectotype Designations

Two specimens in the original Fabricius collection in the Kiel Museum in Kiel, Germany, were examined for me by Dr. Bengt-Olof Landin, and the male bearing an old label, "cuniculus," written in an old handwriting, probably Fabricius' own, was selected to be designated lectotype of the species. Dr. Landin has attached the following label, "Lectotypus *Geotrupes cuniculus* Fabr. Design. 1957 B.-O. Landin." He states that the lectotype is "comparatively well preserved: both antennae, and left meso- and metatarses are unbroken." He provided sketches of the clypeal teeth, foretibia, tip of the prosternal process and the male genitalia. A male from St. Croix, Virgin Islands, sent for comparison with the type, was returned with Dr. Landin's statement that it agreed completely with the lectotype.

Dr. Britton informs me that lectotypes have not been officially chosen for the Bates species, *Ligyrus sallaei*, *L. laevicollis*, and *L. latifovea*, but that a specimen in each series bears the name label in Bates' handwriting, also a red "Type" label, and that these have been unofficial lectotypes for many years. I select these specimens as lectotypes. Sex and localities for these lectotypes as given on the labels are as follows:

sallaei: ♂, Almolonga, Mexico. (Höge.)
laevicollis: ♂, Acapulco, Guerrero. (Höge.)
latifovea: ♀, Teapa, Mexico. Salle Collection.

CLASSIFICATION AND MORPHOLOGY

The genus *Ligyrus*, here considered as a synonym of the true *Bothynus*, was placed by Casey in the tribe Pentodontini of the subfamily Dynastinae. Arrow (1937) placed the genus in the tribe Oryctini, with all of Casey's genera listed above as subgenera.

The species agree in the following characters: labial palpi inserted at the sides of the mentum which is narrowed in front; mandibles prominent and toothed externally; head with a strong transverse carina, sometimes reduced to two widely spaced tubercles; clypeus more or less triangular, reflexed, with two erect teeth at apex; pronotum frequently with an apical tubercle and anterior depression; elytra with four pairs of oblique geminate striae, stridulating organs on inner surface; the claws equal except on fore tarsi in males of a few species, anterior tarsi not elongate in male; the anterior coxae transverse, not prominent; posterior tibiae expanded apically, more or less truncate and ciliate; aedeagi usually distinct but similar in structure.

The genus is American, ranging from Canada to Argentina and Chile. Arrow listed 52 species in the Junk catalog, but included 24 of the Casey species here considered synonyms. Probably 40 or more species are to be found throughout the Western Hemisphere.

A few species are of economic importance. *Bothynus gibbosus* (DeGeer) is known as the carrot beetle in economic literature. Various species have been recorded as attacking carrot, celery, parsnip, beet, potato, cabbage, corn, cotton, sunflower, dahlia, amaranthus, and other crops and weeds.

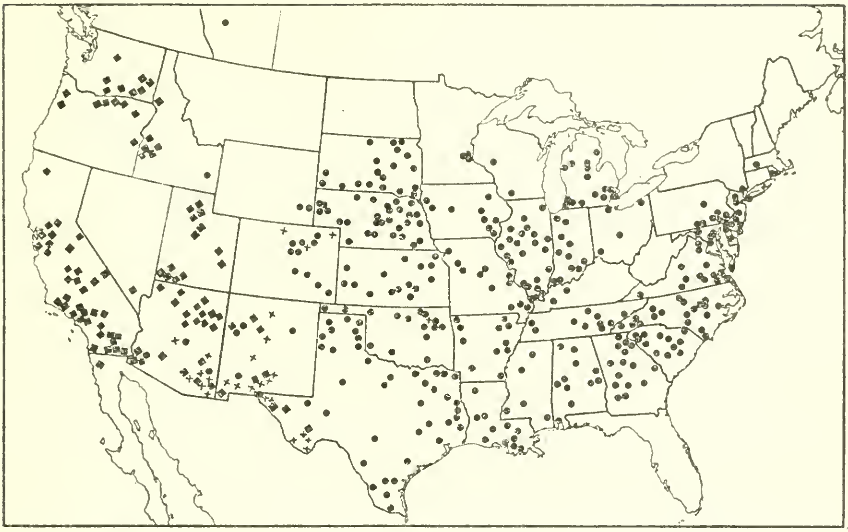

Figure 1.—Distribution in the United States of: *Bothynus gibbosus gibbosus* (DeGeer) (●); *B. g. obsoletus* LeConte (▨); and intermediates of the two (×).

The species inhabiting the United States and Canada superficially are of two forms, the large, dark colored, more elongate species typified by *relictus* (Say), and the smaller, shorter, reddish brown species closely allied to *gibbosus* (DeGeer). Intermediate forms occur in Central and South America. Several subgenera may be represented but their limits cannot be defined until a more complete revision of

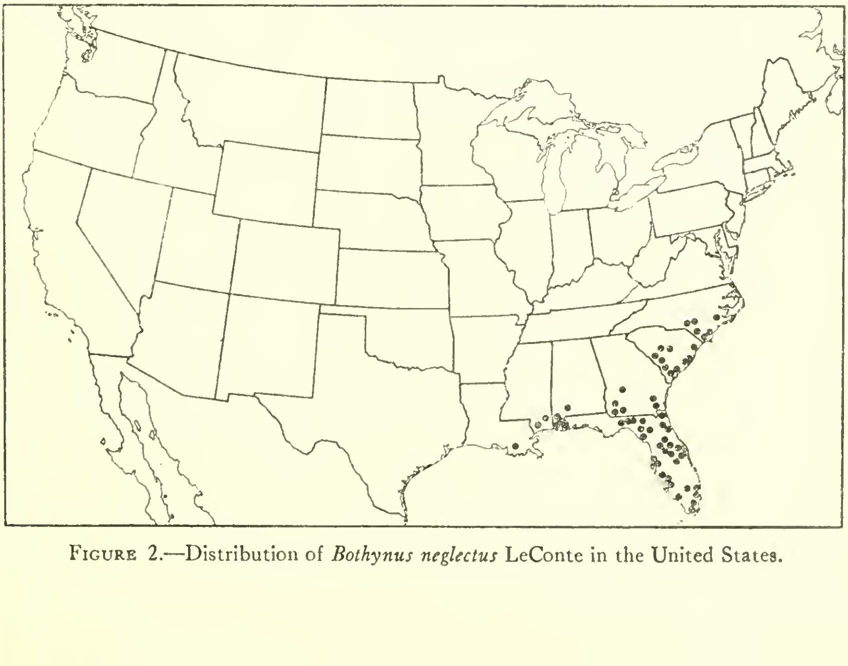

Figure 2.—Distribution of *Bothynus neglectus* LeConte in the United States.

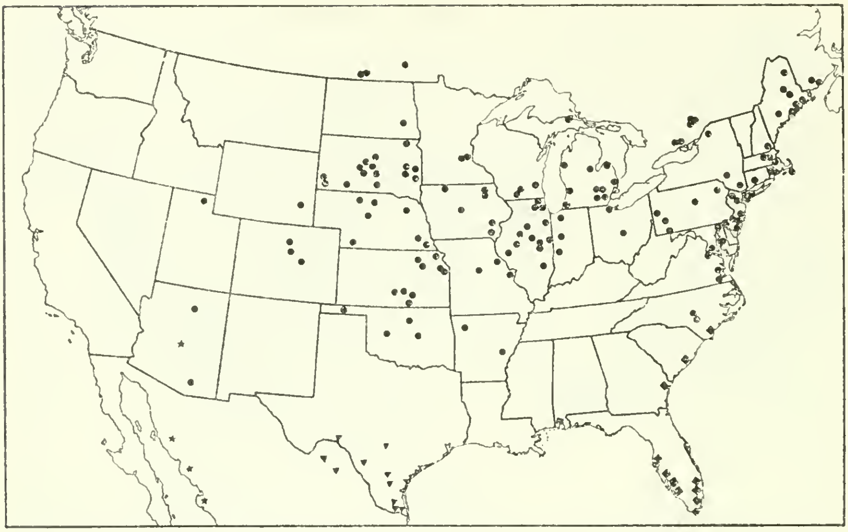

Figure 3.—Distribution in the United States of: *Bothynus relictus* (Say) (●); *B. subtropicus* (Blatchley) (■); *B. sallaei* (Bates) (▲); *B. selanderi* Cartwright (★).

the entire group is undertaken. The *gibbosus* group is usually mixed and partly misidentified in most collections. *Oxygrylius ruginasus* (LeConte) and *O. peninsularis* Casey with similar color, form, punctures, pronotal impression, and denticle are frequently included as well. *Oxygrylius*, however, is easily separated from *Bothynus* by the clypeus being produced medially to a single, sharp, upturned tooth, while *Bothynus* always ends anteriorly in two teeth or denticles.

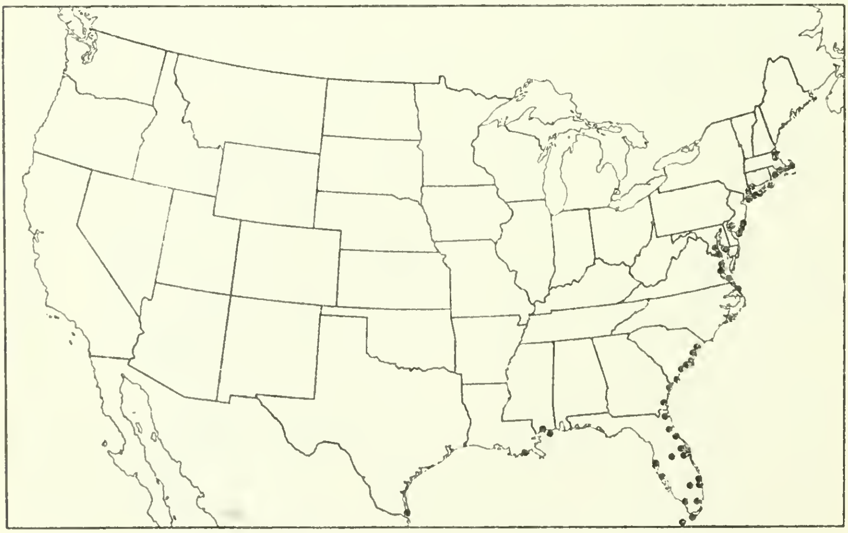

Figure 4.—Distribution of *Bothynus morio* LeConte in the United States.

Key to species of *Bothynus* of the United States

1\. Apex of prosternal process behind anterior coxae completely hairy; smaller species usually less than 18 mm. in length 2

Apex of prosternal process at least partly nude; larger species usually more than 18 mm. in length 5

2\. Outer anterior face of fore tibia smooth adjacent to longitudinal row of coarse setigerous punctures (fig. 6*f*) 3

Outer anterior face of fore tibia closely, finely to roughly punctulate adjacent to longitudinal row of coarse setigerous punctures (fig. 6*e*) 4

3\. Punctures of pronotum and elytra very coarse; habitus as in *gibbosus* (DeGeer); coastal plain; North Carolina to Louisiana. **neglectus** LeConte

Punctures of pronotum and elytra fine to very moderate; habitus slightly more elongate; found in sandy areas of seacoast; Massachusetts to Texas. **morio** LeConte

4\. Hind tibia short and wide, length of inside edge usually less than twice as long as apical width; first segment of posterior tarsus apically noticeably widened laterally, the width often more than the length of the 2d segment; punctures of elytra not so noticeably annular, closer and smaller, more nearly uniform near margin around apical third; pronotum noticeably convex below lateral margins; larger than typical *gibbosus*; usually west of Rocky Mts. **gibbosus obsoletus** LeConte

Hind tibia longer and not so wide, length of inside edge more than twice the apical width; first segment of posterior tarsus with sides nearly straight, not wider than length of 2d segment; elytral punctures usually distinctly annular; pronotum not noticeably convex below lateral margin; east of the Rocky Mts. . . . . **gibbosus gibbosus** (DeGeer)

5\. Pronotum without apical impression; male anterior claw joint swollen, the anterior claw broad and abruptly bent at base 6

Pronotum with at least a small apical impression; male anterior claw and its joint normal 7

6\. Anterior tibia normal, only three large teeth; pygidium scabriculate and closely, finely to moderately punctate at base and sides; middle and northeastern United States, eastern Canada . . . . **relictus** (Say)

Anterior tibia with an additional small but distinct tooth between the 2d and 3d large teeth; pygidium moderately coarsely punctate, the punctures evenly scattered throughout, a very little scabriculate sculpture at extreme base; southern Texas . . . . **sallaei** (Bates)

7\. Frontal carina widely interrupted at middle and joining lateral carina at sides; clypeal teeth widely separated; size moderate, 14 to 20 mm.; tip of Florida and West Indies . . . . **cuniculus** (Fabricius)

Frontal carina interrupted but not reaching sides, or reduced to two widely separated, conical tubercles; clypeal teeth usually separated by less than their basal width; size large, 24 to 29 mm. 8

8\. First wide elytral interval outside sutural stria smooth and shining, rarely with fine punctures but always without the coarse punctures found on the next two intervals . . . . **laevicollis** (Bates)

First wide interval with coarse punctures as found on next two 9

9. Coarse punctures of all elytral intervals similar, shallow and indistinct to moderately deep; apex of prosternal process divided by a distinct groove, the anterior part nude, smooth and convex, the posterior part hairy; frontal rugae appearing as sharply delimited ridges on a flat surface; Arizona, Mexico . . . . **selanderi,** new species
   Coarse punctures of all elytral intervals deep and distinct; prosternal process not divided, the nude apex with uneven surface, the long coarse hairs invading the nude area from back and sides; frontal rugae sharply delimited only on posterior side, not delimited anteriorly; North Carolina to Florida to Alabama . . . . **subtropicus** (Blatchley)

Bothynus gibbosus gibbosus (DeGeer)

Scarabaeus gibbosus DeGeer, 1774, p. 322.
Geotrupes juvencus Fabricius, 1775, p. 32.
Podalgus variolosus Burmeister, 1847, p. 121.
Podalgus juvencus Burmeister, 1847, p. 121.
Ligyrus juvencus Burmeister, 1847, p. 542.
Ligyrus gibbosus LeConte, 1856, p. 20.
Ligyrus parallelus Casey, 1915, p. 194.
Ligyrus puncticauda Casey, 1915, p. 195.
Ligyrus texanus Casey, 1915, p. 195.
Ligyrus breviusculus Casey, 1915, p. 196.
Ligyrus lacustris Casey, 1915, p. 196.
Ligyrus laticauda Casey, 1915, p. 197.
Ligyrus laetulus Casey, 1915, p. 197.
Ligyrus bicorniculatus Casey, 1915, p. 198.
Ligyrus rubidus Casey, 1915, p. 198.
Ligyrus curtipennis Casey, 1915, p. 199.
Ligyrus lucublandus Casey, 1915, p. 199.
Ligyrus farctus Casey, 1915, p. 200.

Length 10 to 17 mm., width 6 to 11 mm. Oblong-oval, convex, shining, reddish brown. Clypeus apically bidentate, the teeth separated by their basal width, surface finely rugulose, a few coarse shallow punctures along edge of the frontal carina which is thin, sometimes feebly sinuate at middle and not reaching sides. Front rugose anteriorly, a few coarse punctures above the eyes and across the middle, base otherwise smooth. Pronotum convex, anterior angles acute, a little less than right angled, posterior angles rounded, sides finely margined, subparallel over basal half, strongly converging anteriorly, base not margined, sinuate, anterior median tubercle moderate, the depression or pit behind it moderately deep and distinct, its length from one-fourth to one-third the thoracic length, surface moderately coarsely punctate throughout, the punctures separated by from one to three times their diameters, those near and in the anterior depression slightly smaller. Scutellum smooth or with a few punctures. Elytra a little longer than wide, about twice as long as the pronotum; very fine punctures scattered throughout and mixed with coarse, deep and usually distinctly annular punctures, the annular punctures of the oblique geminate striae mostly separated by their diameter or less, those of the intervals about as close at the sides but less so on the disc, coarse punctures finer and closer posteriorly. Pygidium quite closely, finely to very moderately punctate throughout, the punctures separated generally by one to three times their diameters, sometimes less closely at apex, laterally finer and closer in the corners, at times almost scabriculate. Undersurface quite hairy, the strong prosternal process behind the front coxae completely so. Anterior tibia closely, finely, confusedly punctate just outside the longitudinal row of coarse setigerous punctures. Apex of hind tibia moderately flaring, its width less than half the length of the tibia measured along the inner edge. First segment of the posterior tarsus usually very little produced laterally, its apical width less than the length of the second segment. Aedeagus as in figure 5*b*.

TYPE: Probably lost. Through the kindness of Dr. Rene Malaise, the specimen purported to be the type of *Scarabaeus gibbosus* in the DeGeer collection in the Riksmuseum, Stockholm, was loaned to me for study. To my surprise I found it to be a specimen of *Cyclocephala*. This specimen could not possibly have been the type of *Scarabaeus gibbosus* DeGeer since it does not agree with the original description or the plate showing a rather poor drawing of the species. It does not have the anterior pronotal depression or pit mentioned in the original description and clearly indicated in the drawing. Further, it does not agree in size, color, or morphological characters as given in the original description. Dr. Malaise states there is no other specimen remaining in the DeGeer collection which could have been the type. The type of *Scarabaeus gibbosus* DeGeer must therefore be considered lost or destroyed.

TYPE LOCALITY: Pennsylvania.

SPECIMENS EXAMINED: 2,700.

DISTRIBUTION: Typical *gibbosus* probably occurs in all States east of the Rocky Mountains except Florida and possibly Vermont, New Hampshire, and Maine. See map, figure 1.

CANADA: ALBERTA: Wimborne. ONTARIO: Chatham, Essex Co., Point Pelee, Port Rowan. UNITED STATES: ALABAMA: Auburn, Birmingham, Decatur, 5 miles northeast of Eutaw (Green Co.), Florence, Mobile, Monroeville, Noccalula, Opelika, Selma, The Sinks (Bibb Co.), Tuscaloosa, Wadley. ARIZONA: Portal, 6 miles southeast of Wilcox. ARKANSAS: Batesville, Boone, Booneville, Bentonville, Brinkley, Chicot Co., Cottonplant, Fayetteville, Hope, Imboden, Jonesboro, Marianna, Stuttgart, Washington Co. COLORADO: Denver, Canon City, Fort Morgan (Morgan Co.), Golden, Kersay, Lamar, Littleton, Mill Gulch, Pueblo, Rocky Ford, Roggen, Two Buttes. DELAWARE: Bridgeville, Middleton, Newark, southern Delaware. DISTRICT OF COLUMBIA. GEORGIA: Athens, Barnesville, Clarke Co., Cornelia, Danielsville, Eatonton, Experiment, Gainesville, Hartwell, Leesburg, McRae, Prattsburg, Spalding Co., Sylvania (Screven Co.), Town Co., Umatilla, Wellston, Wenona. IDAHO: Pocatello. ILLI-

NOIS: Anna, Cairo, Carbondale, Champaign, Chester, Chicago, Danville, Decatur, Dixon Springs, Elizabethtown, Golconda, Harrisburg, Havana, Henry, Heyworth, Hillview, Industry, Kampsville, Knox Co., Metropolis, Mt. Carmel, Mt. Vernon, Normal, Peoria, Pittsfield, Pontiac, Putnam Co., Quincey, Taylorville, Urbana, West Frankfort. INDIANA: Bluff, Clark Co., Henryville, Indianapolis, Lafayette, Lake Co., Madison, Marion Co., Miller, North Judson, Orleans, Posey Co., Spencer Co., Terre Haute, Vigo Co. IOWA: Ames, Cedar Rapids, Dennison (Crawford Co.), Independence, Iowa City, Keokuk, Mt. Pleasant, Missouri Valley, Muscatine, Sioux City. KANSAS: Atchison, Clay Co., Douglas Co., Ford Co., Franklin Co., Garden City, Lakin, La Crosse, Lawrence, Newton, Reno Co., Scott City, Sylvia, Topeka, Wellington, Wichita. KENTUCKY: Dunmor, Fordville. LOUISIANA: Alexandria, Baton Rouge, Berwick, Covington, Franklin, Gueden, Leesville, Morgan City, Nacogdoches, North Iberia, Oliver, Orange, Ruston, Sunset. MARYLAND: Baltimore, Cabin John, College Park, Edgewood, Glen Echo, Hagerstown, Hyattsville, Kenwood Beach, Plum Point. MASSACHUSETTS: West Springfield. MICHIGAN: Ann Arbor, Base Line Lake, Charity Island, Dearborn, Delhi (Washtenaw Co.), Harbert Dunes (Berrien Co.), Iosco Co., Ithaca, Livingston, Macomb Co., Midland Co., Mt. Clemens, Osceola Co., Pentwater, Rochester (Oakland Co.), Sawyer Dunes (Berrien Co.), Stevensville (Berrien Co.), Sturgis, Sumner, Van Buren Co., Whitmore Lake. MINNESOTA: Anoka Co., Big Lake, St. Paul. MISSISSIPPI: Greenwood, Jackson, Lafayette Co., Lucedale, Natchez. MISSOURI: Booneville, Charleston, Columbia, Concordia, Kimmswick, Lathrop, Louisiana, Overland, Rankin, Richmond, Rolla, St. Louis, Webster Groves, Williamsville. NEBRASKA: Ainsworth, Alliance, Ansley, Antioch (Sheridan Co.), Bradshaw, Broken Bow, Columbus, David City, Fairbury, Fairmont, Halsey, Holdrege, Lincoln, Marquette, Mackell (Dixon Co.), McCook, Mindon, Mitchell, Neligh, Norfolk, Ogallala, Omaha, O'Neill, Plainview, Ravenna, St. Edwards, Scottsbluff, Valentino, York. NEW JERSEY: Atlantic City, Boonton, Hadden Heights, Jackson Mills, Lakehurst, Newark, Palmyra, Paterson, Rancocas Park, Somerset Co., Wildwood. NEW MEXICO: Deming, Grants, Hot Springs-Las Vegas. NEW YORK: Babylon, Brooklyn, Long Beach, Montauk, Nepeague, Rock Beach, Rosedale. NORTH CAROLINA: Brunswick Co., Carthage, Columbus Co., Durham, Fayetteville, Flat Rock, Goldsboro, Hendersonville, Hickey, Julian, Maxton, Morganton, Raleigh, Rica Square, Rocky Mount, Southern Pines, Statesville, Swain Co., Tewaccia, Tryon, Washington, Wendell, Whiteville, Wilson, Zebulon. OHIO: Ashtabula, Cedar Point, Cincinnati, Columbus. OKLAHOMA: Bartlesville, Catoosa, Claremore, Comanche Co., Durant, Enid, Erick, Kenton (Cimarron Co.), La Verne (Harper Co.), Lawton, Muskogee, Okmulgee, Osage Co., South McAlister, Springfield, Stillwater, Texas Co., Tulsa. PENNSYLVANIA: Conshohocken, Gettysburg, Kennett Square, Lewisburg, Mt. Alto, Overbrook, Philadelphia, Reading, West Grove, York. RHODE ISLAND: Providence. SOUTH CAROLINA: Aiken, Antreville, Batesburg, Bennetsville, Camden, Chester, Clemson, Columbia, Florence, Greenwood, Meredith, Monck's Corner, Pendleton, Sumter. SOUTH DAKOTA: Beresford, Britton, Brookings, Chamberlain, Claremont, Elk Point, Gregory, Hecla, Henry, Highmore, Hot Springs, Huron, Martin, Mobridge, Murdo, Pine Ridge, Pukwanna, Rapid City, Tyndall, Vermillion, Vernon, Winner. TENNESSEE: Athens, Burrville, Chattanooga, Dyersburg, Greenville, East Ridge, Jackson, Knoxville, McMinnville, Nashville, Sevierville. TEXAS: Amarillo, Barstow (Ward Co.), Brazos Co., Canadian, Canyon, Carthage, Childress, Chillicothe, College Station, Conroe, Corpus Christi, Dalhart, Dallas, Dickinson, Dimmit Co., Ellen, Fort Stockton, Fort Worth, Friona, Hereford, Hidalgo Co., Hopkins Co., Kerrville, Kingsville, Kirbyville, Laredo, Lufkin, Merit, Palo Doro State Park, Paris, Plainview, Ranger, Rusk, San Diego, Smith Co., Spearman, Spur, Sweetwater, Texarkana, Timpson, Trinity Co., Victoria, Waco, Wichita Falls, Winter Haven, Wolf City. VIRGINIA: Amelia, Arlington, Cape Charles, Falls Church, Farmville, Fort Monroe, Great Falls, Nelson Co., Newport News, Norfolk, Pennington Gap, Petersburg, St. Lea, South Boston, Tappahannock, Williamsburg. WISCONSIN: Black River Falls, Broadhead (Green Co.). WYOMING: Wheatland, Platte Co.

REMARKS: *Bothynus gibbosus* (DeGeer) was described from Pennsylvania in 1774. Since no other species of similar appearance is known to occur in Pennsylvania, we can be reasonably sure of its identity even though the original description might apply to other species equally well.

It is surprising that this species does not occur in Florida, but among the many specimens seen from that State not one has been *gibbosus*. There have been a number of published records of *gibbosus* in Florida, notably Blatchley (1928). However, the only specimens labeled *L. gibbosus* (DeGeer) from Florida now remaining in the Blatchley collection are *neglectus* (LeConte).

Bothynus gibbosus obsoletus LeConte

Bothynus obsoletus LeConte, 1847, p. 87.
Ligyrus gibbosus obsoletus LeConte, 1856, p. 20.
Ligyrus californicus Casey, 1909, p. 283 (new synonymy).
Ligyrus spissipes Casey, 1909, p. 283 (new synonymy).
Ligyrus effetus Casey, 1915, p. 200 (new synonymy).
Ligyrus arizonensis Casey, 1915, p. 201 (new synonymy).
Ligyrus brevipes Casey, 1915, p. 202 (new synonymy).
Ligyrus laevicauda Casey, 1915, p. 202 (new synonymy).
Ligyrus laticollis Casey, 1915, p. 203 (new synonymy).
Ligyrus scitulus Casey, 1915, p. 203 (new synonymy).

TYPE: LeConte collection, Museum of Comparative Zoology, No. 3715.

TYPE LOCALITY: Long's Peak, Colo.

SPECIMENS EXAMINED: 1,856.

DISTRIBUTION: See map, figure 1. Of typical *obsoletus*:

UNITED STATES: ARIZONA: Adamana, Aztec, Cameron, Chiricahua Mts., Cottonwood, Ehrenberg, Flagstaff, Fredonia, Grand Canyon, Holbrook, Joseph City, Leupp, Littlefield, Menoopie (Cococino Co.), Navaho, Phoenix, 5 miles west of Portal, Prescott, Roll, Safford, Somerton, Tempe, Tuba, Tucson, Wellton, Wilcox, Winslow, Yuma. CALIFORNIA: Alhambra, Apple Valley, Bakersfield, Banning, Bartow, Ben Lomond, Berkeley, Blythe, Borrego Springs, Burbank, Cajon Pass (San Bernadino Co.), Cathedral City, Chino, Clermont, Colton, Davis, Death Valley, Delhi, El Centro, El Monte, Fort Yuma, Fresno, Glendale, Hawthorne, Highgrove, Huntington Beach, Imperial Co., Indio, Island Mtn. (Trinity Co.), Jacumba, Kaweah, Lancaster, Lindsay, Loma Linda, Los Angeles, Los Banos, Midway, Modesto, Murray Dam (San Diego Co.), North Hollywood, Ontario, Olancha (Inyo Co.), Oro Grande, Oxnard, Palmdale, Palm Desert, Palm Springs, Pasadena, Playa del Rey, Porterville, Riverside Co., Rumsey, Sacramento, Salien Basin, San Bernadino, San Diego, San Fernando, Santa Barbara, Thousand Palms, Tracy, Ventura Co., Victorville, Visalia, Wescott, Whittier. COLORADO: Long's Peak. IDAHO: Boise, Caldwell, Freedom, Lewiston, Notus, Parma, Star. NEVADA: Las Vegas. NEW MEXICO: Alamogordo, Albuquerque, Drolets, Fort Wingate, Grand Canyon, Grants (Valencia Co.), Jemez Springs, Las Cruces, Lordsburg, Rodeo, Roswell. OREGON: Arlington, Biggs, Boardman, Corvallis, Dalles, Hermington, Island City, Ontario, Pendleton, Rufus, Umatilla. TEXAS: Davis Mts., El Paso, Fabans, Sierra Blanco (El Paso Co.), Van Horn. UTAH: Clinton, Delta, Farmington, Green River, Hooper, Hermiston, Kaysville, Knab, Layton, Moab, Oren, Pine Valley, Roy, St. George, Salt Lake City, Santa Clara, Spanish Fork, Syracuse, Wasatch Mts., Washington Co., Zion National Park. WASHINGTON: Dayton, Pasco, Pullman, Toppenish, Walla Walla, Wawawai, Wenatchee, Yakima. MEXICO: AGUASCALIENTES: Aguascalientes. BAJA CALIFORNIA: Enzenada, San Felipe. CHIHUAHUA: 20 miles southwest of Camargo, Juarez, Marachee (10 miles south of Las Delicias), Ojo Laguna, Samalayuca, Santa Barbara. DURANGO: Durango. SAN LUIS POTOSÍ: San Luis Potosí, 30 miles southwest of San Luis Potosí. SONORA: Rocky Point. ZACATECA: San Alto.

Of specimens intermediate between *gibbosus* (DeGeer) and *obsoletus* LeConte:

UNITED STATES: ARIZONA: Bonita, Cochise Co., Douglas, Graham Mts., Phoenix, Portal, Tucson, Wilcox. COLORADO: Crook, Fort Collins, Roggen. NEW MEXICO: Albuquerque, Deming, Escondido, Jemez Mts., Lordsburg, Rodeo, State College, Thatcher. OKLAHOMA: Tulsa. TEXAS: Alpine, Brewster Co., Costolon, Dalhart, Davis Mts., El Paso, Fort Davis, Presidio. MEXICO: AGUASCALIENTES: Aguascalientes. CHIHUAHUA: Arroyo Caterinas (15 miles south of Matamoros), 10 miles south of Las Delicias, Santa Barbara. DURANGO: Durango. SAN LUIS POTOSÍ: San Luis Potosí, 30 miles southwest of San Luis Potosí.

REMARKS: *Bothynus obsoletus* LeConte is easily separated from typical *gibbosus* from the Eastern States. It is somewhat larger (11 to 20 mm. in length), smoother in appearance with denser pilosity on the underside. The sides of the pronotum just under the margin are convex, at times so much so that the lateral margin anteriorly appears almost carniform. Posteriorly at sides and apex the punctures of the elytra become closer, finer, and nearer one size in *obsoletus*. The punctures of the pronotum and elytra are finer and usually not noticeably annular even in the elytral striae. The carina extending the elytral margin inward around the humerus is lower down and does not continue inward as far as in typical *gibbosus*. The posterior tibiae are short, heavy, and very wide apically, their width usually more than half the tibial length as measured along the inside edge. The first segment of the posterior tarsus is comparatively narrow basally and produced laterally at the apex, one side being nearly straight and the other noticeably sinuate in outline. Its width apically is frequently greater than the length of the second segment. Typical *obsoletus* is found in western Idaho, Washington, Oregon, California, Utah, Arizona, and New Mexico. Aedeagus as in figure 5*f*. West of the Rocky Mountains, specimens of *obsoletus* LeConte show very little variation. In southeastern Arizona, New Mexico, parts of Colorado, and western Texas in the Big Bend area, however, specimens are very frequently intermediate in character between typical *obsoletus* and *gibbosus*. Variations in the depth and form of the punctures, the length and width of the posterior tibiae and tarsal segments, and the convexity of the side margins of the pronotum are most noticeable. The degree of variation in each character differs in individual specimens to such an extent it is often quite impossible to decide which name should be applied. Because the characters used to separate the two forms tend here to merge or become intermediate in varying degree, I believe *obsoletus* should be considered a subspecies of *gibbosus*. LeConte (1856) called it a variety of *gibbosus*. Localities in which the more or less intermediate forms have been found are shown on the map (fig. 1). There are three typical specimens of *obsoletus* in the Casey collection bearing the locality label of Lincoln, Nebr., but I believe these are mislabeled. Casey had set them aside without determination. Two specimens labeled "Neb." were found in the Bolter collection, Illinois Natural History Survey.

Bothynus morio LeConte

Bothynus morio LeConte, 1847, p. 87.
Ligyrus morio LeConte, 1856, p. 20.
Ligyrus longulus Casey, 1915, p. 193 (new synonymy).
Ligyrus virginicus Casey, 1915, p. 193 (new synonymy).
Ligyrus remotus Casey, 1915, p. 194 (new synonymy).

Length 12 to 16 mm., width 7 to 9.5 mm. Oblong, convex, shining, reddish brown to blackish brown. Clypeus apically bidentate, the teeth sharp and frequently almost spiniform, separated by about their basal width or slightly more surface slightly roughened anteriorly, smooth posteriorly in front of the thin, sharp, transverse, frontal carina, the carina slightly sinuate at middle and not reaching lateral margin. Head punctate-rugose behind carina, smooth basally. Pronotum as in *gibbosus* except that the anterior pit or depression is usually smaller and not so deep, and the punctures are usually much finer and not as deep. The elytra are slightly longer and the sides more nearly parallel than in *gibbosus*, with the coarse punctures finer and rarely noticeably annular. Pygidium with finer punctures throughout, fewer apically, very close to scabriculate laterally in the corners, and in the male at extreme base. Under surface hairy as in *gibbosus*, the prosternal process similarly completely covered with stiff hairs. Anterior tibia smooth and shining outside the longitudinal row of coarse setigerous punctures. Posterior tibia not as slender as in *gibbosus*, thicker through the middle and less flaring at the apex. Aedeagus as in figure 5*c*.

TYPE: Museum of Comparative Zoology, LeConte collection, No. 3716.

TYPE LOCALITY: "Provinciis mediis."

SPECIMENS EXAMINED: 280.

DISTRIBUTION: Ocean beaches and shores of rivers and bays near the ocean from Massachusetts to Texas. See map (fig. 4).

UNITED STATES: CONNECTICUT: Stamford, Westport. FLORIDA: Bell Glade Capron, Crescent City, Edgewater, Enterprise, Kissimmee, Logger Head Key (Dry Tortugas), Long Key (Pinelas Co.), Marco, Miami, Miami Beach, Palm Beach, Pass-a-Grille, Ponte Vedra Beach, Sarasota, Titusville (Brevard Co.), Vilano Beach, Virginia Key (Dade Co.), Volusia, West Palm Beach. GEORGIA: St. Simons Island, Tybee Island. LOUISIANA: Grand Isle. MARYLAND: Chesapeake Beach, Dorchester Co., Kenwood Beach. MASSACHUSETTS: Eastham, Harwichport, Nantucket, Plum Island Beach, Stoneham, Woods Hole. MISSISSIPPI: Gulfport, Horn Island. NEW JERSEY. Anglesea, Avalon, Five Mile Beach, Island Beach, Ocean Beach, Salem, Sea Island City, Stone Harbor. NEW YORK: Barren Island, Coney Island, Jones Beach, Long Island, Nepeague, Orient, Plum Beach, Rockaway. NORTH CAROLINA: Beaufort, Cape Hatteras, Kill Devil Hill, Kitty Hawk, Long Beach. RHODE ISLAND: Warwick, Watch Hill. SOUTH CAROLINA: Bulls Island, Charleston, Folly Beach, Hilton Head Island, Isle of Palms, Myrtle Beach, Seabrooks Island, Sullivans Island. TEXAS: Brownsville. VIRGINIA: Cobb Island, Fort Monroe, Tappahannock, Virginia Beach. WEST INDIES: BAHAMA ISLANDS: Allans Cay (Abaco Cays), Eleuthera Island, Grand Bahamas Island, Andros Island (Mangrove Cay), South Bimini.

REMARKS: In general *Bothynus morio* LeConte is a smoother, slightly longer, and darker species than *gibbosus*, which it otherwise resembles. The smooth outer face of the anterior tibia (fig. 6*f*) is a character shared with *neglectus* LeConte, but whereas *morio* is more finely punctate and of smoother appearance than *gibbosus*, *neglectus* is much more coarsely punctate and rougher than *gibbosus*. The male genitalia of *morio* LeConte appears to be nearly identical with that of *gibbosus* (DeGeer) and the subspecies *obsoletus* LeConte. See figure 5. It is attracted to lights.

Some specimens of *morio* from Miami, Fla., have punctures much coarser than usual, but they still appear smoother than *gibbosus* and the foretibiae are smooth as is usual in the species. Perhaps these specimens provide an example of character displacement.

Bothynus neglectus LeConte

Bothynus neglectus LeConte, 1847, p. 87.
Ligyrus juvencus LeConte, 1856, p. 20 (not Fabricius, 1775, **p. 32**).
Ligyrus neglectus Casey, 1915, p. 198.

Length 14 to 17 mm., width 8 to 10 mm. Oblong-oval, convex, shining, reddish brown. Clypeus apically bidentate, the teeth separated by about their basal width or a little more, surface finely rugose in front, nearly smooth posteriorly along the thin, sharp, frontal carina which does not reach the sides. Head shallowly coarsely punctate-rugose back of the carina, smooth at base. Pronotum convex, anterior angles sharp, less than a right angle, apex and sides margined, sides subparallel over basal half, strongly converging anteriorly, base sinuate, not margined, apical tubercle strong, depression back of it small, moderately deep, a little less than a third as long as pronotum; surface very coarsely, deeply punctate, punctures separated on the disc by about one diameter, along the base by several diameters, fewer in front and at extreme sides. Scutellum with a few scattered fine punctures. Elytra a little longer than wide, slightly wider posteriorly, punctures annular, deep and very coarse, those of the oblique geminate striae separated by about one diameter or less, punctures finer and closer at sides and apex, sometimes scattered extremely fine punctures evident throughout. Pygidium with fine scattered punctures separated by three or four diameters throughout, very finely scabriculate at sides and base in males. Undersurface somewhat hairy, the prosternal process completely covered apically with stiff hairs. Anterior tibia smooth, or rarely a few scattered fine punctures, remote from the longitudinal row of coarse setigerous punctures. Apex of hind tibia very moderately flaring, its apical width less than half the tibial length. Tarsi possibly a little more slender than in *gibbosus* (DeGeer). Aedeagus distinct (see fig. 6*d*).

Type: LeConte collection, Museum of Comparative Zoology, No. 3714.

Type locality: Southern States, "provinciis australibus."

Specimens examined: 234.

Distribution: Coastal plain of Southeastern States, North Carolina to Louisiana. See map (fig. 2).

Alabama: Baldwin Co., Foley, Magazine Point, Mobile Co., Monroeville, Mt. Vernon, Wilmer. Florida: Alachua Co., Canal Point, Clewiston, Crescent City, De Funiak Springs, Dunedin, Elfers, Enterprise, Fort Lauderdale, Fort Myers, Gainesville, Hialeah, High Springs, Homestead, Kissimmee, Lake City, Largo, Leesburg, Levy Co., Madison Co., Marco, Melbourne, Miami, Monticello (Jefferson Co.), Orlando, Paradise, Quincy, Sanford, Tampa, Tarpon Springs, Welaka, Winter Park. Georgia: Bainbridge, Billy's Island (Okefenokee Swamp), Cordele, Newton, Screven Co., Thomasville, Waycross. Louisiana: Berwick. Mississippi: Gulfport, Lucedale. North Carolina: Brunswick Co., Hamlet, Long Beach, New Bern, Southern Pines, White Lake, Wilmington. South Carolina: Aiken, Allendale, Beaufort, Blackville, Cayce, Charleston, Columbia, Fairfax, McClellanville, Mt. Pleasant, Ridgeland, Yemassee.

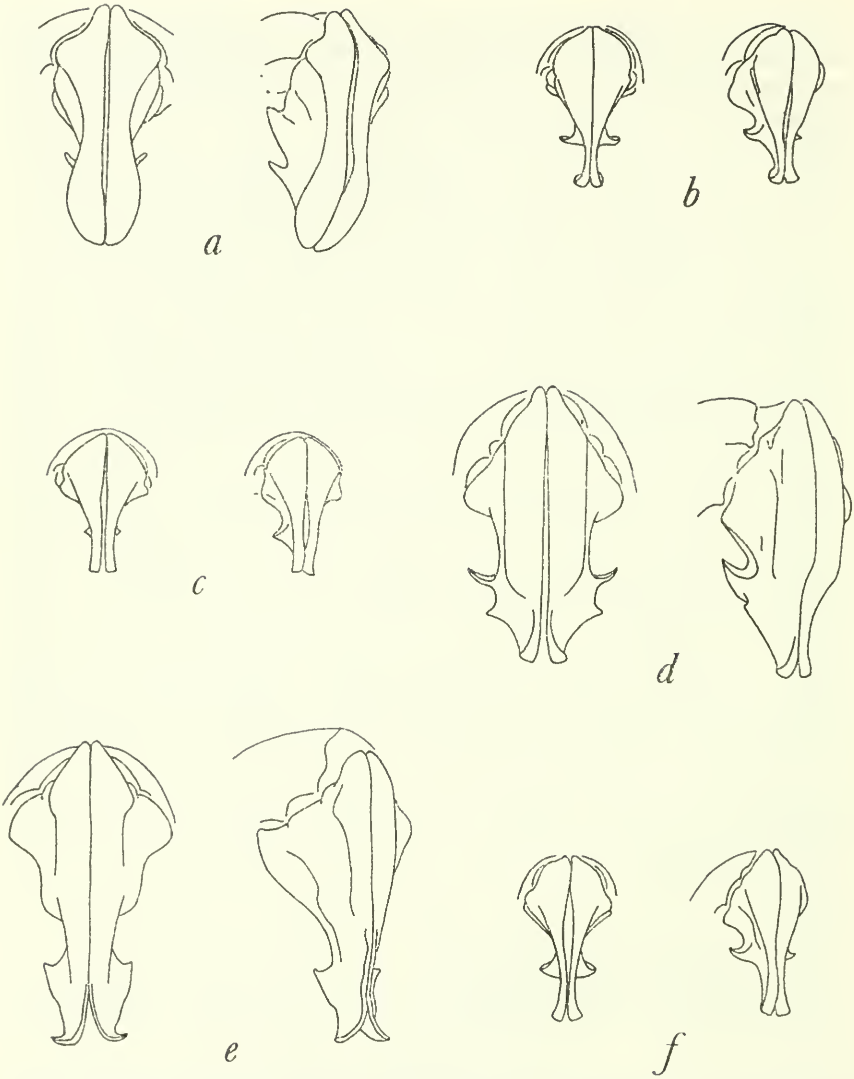

Figure 5.—Aedeagi of: *a*, *Bothynus sallaei* (Bates); *b*, *B. gibbosus gibbosus* (DeGeer); *c*, *B. morio* LeConte; *d*, *B. subtropicus* (Blatchley); *e*, *B. selanderi*, new species; *f*, *B. gibbosus obsoletus* LeConte.

Remarks: The very coarse punctures of the uppersurface and smooth anterior tibiae are the diagnostic characters for this species. It is very close to *gibbosus* (DeGeer) and *morio* LeConte but is easily separated from them. Casey included in his collection four specimens of *neglectus* in his series of *gibbosus*, a surprising and almost unbelievable error when we remember his keen observation and predeliction for describing species on minor variations. His collection contains a

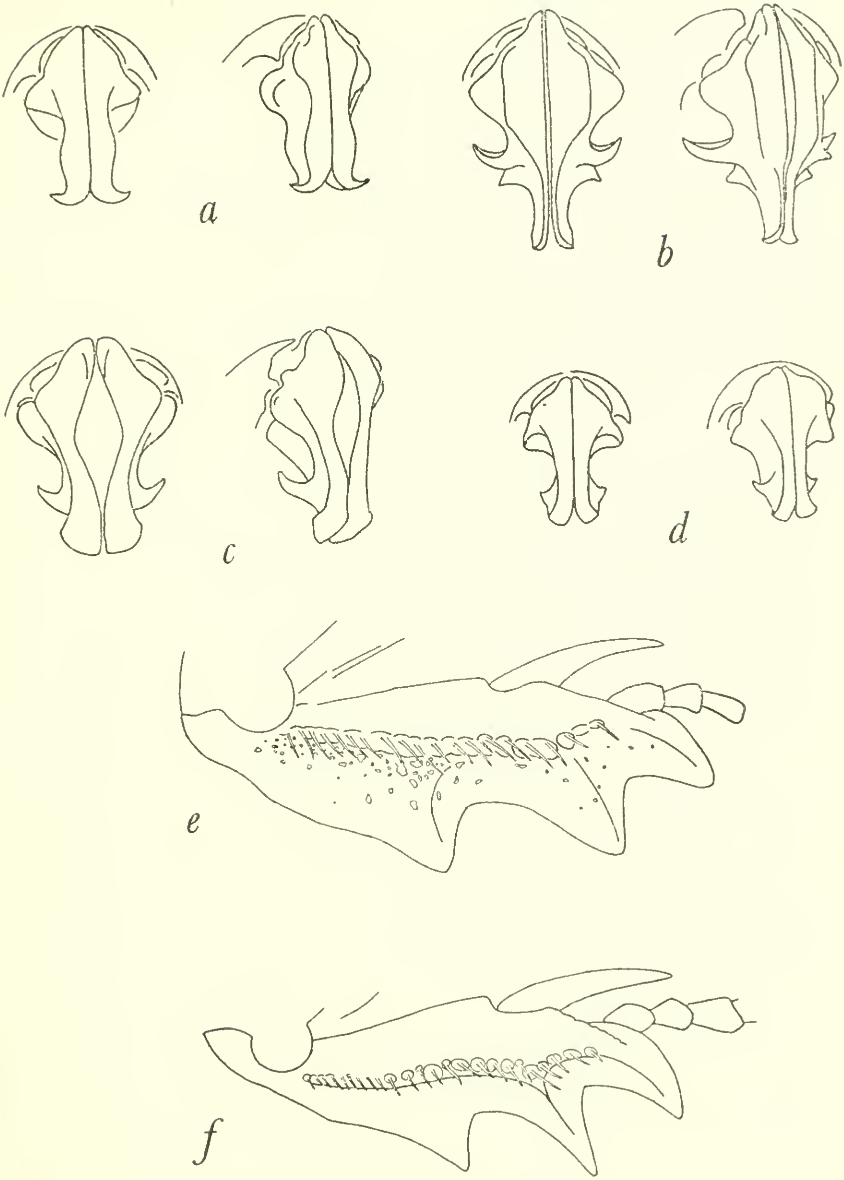

FIGURE 6.—*a–d*, Aedeagi of: *a*, *Bothynus cuniculus* (Fabricius); *b*, *B. laevicollis* (Bates); *c*, *B. relictus* (Say); *d*, *B. neglectus* LeConte. *e*, *f*, Foretibia of: *e*, *B. gibbosus gibbosus* (DeGeer); *f*, *B. morio* LeConte.

single correctly identified specimen of *neglectus* and the four of the same species in the *gibbosus* series, specimens numbered 2, 15, 17, and 18.

LeConte (1856) thought his *neglectus* was perhaps the same as *juvencus* Burmeister, 1847, and he was probably correct since Burmeister in his description of *Podalgus variolosus* (*Bothynus gibbosus* (DeGeer)) stated that the punctures were smaller than in his following species, *P. juvencus*. The Burmeister specimens were from South Carolina. However, the name *juvencus* was first used by Fabricius in 1775 for the species previously named *gibbosus* by DeGeer. Dr. Britton has very kindly compared specimens of *gibbosus* with the type of *juvencus* Fabricius in the Banks collection in the British Museum (Natural History) and states that *juvencus* Fabricius "agrees with your *L. gibbosus*, the front tibiae being obviously punctured outside the longitudinal row of setigerous punctures."

***Bothynus relictus* (Say)**

Scarabaeus relictus Say, 1825, p. 194.
Ligyrus relictus LeConte, 1856, p. 21.
Ligyrodes relictus Casey, 1915, p. 183.
Ligyrodes clypealis Casey, 1915, p. 181.
Ligyrodes parviceps Casey, 1915, p. 182.
Ligyrodes quadripennis Casey, 1915, p. 182.
Ligyrodes verncicollis Casey, 1915, p. 183.
Ligyrodes dawsoni Casey, 1924, p. 334.

Length 17 to 24 mm., width 10 to 13 mm. Oblong, convex, shining, dark reddish brown to piceous. Clypeus apically bidentate, the erect triangular teeth basally contiguous, surface finely, closely rugose. Head slightly concave, finely, closely rugose back of the thin, sharp, posteriorly directed, widely interrupted frontal carina which does not extend to the side margins, a few fine punctures above the eyes, base smooth. Pronotum convex, sides margined and evenly arcuate, converging anteriorly, base sinuate, without margin, apex without tubercle and depression; surface quite evenly yet irregularly moderately punctate throughout, punctures slightly smaller anteriorly, generally separated by one to four or five times their diameter. Scutellum with a few scattered fine punctures. Elytra with sides subparallel, disc coarsely, annularly punctate, these punctures finer and much closer at sides and apex, with fine punctures intermixed throughout, the coarse annular punctures of the oblique geminate striae separated by one diameter or less. Pygidium widely punctate-scabrous basally and at sides, middle quite closely moderately to coarsely punctate, the punctures separated by one diameter or less to a little more than one diameter at apex. Underside anteriorly moderately hairy, the apex of the prosternal process behind the anterior coxae usually with a smooth, convex, anterior part separated from the hairy posterior part by a distinct groove. Anterior tibia smooth outside the longitudinal row of coarse setigerous punctures, males with claw segment swoolen, the anterior claw broad and abruptly bent at base. Aedeagus distinct (see fig. 6*c*).

Type: Probably destroyed.

Type locality: Pennsylvania.

Specimens examined: 953.

Distribution: Canada, north-central and northeastern United States. See map (fig. 3).

CANADA: Ontario: Amprion, Constance Bay, Ottawa, Marmora, Prince Edward Co., Queens Park, Rostrevor, Wellington. Manitoba: Aweme, Wawansea, Winnipeg. New Brunswick: Fredericton, St. John. Quebec: Aylmer, Como, Hull. UNITED STATES: Arizona: Cameron, Tucson. Arkansas: Fayetteville, Stittgart. Colorado: Boulder, Colorado Springs, Denver. Connecticut: Hamden, New Canaan, New Haven, Sheffield Isle, Stamford. Delaware: Newark, Wilmington. District of Columbia. Illinois: Algonquin, Antioch, Atwood, Champaign, Chicago, Cicero, Danville, Edgebrook, Evanston, Havana, Homer, Lacon, Lake Forest, Momence, Moline, Newton, Normal, Palos Park, Pittsfield, Riverside, Rock Island, Urbana. Indiana: Lafayette, Laporte Co., Miller, Vigo., Warsaw. Iowa: Ames, Carter Co., Clermont, Gruver, Independence, Iowa City, Kelso, Mt. Pleasant. Kansas: Atchison, Douglas Co., Lawrence, Manhatten, Mt. Hope, Reno, Riley Co., Sylvia, Wellington, Wichita. Maine: Augusta, Bar Harbor, Lincoln, Millinocket, Mt. Desert, Presque Isle, Round Pond. Maryland: Cambridge, Cecil Co., Edgewater. Massachusetts: Cohasset, Dorchester, Nantucket, Wilmington, Woburn. Michigan: Ann Arbor, Bay Co., Berrien Co., Charity Isle, Duck Lake (Muskegan Co.), Detroit, Livingston Co., Manistee, Port Austin (Huron Co.), Richmond, Rochester (Oakland Co.), Sand Point (Huron Co.), Southfield (Oakland Co.), Whitefish Point (Chippewa Co.). Minnesota: Hennepin Co., St. Paul. Missouri: Boonville, Louisiana, St. Louis. Montana: State label only. Nebraska: Ainsworth, Bennet, Halsey (Thomas Co.), Lincoln, McCook, Neligh, Valentino. New Hampshire: Durham, Hampton. New Jersey: Avenel, Boonton, Brunswick, Hopatcong, Island Beach, Madison, Newark, Paterson, Perth Amboy, Rahway, Seaside Park, Spring Lake, Woodbury. New York: Babylon, Brooklyn, Callicoon, Coronado Island, Elmhurst, Flatbush, Fort Totten, Hague, High Bridge, Long Beach, Long Island, Lyons (Wayne Co.), Nepeague, New Rochelle, Plattsburg, Potsdam, Rosedale, Staten Island, Unionport, West Point. North Carolina: Carthage, Southern Pines. North Dakota: Jamestown. Ohio: Buckeye Lake, Cedar Point. Oklahoma: El Reno, Norman, Optima, Stillwater. Pennsylvania: Beaver Falls, Canadensis, Jeanette, Lock Haven, Ohiopyle. Rhode Island: Warwick. South Dakota: Britton, Brookings, Capa, Chamberlain, Chester, Fort Thompson, Hecla, Highmore, Hill City, Hot Springs, Martin, Murdo, Oak Wood, Oldham, Pierre, Tyndall, Volga, Winner. Utah: Logan. Virginia: Arlington, Norfolk, Phoebus. Wisconsin: Brodhead (Green Co.), Madison, Milwaukee. Wyoming: Wheatland.

Remarks: Casey placed this species in a new genus, *Ligyrodes*, mainly because of the modification of the anterior tarsi in the male, nude apex of the postcoxal prosternal process, and different habitus of the body. Unfortunately, all of these characters are quite variable among the other species found south of the United States and it becomes impossible to separate them on the characters given.

Whether *Ligyrodes* might be retained as a subgenus must be decided by a complete revision of the genus.

Bothynus sallaei (Bates)

Ligyrus sallaei Bates, 1888, p. 318.
Ligyrodes sallei Casey, 1915, p. 184.
Ligyrodes aztecus Casey, 1915, p. 184.
Ligyrodes propinquus Casey, 1915, p. 183.

Length 18 to 23 mm., width 10 to 12 mm. Oblong, convex, shining, dark red-brown to piceous. Clypeus apically bidentate, the upturned, triangular teeth usually contiguous at base, surface moderately rugose, not as finely or closely as in *relictus* (Say). Head slightly concave and similarly rugose back of the very widely interrupted frontal carina which does not extend to the lateral margins, the two parts directed posteriorly as in *relictus* but appearing more as blunt tubercles; basally smooth with a few fine punctures between and above the eyes. Pronotum convex, apically angulate at middle but without tubercle and depression, sides evenly arcuate, margined, anteriorly convergent, base sinuate without margin; surface with rather evenly distributed fine or moderate punctures which become coarser at sides and toward posterior angles, generally separated by two or more diameters, possibly a little finer and not as close as in *relictus*. Scutellum with a few scattered very fine punctures. Elytra only slightly wider behind, punctures as in *relictus* but not as coarse. Pygidium without scabrous sculpture except very narrowly at base in the male, coarsely punctate throughout, closely at base and sides, separated by less than their diameters, gradually sparser and finer apically. Underside anteriorly moderately hairy, the prosternal process back of the anterior coxae with a round, convex, smooth, shiny part in front set off from a posterior, flat, dull, smooth posterior part bordered by stiff hairs. Anterior tibia smooth outside the longitudinal row of coarse, setigerous punctures, a small, distinct, extra tooth between the second and third large teeth; male claw segment swollen, the anterior claw broad and abruptly bent at base. Aedegus distinct (see fig. 5*a*).

Lectotype: British Museum (Natural History).

Type locality: Almolonga, Mexico.

Specimens examined: 151.

Distribution: Southern Texas and Mexico. See map (fig. 3).

UNITED STATES: Texas: Brownsville, Del Rio, Dimmit Co., Harlingen, Hidalgo Co., Houston, Kingsville, New Braunfels (Comal Co.), Robstown (Nueces Co.), Weslaco. MEXICO: Chihuahua: Texcoco. Coahuila: La Babia (Tanque de Malone), Mosquiz (Río Sabinas). Federal District: Mexico City. Guerrero: Teloloapán. Mexicó: Chapingo. Morelos: Cuernavaca, Teguesquitengo. Nayarit: Jalisco, Tepic. Nuevo León: Monterrey.

PUEBLA: Tehuacán. SAN LUIS POTOSÍ: Tamazunchale. SINALOA: Mazatlán. SONORA: Agua Caliente (8 miles east of Zacatecas). TAMAULIPAS: Victoria VERA CRUZ: Jalapa.

REMARKS: *Bothynus sallaei* (Bates) may be recognized and separated from *relictus* (Say) by the shining, coarsely punctate pygidium and the small, distinct, extra tooth between the large second and third teeth of the anterior tibia.

***Bothynus cuniculus* (Fabricius)**

Geotrupes cuniculus Fabricius, 1801, p. 20.
Scarabaeus antillarum Palisot de Beavois, 1805, p. 104.
Bothynus cuniculus Hope, 1837, p. 95.
Heteronychus tumulosus Burmeister, 1847, p. 101.
Ligyrus tumulosus Bates, 1888, p. 315.
Ligyrus cuniculus Arrow, 1937, p. 37.

Length 14 to 20 mm., width 7 to 11 mm. Oblong-oval, convex, shining, reddish brown to piceous. Clypeus apically bidentate, the erect triangular teeth widely spaced, separated by their basal width or more, surface finely closely rugose, the posteriorly directed frontal carina sinuate, strong and thin, widely interrupted at middle, joining lateral carina at sides. Head similarly rugose back of the carina, breaking into moderate punctures just in front of the smooth, shining occiput. Pronotum convex, with anterior and lateral margins as usual, base without margin, weakly sinuate, apical denticle small with a small, usually shallow depression behind it less than one-fourth the pronotal length; surface very evenly, finely to moderately punctate throughout, punctures everywhere separated by one to four times their diameters, the apical depression with a trace of rugose sculpture. Scutellum smooth, rarely with a few minute punctures. Elytra slightly wider behind the middle, moderately coarsely punctate, the punctures finely annular, very fine punctures intermixed throughout, the oblique geminate striae deep, their punctures usually separated by less than their diameters, all punctures finer laterally and apically. Pygidium coarsely, deeply punctate, slightly smaller apically, generally separated by one or two diameters. Underside anteriorly moderately hairy, prosternal process behind anterior coxae apically flat to convex, narrowly nude, the long stiff hairs encroaching from back and sides. Anterior tibia smooth outside the longitudinal row of coarse, setigerous punctures, claws normal. Male aedeagus distinct (see fig. 6*a*).

TYPE: Zoological Museum, Kiel, Germany.

TYPE LOCALITY: "America."

SPECIMENS EXAMINED: 67.

DISTRIBUTION: Florida Keys and West Indies.

UNITED STATES: FLORIDA: Key West, Dry Tortugas. BERMUDA. WEST INDIES: BAHAMA ISLANDS: Eleuthera, North Bimini, South Bimini, New

Providence (Nassau), Andros, Barry (Fraziers Hog Cay). BARBADOS. PUERTO RICO: Mayaguez, Ponce, Fajarda. GUADALOUPE. DOMINICA: Roseau, Portsmouth. ST. VINCENT. JAMAICA.

REMARKS: In addition to the specimens mentioned above I have seen a specimen labeled "Port Hope, Ontario. Dr. Bethune. Wickham Collection," and another labeled "Cal., H. F. W. Casey Collection." These two localities are so far from the known distribution it seems unwise to accept the label data without further confirmation.

The Alabama record of *Ligyrus tumulosus* Burmeister published in the Löding (1945, p. 108) list was based on a misidentified specimen of *L. subtropicus* Blatchley. I have examined the Löding specimens.

Burmeister described *Heteronychus tumulosus* from "Nord-Amerika (Sud-Carolina) und Westindien (St. Domingo)." The specimens labeled South Carolina may have been picked up on Bermuda on a voyage to or from the colony in South Carolina. The species does not occur in South Carolina.

Bothynus laevicollis **(Bates)**

Ligyrus laevicollos Bates, 1888, p. 316.—Schaeffer, 1909, p. 384.
Ligyrus bryanti Rivers, 1891, p. 97.

Length 21 to 26 mm., width 12 to 14 mm. Oblong, shining, piceus. Clypeus bidentate, the teeth practically contiguous at base, sides finely, sharply margined, front and clypeus finely rugose, frontal carina reduced to two widely separated, rather large, conical tubercles. Pronotum convex, finely margined apically and laterally, the slightly sinuate base without margin, apical median denticle small with a more or less triangular flat to very slightly concave, finely rugose area behind it, this area about one-fourth as wide as apical margin, apical angles acute; surface smooth and shining basally with very fine punctures becoming more evident at sides and gradually becoming fine to moderate in anterior angles where they are separated by about one diameter or less, occasionally a few are confluent. Scutellum smooth and shining with a few scattered minute punctures. Elytra 1 to 2 mm. longer than wide, sides slightly divergent, widest slightly beyond the middle; humeral and apical umbones, first wide interval and narrow strip across base, smooth and shining with only scattered minute punctures, oblique geminate striae and remainder of disc coarsely, distinctly punctate, the punctures annular, evenly distributed, separated by one or two diameters in the intervals, punctures rapidly becoming fine to very fine and close laterally outside third pair of striae, apically beyond the umbone the punctures are close, mixed, fine and moderately coarse. Female pygidium with somewhat unevenly scattered but fairly closely spaced fine to moderate punctures throughout, scabriculate in corners and across base; male pygidium smooth, shining, minutely punctate apically, widely densely scabriculate laterally and basally. Underside sparsely hairy; prosternal process apically smooth and convex anteriorly, posteriorly and laterally clothed with long stiff hairs. Anterior tibia smooth in front, cariniform outside longitudinal row of coarse, setigerous punctures, scattered shallow, fine punctures beyond carina; tarsi normal. Male aedeagus distinct (see fig. 6*b*).

LECTOTYPE: British Museum (Natural History).

TYPE LOCALITY: Acapulco, Guerrero, Mexico.

SPECIMENS EXAMINED: 56.

DISTRIBUTION:

UNITED STATES: "ARIZONA." MEXICO: BAJA CALIFORNIA: Cape San Lucas, San Felipe, San José del Cabo, Santa Rosa. CHIAPAS: Tapachula (cotype). GUERRERO: Acapulco. NAYARIT: San Blas. SINALOA: Mazatlán.

REMARKS: *Bothynus laevicollis* (Bates) is recognized by the very smooth, shining, first interval of the elytra. There seems to be no doubt that *L. bryanti* Rivers, described from Baja California, is identical. Dr. E. B. Britton of the British Museum (Natural History) very kindly supplied a cotype of *L. laevicollis* Bates for study. We have a series previously determined as *L. bryanti* from Baja California. No differences are discernible. The specimen from Phoenix, Ariz., determined as *laevicollis* by L. W. Saylor is not this species but is a female of the species described in this paper as *Bothynus selanderi*, new species.

Bothynus selanderi, new species

Ligyrus laevicollis Saylor, 1946, p. 44 (not Bates, 1888, p. 316).

HOLOTYPE MALE: USNM 63912. Length 28 mm., width 14 mm. Oblong, shining, piceous. Clypeus bidentate, the upturned teeth separated by about their basal width, clypeus and front continuously finely rugose, the rugae appearing as tiny ridges on a flat surface, i. e., not declivous on only one side, clypeal carina represented by two very widely spaced conical tubercles, more widely spaced than in *laevicollis* (Bates), occiput narrowly smooth. Pronotum convex, apically and laterally margined, base slightly sinuate, without margin, apical angles acute, apical denticle moderate with a shallow depression behind it less than one-fourth the length of the pronotum, a vague smaller depression about half as wide and half as deep on each side of the median depression; surface of median depression rugose, the rugae extending laterally to but not into the smaller depressions which are closely, distinctly punctate within, elsewhere the punctures are moderately coarse and deep on the disc just behind the median depression where they are separated by about their diameter, coarser, closer and shallower toward the anterior angles where the sculpture becomes more or less rugose, quite coarse toward the posterior angles, smoother and more finely punctate over the lateral fovea, and rapidly much finer and sparser basally at middle. Scutellum smooth with scattered indistinct, very fine punctures. Elytra elongate, sides subparallel, punctures mixed, very fine throughout, moderate in the oblique geminate striae and intervals, and with a very fine, vague, close, minute sculpture, not alutaceous, in addition, all punctures fine laterally and apically. Pygidium finely scabriculate in lateral angles and toward the middle basally, otherwise smooth and very finely and sparsely punctate throughout; more convex than in female. Underside sparsely hairy anteriorly, prosternal process behind anterior coxae with apex nude and convex anteriorly, with long hairs limited to sides and posterior part. Anterior tibia carinate and roughly, coarsely punctate outside the longitudinal row of coarse setigerous punctures, claws normal. Aedeagus distinct (see fig. 5*e*).

Allotype female: Length 29 mm., width 14 mm. Differs from the male in the shape of the pygidium, which is much less convex, with close, mixed fine and moderate punctures throughout, these superimposed on fine scabriculate sculpture along the base and in the lateral angles.

Type locality: Los Mochis, Sinaloa, Mexico, collected July 22, 1955, at light by R. B. and J. M. Selander.

Paratypes: 38 males, 53 females, same data as holotype and allotype; 1 male, Los Mochis, Sinaloa, Mexico, July 25, 1922, C. T. Dodds; 3 males same locality and collector, July 20, 1922; 3 males, 1 female, Hermosillo, Sonora, Mexico, July 9–16, 1953, Borys Malkin; 1 male, Mazatlán, Sinaloa, Mexico, July 21, 1955, R. B. and J. M. Selander; 1 male, Esperanza, Sonora, Mexico, July 15, 1955, F. Pacheco-M., 1 female, Phoenix, Ariz., Aug. 10–20, 1908 (L. W. Saylor collection). See map (fig. 3).

Paratypes will be placed in the British Museum (Natural History), Riksmuseum, Canadian Department of Agriculture, American Museum of Natural History, California Academy of Sciences, Chicago Museum of Natural History, Frey Museum, Museum of Comparative Zoology, and in the private collections of L. J. Bottimer, W. W. Gibson, Henry Howden, Antonio Martinez, P. Francisco Silvario Pereira, Mark Robinson, and R. B. Selander.

Remarks: The typical series shows little variation. However, the shallow depressions on each side of the median, anterior, pronotal depression are more noticeable in some specimens; in some the coarse punctures of the wide interval between the sutural and first geminate striae become vague, shallow and almost obliterated by the other surface sculpture, in others the punctures remain distinct but shallower than the geminate series. The minute surface sculpture, in addition to the coarse and fine punctures, is much more noticeable in some specimens than others but is quite characteristic. Several have a more or less distinct, impunctate, narrow, longitudinal, median area over the basal half of the pronotum. The species ranges from 24 to 30 mm. in length and 12 to 15 mm. in width. It is quite similar to *laevicollis* (Bates) and *subtropicus* (Blatchley) but is easily separated from them by the male genitalia and characters given in the key. *Bothynus selanderi* is named in honor of R. B. Selander, who collected most of the typical series.

***Bothynus subtropicus* (Blatchley)**

Ligyrus subtropicus Blatchley, 1922, p. 30.
Ligyrus blatchleyi Cartwright, 1944, p. 34.

Length 21 to 25 mm., width 12 to 14 mm. Oblong, convex, shining rufopiceous to piceous. Clypeus apically bidentate, the upturned, triangular teeth nearly contiguous at base, surface finely moderately closely rugose, the frontal carina represented by two low, widely spaced, more or less conical tubercles; front of head similarly rugose and slightly concave, the rugulose lines breaking to fine punctures posteriorly, occiput smooth. Pronotum convex with a low denticle on the anterior margin at middle and a flattened area or shallow depression behind it, the depression about one-third the pronotal length; sides margined, arcuate to acute anterior angles, base sinuate without margin; surface finely punctate over disc and at middle of base and sides, gradually much more coarsely punctate to the anterior and posterior angles, fine punctures at base separated by four or more diameters, coarse punctures in anterior angles generally by one diameter or less, the apical anterior depression rugose-punctate. Scutellum smooth or with a few fine punctures. Elytral sides subparallel, surface moderately coarsely punctate with very fine punctures intermixed throughout, the coarse, annular punctures of the oblique geminate striae and the intervals between somewhat coarser than those in the wide interval between the first geminate and sutural stria, all punctures finer and closer at sides and apex. Pygidium widely scabriculate-punctate at base and sides, only slightly less so in the female, otherwise shining and smooth with scattered very fine punctures, extreme apex virtually impunctate. Underside sparsely hairy anteriorly. Apex of prosternal process behind anterior coxae nude, smooth, only slightly convex, with the long, stiff hairs invading the area from sides and rear. Anterior tibia smooth and carinate outside the longitudinal row of coarse, setigerous punctures, claws unmodified. Male aedeagus distinct (see fig. 5*d*).

TYPE: Blatchley collection, Purdue University, Lafayette, Ind.

TYPE LOCALITY: Dunedin, Fla.

SPECIMENS EXAMINED: 69, including holotype.

DISTRIBUTION: Seacoast from North Carolina to Florida to Alabama. See map (fig. 3).

NORTH CAROLINA: Wrightsville Beach. SOUTH CAROLINA: Charleston. GEORGIA: Savannah. FLORIDA: Coconut Grove, Dade Co., Dunedin, Englewood, Everglades, Fort Lauderdale, Fort Myers, Homestead, Key Largo, Key West, Miami, South Miami. ALABAMA: Mobile Co.

REMARKS: Saylor (1946) placed *blatchleyi* Cartwright in synonymy, as I surmised it might be in the original description. I have recently examined Blatchley's type of *subtropicus* and agree that his action was correct. Thus far this has been the only large species of *Bothynus* found in South Carolina, Georgia, and Florida.

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A FURTHER STUDY OF MICRONESIAN POLYCLAD FLATWORMS

By Libbie H. Hyman [1]

The material treated in this article was assembled from several sources: one vial from the Templeton Crocker Expedition of 1933, collected at Vanikoro Island; one vial taken at Guam by D. H. Johnson; three vials collected by Cadet Hand at Kapingamarangi Atoll in the Caroline Islands; six vials from Eniwetok Atoll collected by D. J. Reish; 21 vials collected on Ifaluk Atoll, western Carolines, under the auspices of the Pacific Science Board Atoll Research Program, 1953, mainly by D. P. Abbott, some by F. M. Bayer and others; 20 vials collected in the Palau Islands, 1955, by a team composed of R. R. Harry, H. A. Fehlmann, and F. M. Bayer, from Stanford University and the U. S. National Museum (USNM); and two polyclads found in a miscellaneous collection of material from the Palau Islands presented to the American Museum of Natural History (AMNH).

The field work at Ifaluk and Kapingamarangi Atolls was supported by funds from Contract N 7–onr–29104 (NR 388–001) by the Office of Naval Research, Department of the Navy, and National Academy of Sciences. Work at Palau was undertaken by arrangements with the Pacific Science Board (National Academy of Sciences—National Research Council) and the Office of Naval Research under Contract N 7–onr–291 (57).

The polyclads of the tropical and subtropical waters of the vast Indo-West Pacific region are imperfectly known and have not been

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[1] American Museum of Natural History, New York, N. Y.

systematically collected. Species from this area are widely scattered in the literature. Articles dealing specifically with Micronesian polyclads are those of Kato (1943) and Hyman (1955b). Kato listed three new and four known species from the Palau Islands, of which only one was recovered in the present material, and Hyman two new and two known species from Micronesia, of which one has been recovered here. The prevalence of known species in even such small collections indicates a wide distribution of polyclad species in the Indo-West Pacific area.

Taxonomic categories have been defined in previous publications, especially Hyman (1953a), and definitions will not be repeated here. Only categories not found in previous articles will be explained.

Order Polycladida

Suborder Acotylea

Section Craspedommata

Family Latocestidae Laidlaw, 1903

Latocestus pacificus Laidlaw, 1903

Figure 1*a–c*

Material: One specimen collected by the Stanford team at the Palau Islands, Sta. 64, from a small bay at the south end of the lagoon of Eil Malk, Aug. 7, 1955.

General characters: The worm, 11 mm. long and about 1 mm. wide, has the strap shape typical of the genus (fig. 1*a*). It is brown, of thick, opaque consistency. The numerous small eyes begin well posterior to the anterior margin as a median band, irregular at first but becoming bilateral in arrangement before reaching the brain; anterior to the brain the eyes spray out over the anterior end as usual in the genus (fig. 1*b*). The marginal eyes are not well delimited from the frontal eyes but continue for a short distance posterior to the level of the brain. The position of the brain is shown in figure 1*b*. Because of the dark, opaque consistency of the worm the exact arrangement of the eyes was difficult to ascertain and, further, little could be seen of the internal anatomy. The short ruffled pharynx with the mouth at its posterior end occurs near the posterior end of the worm as typical of the genus, and between the mouth and the posterior margin are seen the male and female gonopores (fig. 1*a*).

Copulatory apparatus: The posterior end of the worm was removed and sectioned sagittally. The contained copulatory apparatuses are shown in sagittal view in figure 1*c* and are characteristic of the genus. The free prostatic vesicle with thick muscular wall and

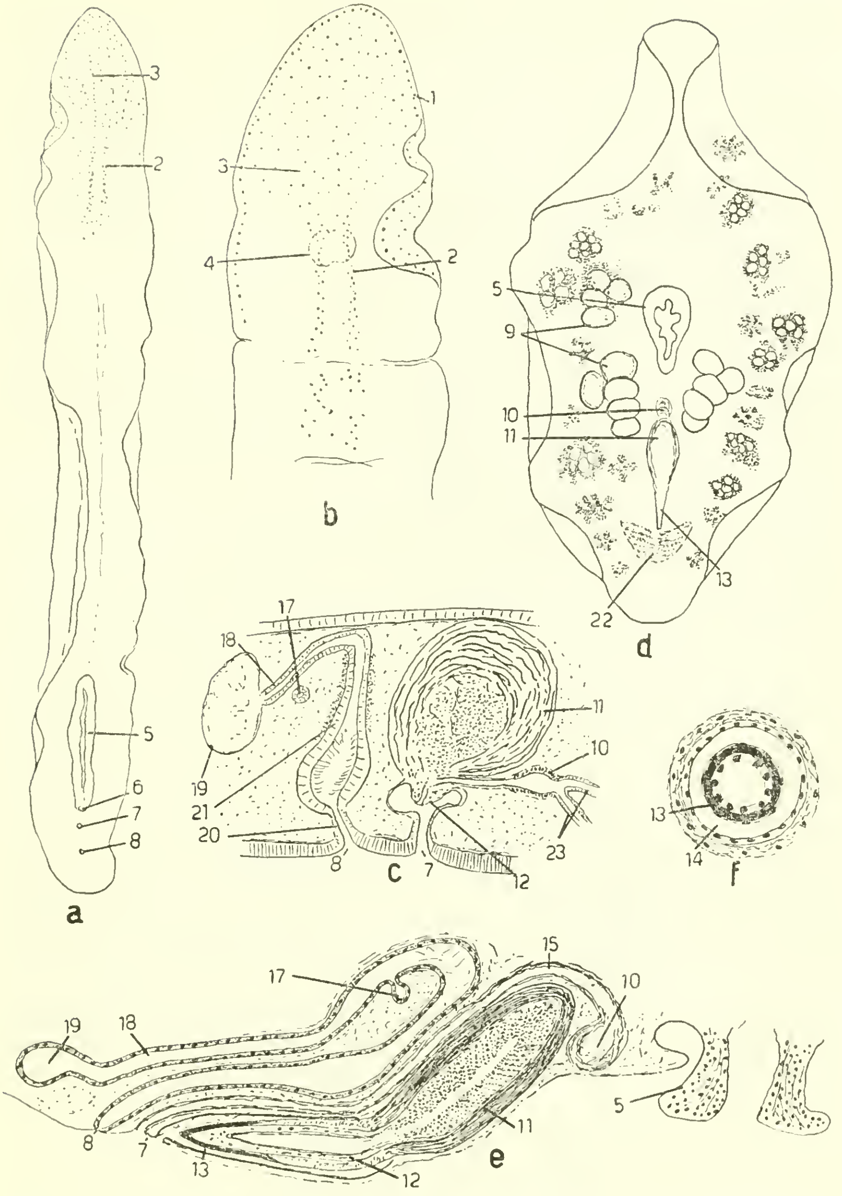

FIGURE 1.—*a–c*, *Latocestus pacificus: a*, dorsal view; *b*, anterior end, enlarged, showing eye pattern; *c*, sagittal view of copulatory apparatuses. *d–f*, *Plehnia tropica: d*, dorsal view; *e*, sagittal view of copulatory apparatuses; *f*, cross section through penis stylet. (For explanation of numbered parts see p. 597.)

glandular interior is relatively large; it stands almost erect, although this may be partly caused by contraction, and terminates below in a small, conical penis papilla, which is entered by the ejaculatory duct formed from in front by the union of the two sperm ducts. The latter have definite coats of circular muscles but are not much thickened. Their union produces a small seminal vesicle, also with a coat of circular fibers, and this continues into an ejaculatory duct that enters the base of the penis papilla.

The female gonopore, distinct from but not far behind the male pore, leads into a vertical female antrum, from which the widened vagina proceeds dorsally, then makes a sharp bend posteriorly, descending to enter the small Lang's vesicle. The common oviduct was seen below the duct leading to Lang's vesicle but its exact point of entrance into this duct was not determinable in the sections.

Specimen: USNM 28640, anterior part as whole mount, postoral part as sagittal sections (one slide).

Remarks: The original description of *Latocestus pacificus* is so meager that certain identification with this species is probably impossible. The present identification must be regarded as merely plausible. It is based on the small size at sexual maturity and the eye arrangement. Laidlaw (1903a) gave the size of the type specimen with some doubt as 12 mm. and stated that gonopores were present although the gonads were immature. Although the gonads could not be seen in the present whole specimen because of its opacity, the copulatory apparatuses indicate full sexual maturity at a length of 11 mm., but the specimen is somewhat contracted and was longer in life. The eye arrangement, especially the long and somewhat paired median streak and the short backward extent of the marginal bands, is very like that shown in the one and only figure of *L. pacificus*. The anterior end of the latter, however, appears abnormally shortened and part may be missing. Laidlaw unfortunately did not depict the location of the brain with reference to the median streak of eyes and it is impossible to believe his statement that the brain was located at 4 mm. from the anterior end of a worm 12 mm. long.

Family Plehniidae Bock, 1913

Plehnia tropica, new species

Figure 1*d–f*

Material: Several specimens, of which five were usable, taken from the alcyonacean *Nephthea* by the Stanford team at the Palau Islands, Sta. 254, reef south of Ngaremediu, east end of Urukthapel, Oct. 27, 1955.

General characters: This is a very small species, of broadly oval form, about 2 mm. long and about half as wide (fig. 1*d*), broadest at the middle and decreasing slightly to the rounded ends. It is white with sprawling black marks in a longitudinal row along each side but some of these are associated with developing clusters of eggs. Eyes are totally wanting. In the center is seen a small ruffled pharynx and behind this, directed backwards, the large prostatic vesicle, posteriorly encased in a conical pointed penis stylet. Behind the tip of the stylet, the cement glands of the female apparatus are noticeable. Groups of eggs in various stages of development are evident in the interior and a cluster of a few very large, presumably ripe eggs was conspicuous in most specimens at a level between the pharynx and the prostatic vesicle, on each side. These were presumably enclosed in the uteri. They seem very large for the size of the worm. Branches of the intestine, not shown in the figure, could be seen in the whole mount radiating to the periphery and passing back to either side of the prostatic vesicle.

Histology: One specimen was mounted whole and the other four were sectioned, two in the sagittal plane and two transversely. Because of lack of proper fixation the histological condition was unsatisfactory and yielded little definite information. Epidermis was lacking everywhere but subepidermal musculature could be detected here and there. The whole interior appeared as a fibrous mesh containing nuclei. Even branches of the intestine were scarcely recognizable. Ovaries and testes are relatively large and about fill the thickness of the body, hence cannot be said to be either dorsally or ventrally located. The large eggs noted in the whole animal were found to be very yolky, filled with large eosinophilous spheres and covered with a layer of dark bodies. The brain could not be definitely identified either on the whole mount or in the series of sections.

Copulatory apparatus: This was satisfactorily worked out on one series of sagittal sections and is shown in sagittal view in figure 1*e*. The large oval prostatic vesicle, of the free type, is the most conspicuous part of the male apparatus. It has a fairly thick muscular wall and a glandular interior of eosinophilous nature. It is oriented somewhat vertically with a forward slant; distally it continues with a sharp bend as the penis papilla which has a horizontal orientation. The elongate penis papilla is housed in a male antrum of the same shape. At its distal end the penis papilla is encased in a sclerotized cone taking the eosin stain that may be regarded as a penis stylet. A cross section through this part of the penis papilla is shown in figure 1*f*. The stylet is covered with a thin layer containing flattened nuclei and is lined by a cuboidal epithelium continuous with the lining epithelium of the unsclerotized part of the penis papilla. Anterior to the proximal end of the prostatic vesicle is found the small, muscular seminal vesicle from which the ejaculatory duct proceeds, passing above the prostatic vesicle and continuing along the posterior side of the latter and dorsal to the penis papilla to open just behind the male gonopore or perhaps, one should say, in common with it. This is certainly a very strange course for an ejaculatory duct; one expects it to enter the base of the penis papilla and this is the case in other species of *Plehnia.* However, the course described appeared clearly indicated in the sagittal series mentioned; it could not be clearly made out in the other series but neither could any entrance into the penis papilla be found. The ejaculatory duct is composed chiefly of a thin muscular wall of longitudinal fibers.

The female apparatus is very similar to that of *Plehnia arctica* (Plehn, 1896). The female gonopore is found shortly behind the exit of the ejaculatory duct. It leads into a long vagina much slanted forward and paralleling the ejaculatory duct. About at the level of the proximal end of the prostatic vesicle the vagina makes a backward curve and after receiving the common oviduct proceeds posteriorly parallel to the vagina as a long duct that terminates in a small oval Lang's vesicle. The whole tract consists of a cuboidal epithelium in which cell walls were missing and has but a slight muscular investment. The large cloud of eosinophilous cement glands, conspicuous in the whole mount, were in evidence in the sections along the vagina but have been omitted from the figure.

DIFFERENTIAL DIAGNOSIS: *Plehnia tropica* differs from other eyeless species of the genus in the course of the ejaculatory duct and the sclerotization of the distal end of the penis papilla.

HOLOTYPE: USNM 28641, one whole mount; also USNM 28685, best set of sagittal sections (one slide).

REMARKS: This is the third eyeless species of *Plehnia* to be discovered. The type of the genus, *Plehnia arctica* (Plehn, 1896), the first example of an eyeless polyclad, came from Spitzbergen. The second, *Plehnia caeca* Hyman (1953a) came from the California coast at some depth and was also found to occur in a variant with two cerebral groups of small eyes. Whether the association of the present species with an alcyonacean is obligatory or accidental cannot be stated but the large yolky eggs and the relatively large copulatory apparatus indicate some tendency to parasitism. The total want of eyes in an acotylean polyclad poses a systematic dilemma as the present classification of the Acotylea is based upon eye arrangement. However, Bock (1913) satisfactorily placed *Plehnia* among the Craspedommata and established the family Plehniidae.

Section SCHEMATOMMATA

Family LEPTOPLANIDAE Stimpson, 1857

***Stylochoplana minuta*, new species**

FIGURE 2*a–c*

MATERIAL: One specimen collected from algal washings in the intertidal zone, Sept. 22, 1953, on Ifaluk Atoll between Elangalap and Falarik Islets, Sta. 65–D–3. Another specimen, collected by D. Reish, Sept. 4, 1956, on fronds of algae on the reef flat on Eniwetok Atoll, Sta. E–79, was doubtfully assigned to this species.

GENERAL FEATURES: This is a very small species; the Ifaluk specimen was 5 mm. long, the Eniwetok specimen 4 mm. long. But both specimens were seen to be sexually mature by the presence of relatively large eggs in a lateral strand on each side (fig. 2*a*). The form is typically leptoplanid, slender, elongated, rounded anteriorly, tapering to a pointed posterior end. Tentacles are wanting. Both specimens appeared colorless or white. The eyes of both specimens are not arranged in tentacular and cerebral clusters, as common in the Leptoplanidae, but form a single irregular row, of 15 eyes on one side, 12 on the other, in the Ifaluk specimen (fig. 2*b*). They were not counted in the other specimen. Even in the cleared specimens little could be seen of the interior structure except the presence of eggs.

COPULATORY APPARATUS: The posterior end of the Ifaluk specimen was removed and sectioned sagittally. The copulatory apparatuses found therein are depicted in figure 2c. The gonopores are somewhat distant from each other (about 0.5 mm.). The male gonopore leads into a tubular, slanting male antrum that appeared to widen internally around a probable penis papilla but these parts were imperfectly present in the sections, hence their representation in figure 2*c* is somewhat conjectural. The lining epithelium of the male antrum is highly glandular, filled with coarse eosinophilous granules. The presence of a penis papilla could not be definitely ascertained. There is present an elongated oval prostatic vesicle with muscular wall and glandular interior. Beneath its proximal end occurs an oval muscular seminal vesicle; the connection of this with the prostatic vesicle was vague in the sections but probably occurs as indicated by the dotted lines in figure 2*c*. The expanded spermiducal vesicle filled with sperm was seen entering the seminal vesicle.

The female apparatus was in a better state of preservation than the male apparatus and its details could be ascertained. The female antrum ascending in a curve from the gonopore is continuous with the vagina of which the distal part is remarkable for its thick mus-

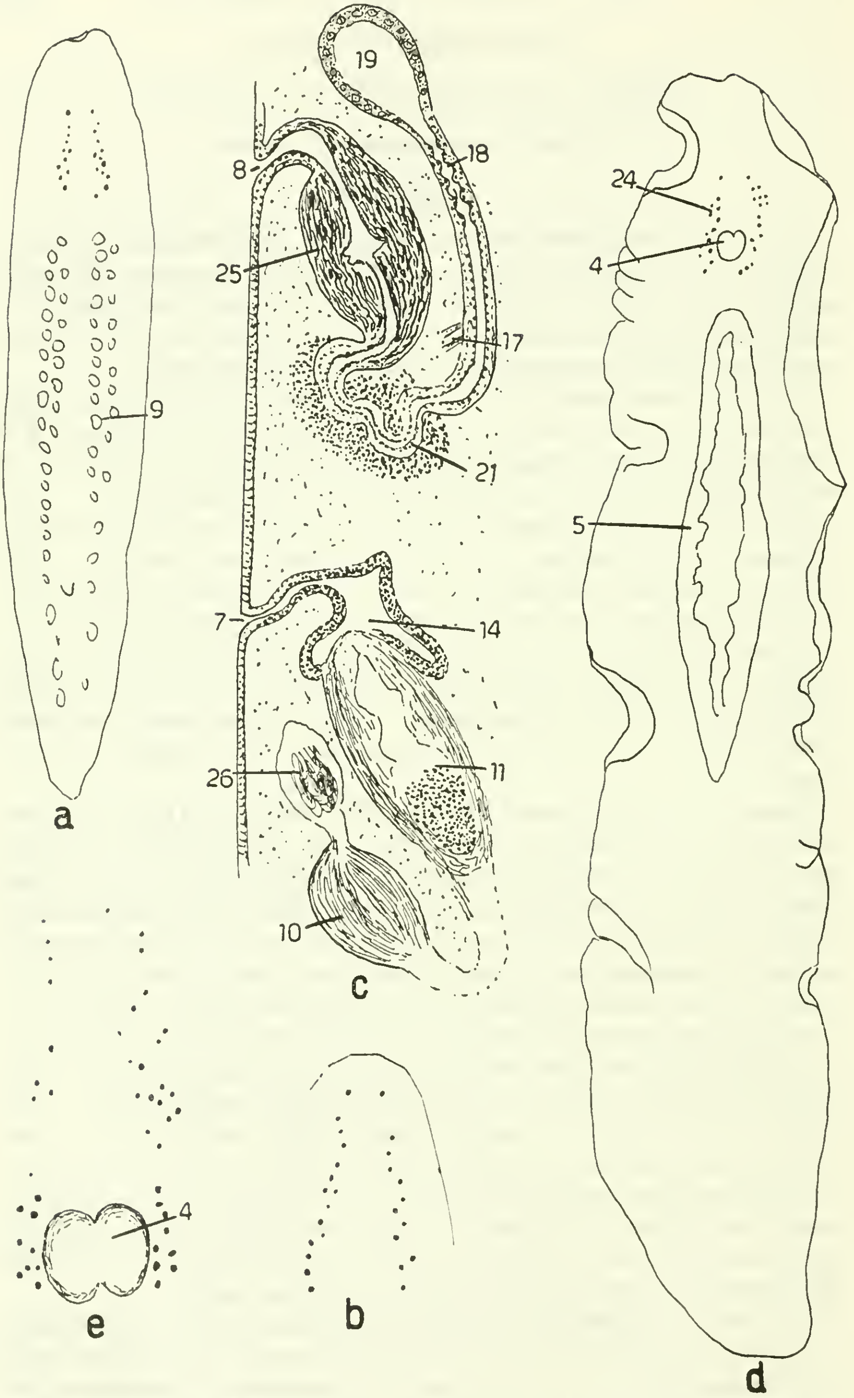

FIGURE 2.—*a–c*, *Stylochoplana minuta: a*, dorsal view; *b*, eyes enlarged; *c*, sagittal view of copulatory apparatuses, female above. *d*, *e*, *Notoplana micronesiana: d*, dorsal view; *e*, eyes enlarged. (Explanation on page 597.)

cular coat, forming a bulbous vagina. This is slanted almost horizontally forward. The vagina then narrows to an apparently sinuous duct but parts here were not as clear as desirable. This sinuous duct receives numerous cement glands; it gradually ascends and finally curves posteriorly. After receiving from below the common oviduct it descends posteriorly to terminate in a small pyriform Lang's vesicle.

The entire Eniwetok specimen (USNM 28670) was sectioned but the sections proved unsatisfactory. As far as it could be discerned the female apparatus resembled that of the Ifaluk specimen, having a bulbous vagina followed by an apparently sinuous glandular section of the vagina, but this again was not clear. The male apparatus could not be followed satisfactorily and was deficient in the same area as the Ifaluk specimen. One point was definite; the two gonopores are close together and the male antrum ascends immediately in front of the vagina. This may represent a geographic difference between the two specimens; or the two specimens may represent different species of *Stylochoplana*. The condition of the sexual apparatus of the Eniwetok specimen does not justify describing it as a distinct species, hence it is doubtfully assigned to *Stylochoplana minuta*.

Differential diagnosis: *Stylochoplana minuta* is dintinguished by the small size at sexual maturity, arrangement of the eyes in a single row on each side, bulbous vagina, and sinuous course of the glandular vagina.

Holotype: USNM 28642. Anterior part of the Ifaluk specimen as whole mount, postpharyngeal region as sagittal serial sections (one slide).

***Notoplana micronesiana*, new species**

Figures 2*d*,*e*; 3*a*

Material: One specimen washed from algae in the intertidal zone, Sept. 4, 1953, Ifaluk Atoll, near south end of Falarik Islet, Sta. 23–E–1.

General features: The worm is 18 mm. long, 3 mm. wide, of elongated slender shape with rounded anterior end, blunt posterior end (fig. 2*d*). Probably white in life, it was pale brown preserved. The eyes (fig. 2*e*) are arranged in a continuous band on each side and are not definitely delimited into cerebral and tentacular clusters. In the cleared specimen scarcely anything could be seen of internal structures. The pharynx was vaguely indicated as shown in figure 1*d*, but sexual structures were not detectable. However, the postpharyngeal region was removed and sectioned sagittally; it was found to contain fully developed copulatory apparatuses.

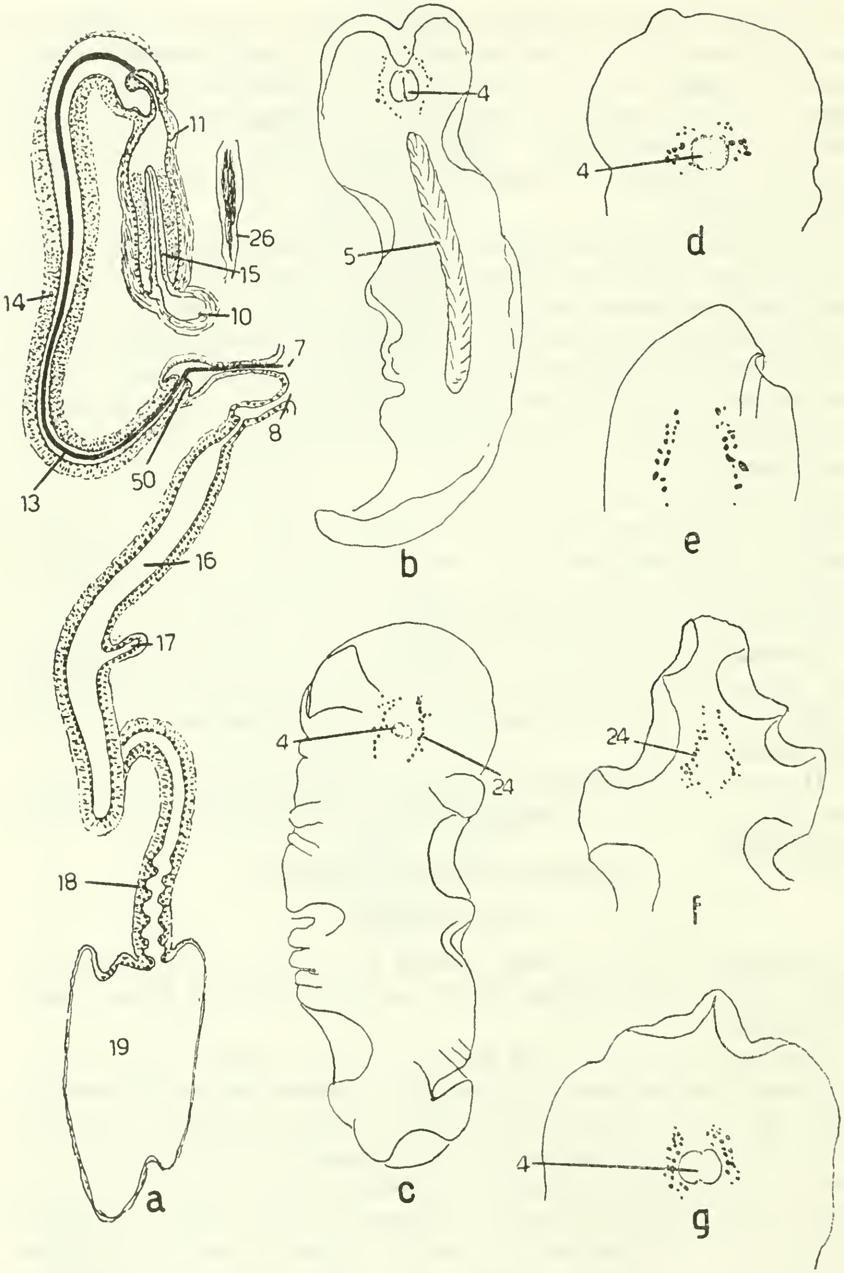

Figure 3.—*a, Notoplana micronesiana*, copulatory apparatuses, male apparatus above; *b*, juvenile leptoplanid from Ifaluk Atoll; *c*, juvenile leptoplanid from Majuro Atoll; *d–g*, juvenile leptoplanids from the Palau Islands. (Explanation on page 597.)

Copulatory apparatus: This is shown in sagittal view in figure 3*a*. The two gonopores are very close together. The male apparatus contains an excessively long penis stylet, represented as solid in the figure, although actually hollow. From the male gonopore the male antrum ascends dorsally as a tubular canal, widens slightly to accommodate a penis sheath, then curves slightly backward, continuing to ascend, and then turns anteriorly as a long narrow canal with a thick muscular investment. Anteriorly it gradually widens, then curves ventrally to a slightly widened chamber that houses the small penis papilla from which the very long stylet springs. The stylet occupies the whole of the very long male antrum and even protrudes from the gonopore. Extending posteriorly from the penis papilla in a horizontal plane is seen the oval prostatic vesicle into which the ejaculatory duct projects as diagnostic of the genus *Notoplana*. Proximally the prostatic vesicle is entered by a small oval seminal vesicle with the usual muscular wall.

The female apparatus is also long and tubular. The short tubular female antrum ascends from the female gonopore, then widens to a vagina that slants dorsally and posteriorly. It is lined by a cuboidal epithelium and has a good muscular investment. After receiving from below the common oviduct, the vagina continues unaltered as a long duct of Lang's vesicle that makes an S turn, then proceeds posteriorly to enter the oval, thin-walled Lang's vesicle of moderate size.

Differential diagnosis: Of the many species of *Notoplana* few are provided with a long penis stylet. The stylet of the present species seems to exceed that of all others in relative length. The eye arrangement and proximity of the gonopores also differentiate *Notoplana micronesiana* from other long-styletted species of the genus.

Holotype: USNM 28643, anterior part as whole mount, copulatory region as sagittal serial sections (one slide).

Euplana gigas (Schmarda, 1859)

Remarks: This is one of the most common and widely spread of Indo-West Pacific polyclads and is easily recognized by the characteristic color pattern, which has been excellently figured in color by Laidlaw (1902) and Kato (1934). This species was previously discussed (Hyman, 1955b), and hence comment here will be limited to distributional records. Four specimens (USNM 28644) were collected by D. H. Johnson on Oca Point, Guam, June 26, 1945. The largest of these was 90 mm. long, preserved, with the gonopores 15 mm. apart. Five specimens (USNM 28645–USNM 28647) were collected by Cadet Hand, July 2, 31, and Aug. 2, 1954, at Kapingamarangi Atoll, at the southern border of the Caroline Islands. These are new records for the species but there is little doubt that this polyclad is spread throughout the Indo-West Pacific from the coast of Africa to Japan and Polynesia.

Juvenile Leptoplanidae

FIGURE 3*b*–*g*

Many of the specimens in the material were juvenile leptoplanids, hence not identifiable. One specimen (USNM 28671), collected by Reish from algae on Majuro Atoll, Sta. E–57, Aug. 30, 1956, might possibly be *Stylochoplana minuta*, as judged by the eye arrangement (fig. 3*c*); this worm is 3 mm. long with 18 eyes on one side, 19 on the other. Most of the specimens collected at Ifaluk Atoll in the Caroline Islands were juvenile leptoplanids, apparently all of one species, that, judged by the eye arrangement, are probably either *Notoplana micronesiana* or *Stylochoplana minuta*. Apparently at the time of collecting, September–October 1953, some common leptoplanid of the atoll had been breeding. These baby leptoplanids were washed from algae in the intertidal zone at Stations 29–B–3, 32–F–5, 39–E–4, 40–F–3, 84–E–5, 85–G–2, 142–F–3, and 179–184–N–4. Figure 3*b* gives the general appearance of these young leptoplanids; this one came from Sta. 39–E–4 and has been returned to the U. S. National Museum as a whole mount (USNM 28677). The others (USNM 28678–USNM 28684) have been returned in the original vials.

There were five other juvenile leptoplanids (USNM 28672–28676) in the collection made by the Stanford team in the Palau Islands. As judged by the eye pattern, none of these is identical with *Notoplana palaoensis* Kato (1943), the only mature leptoplanid reported from the Palau Islands. USNM 28672, collected from Sta. 28, July 21, 1955, is 3 mm. long, pale or white, anteriorly expanded, with a few eyes arranged in tentacualr and cerebral clusters (fig. 3*d*). USNM 28673, from Sta. 47, July 28, 1955, is 2.3 mm. long, dark gray in color, of slender shape, with eyes in two longitudinal bands (fig. 3*e*). USNM 28674, from Sta. 60, Aug. 5, 1955, is 2.8 mm. long, of slender ruffled form, probably white, with eyes in two bands (fig. 3*f*). USNM 28675, taken Oct. 12, 1955, at Sta. 220, is 3.5 mm. long, pale, of broad, elongated form with eyes in two somewhat broad bands (fig. 3*g*); traces of incipient copulatory organs are present. The eye arrangement somewhat resembles that of the specimen from Sta. 47 (fig. 3*e*), but the difference in color precludes identity. USNM 28676, from Sta. 258, Nov. 2, 1955, appears definitely identical with the one from Sta. 60 (fig. 3*f*) and has not been figured; it is 4 mm. long, white, thin and ruffled. Tentacles appeared absent in all cases and the usual central elongated ruffled pharynx is present. All have been returned to the U. S. National Museum as whole mounts.

It is puzzling that the collections contain so many juvenile leptoplanids and so few adult ones. It further appears that a number of distinct species of Leptoplanidae must be present around the Palau Islands.

Family PLANOCERIDAE Lang, 1884

Aquaplana pacifica, new species

FIGURES 4*a*–*c*; 5*a*

MATERIAL: One specimen collected by the Stanford team at Sta. 220, Palau Islands, southeastern end of Koror Island in Oyster Pass, near east entrance of Iwayama Bay, Oct. 12, 1955.

GENERAL CHARACTERS: The specimen is of broadly oval form (fig. 4*a*), measuring 14 by 11 mm., and of a transparent texture but peppered with minute brown dots that are very abundant over the copulatory region but diminished over the pharyngeal area. There are two tentacles, contracted to rounded form, that contain no eyes but are also peppered with brown dots. The numerous eyes occur in paired tentacular clusters and in a loose cerebral group that is not very definitely paired (fig. 4*b*). From the central ruffled pharynx narrow intestinal branches radiate to the periphery, and a main intestinal branch extends anteriorly, subdividing into three. The uteri, stuffed with eggs, begin just behind the tentacles and curve posteriorly lateral to the pharynx, converging to the female copulatory apparatus. The copulatory apparatuses are found somewhat posterior to the pharynx, and because of the transparency of the animal show many details prior to sectioning (fig. 4*c*).

COPULATORY APPARATUS: The copulatory region was removed and sectioned sagittally, and the apparatuses are shown in sagittal view in figure 5*a*. All parts of the male apparatus are bound within the same muscular sheath (fig. 4*c*). The spermiducal vesicles (expanded sperm ducts) approach the male apparatus from behind, and at its sides acquire a thick coat of circular fibers, thus becoming spherical spermiducal bulbs. Their muscle fibers are continuous with those of the rest of the male apparatus (fig. 4*c*). Prostatic vesicle and cirrus sac form one continuous structure with a continuous muscle coat. The anterior end of this structure constitutes the prostatic vesicle, not demarcated from the cirrus sac. It has a thick muscular coat of fibers that mostly parallel its external contour and the relatively small pyriform cavity is lined by ridges of glandular epithelium, filled with eosinophilous granules. The prostatic duct continues posteriorly as the ejaculatory duct, centrally placed in the cirrus sac. This duct shortly receives the short common sperm duct into its ventral side (fig. 5*a*), formed by the union of the two sperm ducts.

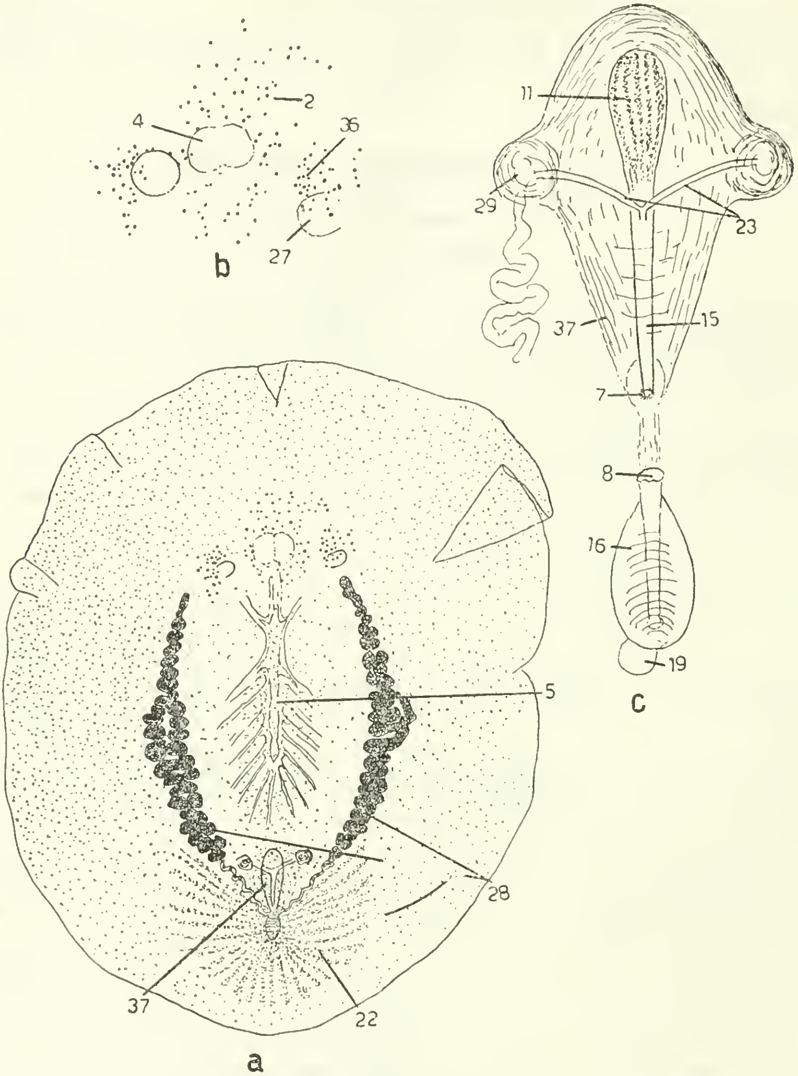

FIGURE 4.—*Aquaplana pacifica: a*, dorsal view; *b*, eyes enlarged; *c*, copulatory apparatuses as seen looking down on whole animal. (Explanation on page 597.)

These course separately from the spermiducal bulbs through the thick muscular wall of the cirrus sac. The cirrus sac is of elongated conical form, gradually narrowing to the male gonopore. Posteriorly its wall continues as a cirrus papilla, armed with a few teeth, that projects posteriorly beyond the male gonopore and is basally enclosed in a short male antrum. There is no other armature of the male apparatus except the teeth or thorns on the cirrus papilla.

The female gonopore, located shortly behind the male gonopore and almost reached by the protruding cirrus papilla, leads into a vertical female antrum from which the long vagina slants anteriorly, paralleling the cirrus sac, then curves backwards and descends towards the ventral body wall. The ascending part of the vagina is glandular, lined by a tall epithelium that receives the numerous cement glands. Shortly after curving backward, the vagina alters into a strongly muscular tube with a cuticularized lining. The thick muscular wall of interwoven muscle fibers pursuing a mostly circular course is well delimited from the surrounding mesenchyme. After turning downward, the vagina again alters its histological character, losing the definite muscular coat and becoming lined with a tall cellular epithelium. As it continues to descend, the vagina enlarges into a sac that receives into its anterior wall the common oviduct; it then narrows again as the duct of Lang's vesicle that makes an upward bend and terminates in a small oval Lang's vesicle (fig. 5*a*). A copulatory bursa is wanting.

Differential diagnosis: *Aquaplana pacifica* differs from the only other species of the genus, *A. oceanica* (Hyman) (1953b), in the lack of a copulatory bursa and the much smaller size of Lang's vesicle.

Holotype: USNM 28648, one whole mount with copulatory region removed, the latter as sagittal sections (three slides).

Remarks: There is good correspondence between the general and copulatory anatomy of the two species of *Aquaplana*. In *A. oceanica* the spermiducal bulbs and prostatic vesicle are not quite as closely incorporated with the cirrus sac as in *A. pacifica*. In both species the vagina is differentiated into glandular and muscular regions. The want of a copulatory bursa in *A. pacifica* seems to indicate that this structure is not as taxonomically important as previously supposed. Its lack in *A. pacifica* would certainly not warrant separating the latter into a distinct genus. The important character of the genus appears to be the cirrus papilla armed with thorns. In *A. oceanica* thorns are also present on the wall of the male antrum but these are wanting in *A. pacifica*.

***Paraplanocera fritillata*, new species**

Figures 5*b–d*; 6*a*

Material: One specimen taken by Reish from rocks on the reef flat at Eniwetok Atoll, Sta. E–123, Sept. 7, 1956.

General characters: The specimen (fig. 5*b*) is of broadly oval form, measuring 19 by 17 mm., of thin, transparent texture, with ruffled margins. The color is yellowish gray, slightly mottled with brown, and under magnification a cloud of black dots is seen over

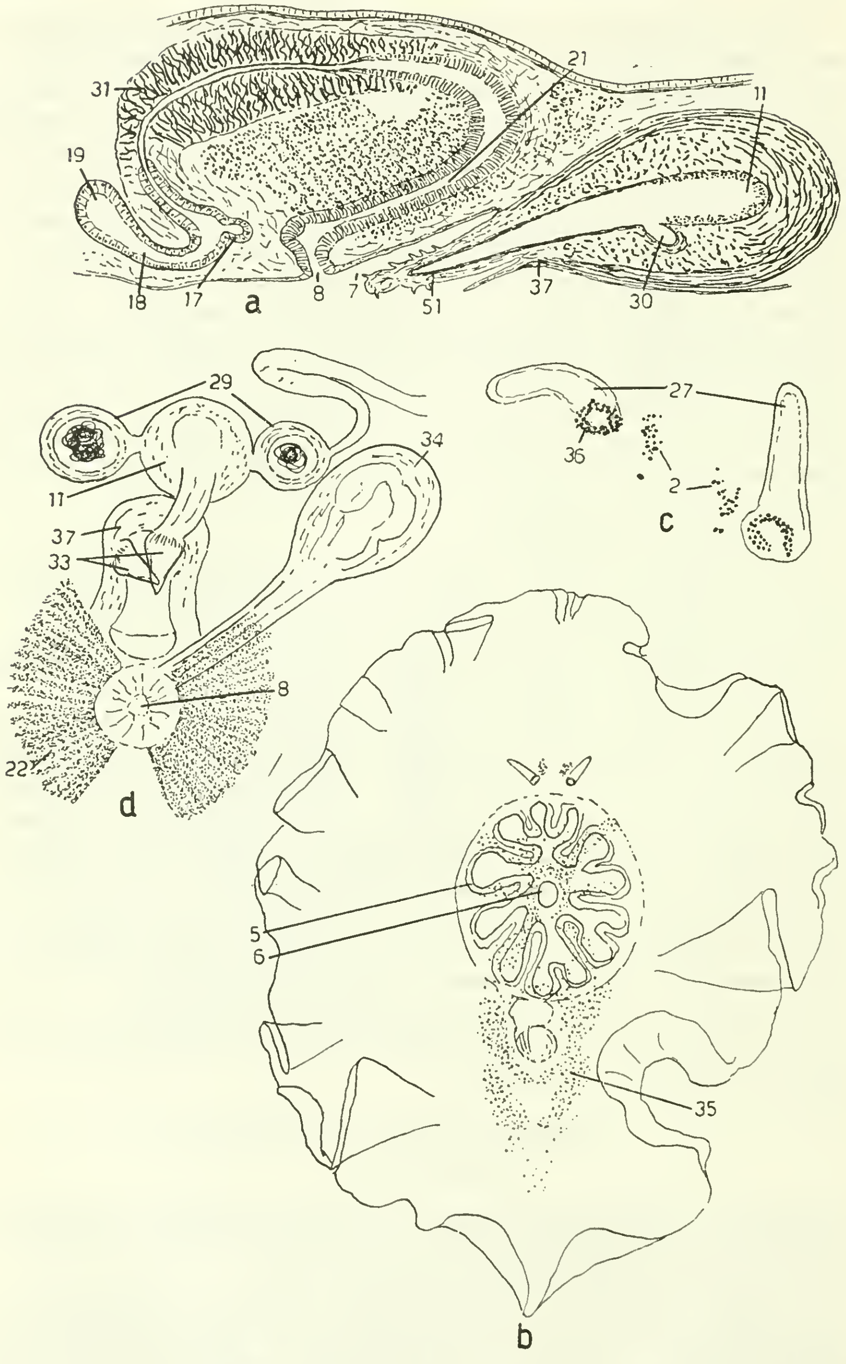

Figure 5.—*a*, *Aquaplana pacifica*, sagittal view of copulatory apparatuses, male apparatus to right; *b–d*, *Paraplanocera fritillata:* *b*, entire animal; *c*, eyes and tentacles enlarged; *d*, copulatory region as seen from ventral side in cleared animal. (Explanation on page 597.)

and around the central organs (pharynx, copulatory apparatuses). Sections show that these dots are located in the mesenchyme and are aggregations of minute black granules. Similar dots are recorded for *P. langii* (Laidlaw) (1902) and *P. rotumanensis* Laidlaw (1903a). There is a pair of elongated tentacles situated far back from the anterior margin. At the base of each tentacle is a circle of densely placed eyes and between the tentacles are two cerebral groups of eyes, of 20–25 eyes each (fig. 5*c*). The rounded ruffled pharynx with central mouth is medially located, slightly anterior to the body center. Behind it appears the copulatory apparatus, of which the main parts are easily seen because of the transparency of the body. There are seen (fig. 5*d*) the round spermiducal bulbs with thick muscular wall of circular fibers to either side of the prostatic vesicle, the cirrus sac with two large teeth, pyriform copulatory bursa extending anteriorly to one side of the male complex, and the vagina surrounded with a halo of cement glands. The copulatory region was removed and sectioned sagittally and the remainder of the worm mounted whole.

COPULATORY APPARATUS: A sagittal view of the apparatus appears in figure 6*a*. The rounded prostatic vesicle forms the anterior end of the male apparatus; it has a moderately thick wall of muscle fibers paralleling its external contour and a glandular interior composed of glandular folds projecting into the lumen and composed of eosinophilous granules. The two accessory prostatic vesicles or pockets found at the posterior side of the main vesicle and very definitely marked off in some species, notably *P. oligoglena*, are here poorly defined, although apparently present. A wide prostatic duct leaves the prostatic vesicle and receives at once a relatively long common sperm duct into its ventral side. The spermiducal bulbs as they approach the prostatic vesicle have a firm muscular coat of circular fibers that is much thicker on the side towards the vesicle and soon becomes incorporated into the muscular coat of the latter. Each spermiducal bulb then narrows to a sperm duct, still with a coat of circular fibers, that soon joins its fellow to produce the common sperm duct. The common sperm duct enters the prostatic duct from below just as the latter leaves the prostatic vesicle. The right spermiducal vesicle does not coil extensively in front of the bursa as it does in *P. oligoglena.*

The prostatic duct with ciliated epithelial lining, thin but muscular dorsal wall, and thicker muscular ventral wall, curves posteriorly above the anterior part of the cirrus sac and enters the dorsal wall of this sac at about its middle. The cirrus sac is an oval body with excessively thick muscular wall. The muscles run mostly at right angles to the external contours but actually a web of fibers is present. Into the lumen of the anterior part of the cirrus sac there projects a very large tooth covered with a cuticularized coat; at its base a small tooth is seen on each side but no other teeth were evident in the anterior part of the sac. At about the middle there is another similar large tooth with cuticularized surface and distal to this the lumen is lined with small teeth that increase in size distally to the beginning of the male antrum proper. The antrum is a tubular exit lined by a tall epithelium; its anterior wall forms a pair of glandular pouches that receive eosinophilous secretion. Prostatic duct and anterior part of the cirrus sac are surrounded by a so-called space that is filled with a vague bluish material in stained sections. It seems to be present in all members of the genus.

The female gonopore is well separated from the male pore. It leads into a short tubular female antrum from which the wider vagina with much folded walls ascends. Characteristic of the present species are two strongly marked cement pockets of the vagina, an anterior and a posterior one. Each receives a great cloud of cement glands. The posterior pocket is the larger of the two, although this is not evident in the median section, since it expands laterally, and receives the greater mass of cement glands. Dorsal to the entrance of these cement pockets, the vagina receives the copulatory bursa from in front, then proceeds dorsally and curves posteriorly above the posterior cement mass. At this point it receives separately the two oviducts (not shown in the figure), then descends as the duct of Lang's vesicle and opens into the relatively short Lang's vesicle. The female tract of these parts is lined by a cuboidal to tall epithelium and is rather muscular at first; the muscular investment declines towards Lang's vesicle which has scarcely any muscular fibers outside the epithelium.

The copulatory bursa, not further illustrated, is an extremely muscular pyriform sac that extends anteriorly from the vagina along the right side of the male apparatus to the level of the right spermiducal bulb. The immensely thick muscular wall of a web of muscle fibers gradually diminishes in thickness towards the blind end of the bursa and concomitantly the lumen, which does not seem to be lined by a definite epithelium, enlarges. At the proximal end of the bursa, the wall is relatively thin, although still muscular, and the lumen quite large. The wall is everywhere greatly folded into the lumen. The interior, especially proximally, contains a great mass, presumably sperm, but so dense this cannot be determined certainly.

Differential diagnosis: This is the ninth species to be assigned to the genus and the question of the validity of these species remains baffling. The matter of validity was discussed by Kato (1936), Prudhoe (1945), and Hyman (1953a); Prudhoe, especially, was inclined to reduce the number of species by throwing most into synonymy with *P. oligoglena*. But it now appears to me that insufficient attention has been paid to the available details about the species. In view of the unsatisfactory nature of some of the descriptions and the failure to mention certain points, especially the presence or absence of accessory prostatic vesicles and antral glands of the male apparatus, it seems to me we are not in a position to declare definitely that any one of the species is synonymous with any other.

I am reluctant to add another species to this complicated situation but I am not able to identify my form with any of the previously described species. The present specimen resembles *P. oligoglena* in color and in the presence of two very large teeth in the cirrus sac but differs in the fewer cerebral eyes, the cloud of black dots middorsally, the entrance of the common sperm duct into the prostatic duct, not into the prostatic vesicle, the poor differentiation of the two accessory prostatic vesicles, the extreme differentiation of the two cement pouches, and the shorter Lang's vesicle. The conspicuous coils of the right spermiducal vesicle in front of the bursa, typical of *P. oligoglena*, are wanting.

The cloud of black dots in the middorsal region appears to be a very definite character. It can scarcely be overlooked as it is noticeable at once on low magnification. These dots, as already mentioned, are in the mesenchyme. They are not the same as the dots in the intestinal branches mentioned by several authors. It appears that such dots are recorded only for *P. langi* (Laidlaw) (1902) and *P. rotumanensis* Laidlaw (1903a). *P. langi* is described as white, with "two" cerebral eyes, cylindrical tubular cirrus sac lined throughout with spines, short wide prostatic duct receiving the common sperm duct, and two "folds" in the cirrus sac. If in fact *P. langi* regularly has only two cerebral eyes this would differentiate it from all other species of the genus. The number of cerebral eyes is of course somewhat variable among individuals of the same species but not to that extent. It is not clear just what is meant by the folds in the cirrus sac, but apparently they are not teeth. The description of *P. rotumanensis* is even less satisfactory. The cerebral eyes are rather numerous, divided into two groups on each side, the intestine gives off dorsal diverticula containing brown spots, the prostatic duct enters the cirrus sac on the VENTRAL side, the lumen of the cirrus sac is lined throughout with spines, two folds like those of *P. langi* are present, the common sperm duct enters the prostatic duct, and Lang's vesible is rather large and long. It appears impossible to reconcile *P. fritillata* with either of these descriptions. It has a fair number of cerebral eyes, scarcely divided into two groups on each side, the cirrus sac is thick and oval, not tubular, the prostatic duct is rather long and enters the cirrus sac in the middle of its DORSAL surface, the lumen of the cirrus sac rather lacks spines anteriorly, the two very large teeth are definitely not folds, and Lang's vesicle is rather short. The descriptions of *P. langi* and *P. rotumanensis* do not mention the presence of accessory prostatic vesicles or male antral glands but these structures cannot be presumed to be absent. *P. fritillata* appears to differ from previously described species of the genus in the very strongly differentiated cement pockets, one from the anterior, the other from the posterior side of the vagina. There is no pocket associated with the entrance of the bursa into the vagina as described for *P. misakiensis* Yeri and Kaburaki (1918). These cement pockets, the cloud of black dots, the poor differentiation of the accessory prostatic vesicles, the lack of spination of the anterior part of the cirrus sac, and the short Lang's vesicle may be taken to characterize *P. fritillata.*

Holotype: USNM 28649, one whole mount with copulatory region removed and sectioned (four slides).

Family Callioplanidae Hyman, 1953

Asolenia, new genus

Definition: Callioplanidae without Lang's vesicle; reduced female tract enters the roof of the male antrum; male copulatory apparatus as in *Callioplana.* Type species: *Asolenia deilogyna.*

Asolenia deilogyna, new species

Figure 6*b*,*c*

Material: One specimen collected from algae at the Palau Islands by the Stanford team July 22, 1955, Sta. 30.

General characters: This is a very small worm, 2.5 mm. long, colorless, without tentacles, of a moderately elongated shape (fig. 6*b*). The eyes are rather few in number, arranged in an arc of about a dozen eyes on each side (fig. 6*b*); in this arc, four larger eyes on each side probably represent tentacular eyes. The central ruffled pharynx is encircled anteriorly by the confluent uteri, filled with eggs, and ovaries are seen scattered in lateral regions. At first the specimen was thought to be a juvenile leptoplanid but then the uteri were noticed, evidencing sexual maturity.

Copulatory apparatus: Because of its small size the entire worm was sectioned sagittally. Examination of the sections revealed surprisingly a member of the family Callioplanidae. A sagittal view of the copulatory complex is given in figure 6*c*. The male complex is well developed and clearly shown on the sections. The oval free prostatic vesicle with muscular wall of moderate thickness and glandular eosinophilous interior is in contact on its ventral side with an elongated, oval seminal vesicle with muscular wall. The duct of the

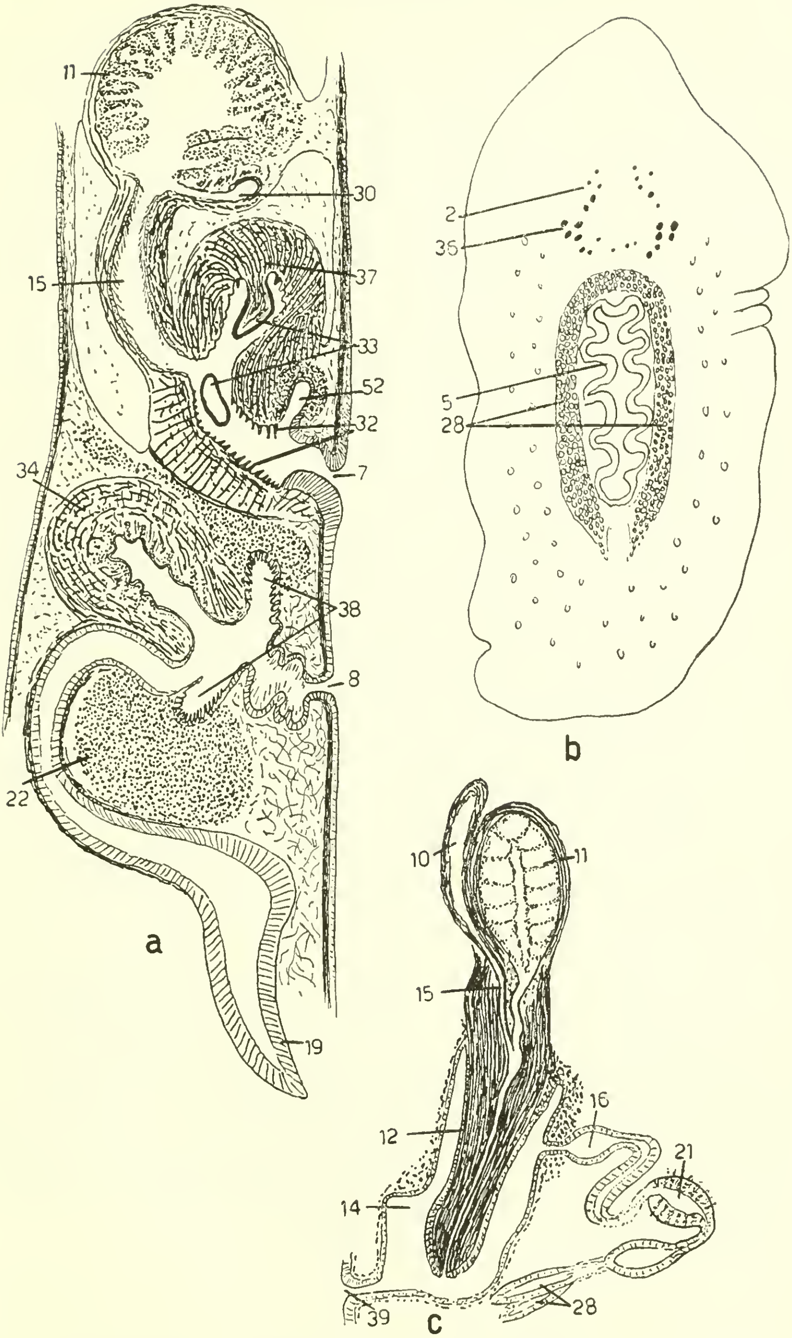

Figure 6.—*a*, *Paraplanocera fritillata*, sagittal view of copulatory complex, male above. *b*, *c*, *Asolenia deilogyna:* *b*, entire animal; *c*, sagittal view of copulatory complex, male above. (Explanation on page 597.)

prostatic vesicle and the ejaculatory duct of the seminal vesicle meet and unite in the proximal part of the penis papilla and the common duct so formed extends along the center of the penis papilla to its tip. The penis papilla is an elongated structure with a thick muscular wall covered with an epithelium that is thickened at the penis tip and proximally becomes continuous with the lining epithelium of the rather spacious male antrum, which exits ventrally by a narrow tubular passage. Under the epithelium of the male antrum is found a considerable muscular investment.

The female apparatus is very curious, much reduced, and springing from the roof of the male antrum, something quite unusual in polyclads. This condition could hardly result from contraction on preservation. The female antrum as it leaves the male antrum is a narrow tube encircled by a thick muscular sphincter. The parts of the female tract are unfortunately poorly preserved in the sections. The antrum widens to an ascending vagina that then descends as a tube with a wall of cuboidal cells. This seems to make a curve and ascend but preservation was poor here. There next comes an oval glandular part of the vagina, definitely seen, entered by cement glands. A narrowed tube leaves this and descends, then widening to a sac that seems to receive two ducts; the connection with these ducts could not be followed although very probably it is as shown in the figure. These two ducts descend behind the male antrum and then curve anteriorly. They seem to be the uteri and could be followed, although not too clearly, to the rear ends of the egg-filled uteri shown in figure 6*b*. It is possible that the two ducts are the double Lang's vesicle characteristic of the genus *Callioplana*, but in that case the uteri would enter the vagina beyond the glandular region and no indication of ducts here could be found.

Holotype: USNM 28686, one set of sagittal sections (one slide).

Remarks: Since the female tract was unclear, it was difficult to make a decision about this worm. If the two ducts discussed above are Lang's vesicles rather than uteri, the specimen could be fitted into the genus *Callioplana*, with which the male system is in accord although the lack of tentacles and the characters of the female system disagree with the two known species of that genus: *C. marginata* (Stimpson) (1857) and *evelinae* (Marcus) (1954). The matter cannot be decided until better material is obtained.

Section EMPROSTHOMMATA

Family CESTOPLANIDAE

Juvenile Cestoplanid

REMARKS: There was present in the material from Ifaluk Atoll one very juvenile cestoplanid, collected Oct. 1, 1953, from the reef ridge at the north end of Falarik. A drawing was not made. It may be recalled that a juvenile cestoplanid was previously reported from the same general area (Hyman, 1955b), but in view of the immaturity of both specimens a specific comparison is impossible. The specimen is deposited in the U. S. National Museum.

Suborder COTYLEA

Family PSEUDOCERIDAE Lang, 1884

Genus *Pseudoceros* Lang, 1884

REMARKS: The genus *Pseudoceros* is one of the largest polyclad genera, comprising at present over 100 valid species. The genus is easily recognized by the combination of smooth dorsal surface, tentacles as upfolds of the anterior margin, and ruffled pharynx. The species, however, are distinguishable mainly on shape and color pattern and the one is distorted and the other often totally lost in preserved specimens. Hence the identification of preserved specimens usually offers formidable difficulty. Whether the male apparatus is single or paired is a useful character and details of the male copulatory apparatus may be of value in specific diagnoses. It now appears that the shape of the pharynx may be decisive. In most species the pharynx has a compact outline but several species are now known in which the pharynx takes what I have termed the butterfly shape, putting out lateral lobulations that increase in length in the anteroposterior direction as in figure 10, c.

In 1950 Marcus published a useful list of the described species of the genus. In the thought of increasing the usefulness of this list I here add some old species overlooked by Marcus and the species described since that date: *fulminatus* (Stimpson) (1855), *guttatomarginatus* (Stimpson) (1855), *interruptus* (Stimpson) (1855), *albicornis* (Stimpson) (1857), *coccineus* (Stimpson) (1857), *japonicus* (Stimpson) (1857), *niger* (Stimpson) (1857), *affinis* (Kelaart) (1858), *atraviridis* (Kelaart) (1858), *dulcis* (Kelaart) (1858), *fuscus* (Kelaart) (1858), *purpureus* (Kelaart) (1858), *luteus* (Plehn) (1897), *izuensis* Kato (1944), *nipponicus* Kato (1944), *evelinae* Marcus (1950), *mopsus* Marcus (1952), *bajae* Hyman (1953a), *canadensis* Hyman (1953a), *mexicanus* Hyman (1953a), *montereyensis* Hyman (1953a), *coralliferus* Hyman (1954), *micronesianus* Hyman (1953b), and *texanus* Hyman (1955c).

I am of the opinion that *Pseudoceros gratus* Kato (1937, also 1943) is identical with *Eurylepta striata* Schmarda (1859). To be sure, the former is described as white with black stripes and the latter as buff with dark brown stripes but the identity of size, shape, and color pattern outweigh such slight color differences which can be caused by ingested food. As the name *striata* is preoccupied by *Eurylepta striata* Kelaart (1858), it appears that Kato's name *gratus* is valid. Therefore the proposal of *strigosus* by Marcus (1950) to cover the Kelaart-Schmarda homonymy is unnecessary.

The genus is characteristic of tropical and subtropical waters and appears to center in the Indo-West Pacific area.

***Pseudoceros perviolaceus*, new name**

Eurylepta violacea Schmarda, 1859, p. 27.
Pseudoceros violaceus, Stummer-Traunfels, 1933, p. 3544.
Not *Planaria violacea* Kelaart, 1858, p. 135.

REMARKS: A specimen referred to this species that was collected in the Palau Islands, July 22, 1954, was sent to the American Museum of Natural History in a lot of miscellaneous material. No other data are available. The specimen conforms satisfactorily to the original description and figure and with Stummer-Traunfels' statements made from Schmarda's specimen. The original specimen from Ceylon measured 60 by 40 mm., the present one 25 by 13, but presumably Schmarda's measurements are from life. The present specimen retains the shape depicted by Schmarda, that is, is broad across the anterior end and narrows regularly toward the posterior end. There is but a single male apparatus as discovered by Stummer-Traunfels. The violet or purple color had dissolved badly in the alcohol which was stained a reddish purple, leaving the animal of a uniform medium brown color.

It was necessary to create a new specific name for Schmarda's species as the name *violacea* is preoccupied by *Planaria violacea* Kelaart, which is a *Pseudoceros* but definitely not identical with Schmarda's species for it has a broadly oval shape and a yellow margin and middorsal stripe. It appears improbable that Schmarda's species can be a variant of *Pseudoceros velutinus* as supposed by Lang (1884, p. 540), for the shape of this is quite different although it, too, has but a single male apparatus.

The specimen is retained in the invertebrate section of the American Museum of Natural History.

***Pseudoceros bedfordi* Laidlaw, 1903**

REMARKS: This large and handsome pseudocerid is easily recognized by the distinctive color pattern, accurately depicted by Bock

(1913) and Kato (1943). The present specimen (USNM 28650)[2] was found swimming near the reef at Ifaluk Atoll, Aug. 12, 1953. Alive it was stated to be at least 100 mm. long, hence is the largest on record; preserved it measured 35 by 36 mm., having contracted strongly to a rounded shape whereas the natural shape is an elongated oval. This species was reported by Kato (1943) from the Palau Islands where it was stated to be common although surprisingly not recovered in the present material from these islands. It is also recorded from Singapore, the Philippines, and Heron Island in the Great Barrier Reef and is evidently widely spread in the western tropical and subtropical Pacific.

Pseudoceros izuensis Kato, 1944

FIGURE 7*a–c*

REMARKS: One specimen was taken on a reef in the Palau Islands by the Stanford team, Aug. 8, 1955, Sta. 69, lagoon margin of reef southeast of Malakal Pass. As the original description is brief, an expanded account of the present specimen appears desirable, especially as there is some slight doubt of its identity with Kato's species.

The preserved specimen (USNM 28651) measures 22 by 16 mm. and is of broadly oval shape and thin consistency (fig. 7*a*). Kato gave the length, preserved, as 20 by 13 mm., but 60 by 28 in life. The tentacles as sketched by Bayer in life appear in figure 7*b*; their appearance in the preserved animal is shown in figure 7*c*. The ruffled pharynx had ruptured through the ventral surface. The color in life as described by F. M. Bayer, who also took a color photograph, was pale green above mottled with white and dotted with black dots, with a median ridge of sepia brown laced with white. The tentacles in life (fig. 7*b*) are sepia brown with white tips and white spots. The body is encircled by a marginal band of olive green composed of radial streaks. Preserved, the animal appears light gray dotted with black dots with a dark margin and a dark middorsal band laced with white. The radial streaks composing the marginal band are still detectable in the preserved specimen. Figure 7*a* attempts to depict the color pattern. The colors agree well with Kato's description except for the tentacles which he described as purplish and the absence of black at the extreme outer margin.

Behind the tentacles is seen the bilobed cluster of cerebral eyes (fig. 7*c*). This disagrees with Kato's statement that the eyes form a single cluster although his figure indicates a slight bilobulation. Kato figured the tentacular eyes, not well discernible in the present specimen.

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[2] A photograph, in color, of this specimen was published in National Geographic Magazine, vol. 109, No. 4, p. 557, April 1956.

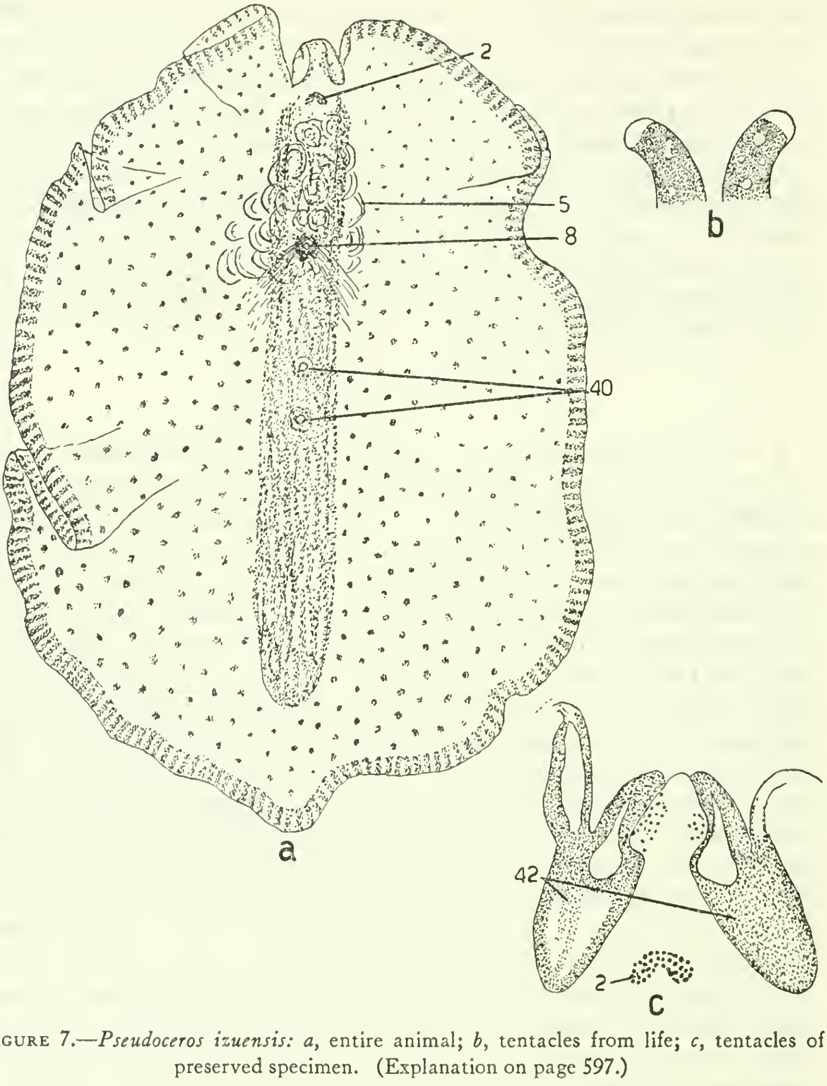

Figure 7.—*Pseudoceros izuensis: a*, entire animal; *b*, tentacles from life; *c*, tentacles of preserved specimen. (Explanation on page 597.)

The specimen is sexually mature but because of the rupture of the pharynx, the number of male pores could not be ascertained, although two are probably present. Kato stated a paired condition of the male apparatus. At the posterior end of the pharynx the female gonopore with accompanying cement glands is obvious (fig. 7*a*). The specimen has two suckers, one behind the other, as shown in figure 7*a*, but this is presumably an anomaly. A central position of the sucker is indicated by Kato.

The small differences mentioned above do not seem adequate grounds for separating the present specimen from Kato's species. *Pseudoceros izuensis* shows considerable resemblance in color pattern to *P. viridis* (Kelaart) (1858), Ceylon, which according to the description and colored figure in Collingwood (1876) also is green with brown tentacles, a brown middorsal stripe, and a brown streaky margin; but the dorsal surface is splotched with brown rather than dotted with black. Contrary to Lang (1884, p. 567), I think *viridis* (Schmarda) (1859) is not identical with *viridis* (Kelaart) as the color patterns of the two species appear somewhat different. It therefore is necessary to rename Schmarda's species, and I propose *virescens*.

***Pseudoceros habroptilus*, new species**

FIGURE 8

MATERIAL: One specimen taken by the Templeton Crocker Expedition, No. 1014, June 5, 1933, at Vanikoro Island, in the Solomons.

GENERAL CHARACTERS: The worm was badly crumpled and the posterior part could not be straightened. After flattening as much as possible the worm appeared as in figure 8. It measures 10 by 6 mm. and is probably of elongated oval form. At the anterior end appear the usual tentacular upfolds of which one is well preserved while the other is contracted and distorted. The tentacular eyes were poorly discernible; the single oval cerebral cluster is shown in the figure. The black-and-white color pattern is pretty and distinctive. The worm is white with a narrow, very black border that also edges the tentacular folds. Paralleling the margin is a wider band of grayish black hue and centrally there is a paired band of similar width and color. The two median bands converge anteriorly and fuse just behind the cerebral eyes. The black bands could not be followed posteriorly because of damage and crumpling here but the black margin obviously encircles the entire worm. The pharynx had probably been shed as rupture was evident ventrally at the appropriate place. The sucker was not clearly evident and is shown conjecturally in figure 8. The worm is juvenile without any traces of the reproductive system.

DIFFERENTIAL DIAGNOSIS: The color pattern is sufficiently distinctive.

HOLOTYPE: USNM 28652, the worm mounted whole.

***Pseudoceros caeruleocinctus*, new species**

FIGURE 9*a*

MATERIAL: The single specimen was taken by the Stanford team at the Palau Islands, Sta. 77, Aug. 10, 1955, crawling on clean sand in a shallow bay on the south shore of Auluptagel Island.

Figure 8.—*Pseudoceros habroptilus*, entire animal. (Explanation on page 597.)

General characters: The preserved worm is of oblong shape, 20 mm. long by 12 mm. wide. The tentacular foldings are prominent (fig. 9*a*), but because of the black color the eyes could not be seen in the cleared worm. The color is described by the collector as velvety black with a narrow, brilliant blue border. Some trace of the blue border remains in the preserved worm. The pharynx was not detectable. There is a single male apparatus with the male pore located 5 mm. from the anterior end. The female pore occurs close behind the male pore. The sucker is located at about the body middle, 10 mm. from the anterior margin.

Differential diagnosis: The blue border distinguishes this species from other black species with a colored border. This pattern, black with a narrow border of a bright contrasting color, is common among species of *Pseudoceros*, but usually the border is red, orange, or yellow, and I know of no previously described species with a blue border.

Holotype: USNM 28653, in alcohol.

***Pseudoceros ferrugineus*, new species**

Figure 9*b,c*

Material: The single specimen was taken by the Stanford team at Sta. 236a, in Iwayama Bay, Palau Islands, Oct. 20, 1955, crawling in about a meter of water on the rocky shelf of the east end of Koror Island, in Oyster Pass.

General characters: The worm is of elongated oval shape (fig. 9*b*), measuring 18 mm. in length by 11 mm. in width, preserved. The tentacular foldings appear slightly developed, both in the preserved worm (fig. 9*c*), and on the color photograph of the live worm. The brilliant coloring in life is preserved on the photograph taken by F. M. Bayer, but, alas, the preserved worm is a dull grayish brown. In life the general color is a bright rusty red blending into a narrow margin of brilliant orange. The dorsal surface is liberally flecked with white on the rusty background and here and there these flecks fuse to form nebulous patches of clear white or tinged with pink in places. The white flecks diminish towards the margin where the rusty red background is much more in evidence. The bright orange marginal line is free from spots. There is some indication of a narrow middorsal line of pale rust that fades away posteriorly.

In the cleared worm (fig. 9*b*) there could be seen the slightly bilobed cluster of cerebral eyes (fig. 9*c*), the ruffled pharynx having the butterfly shape that I have noticed in some species of *Pseudoceros*, the pair of male pores in the concavity of the last lobulations of the pharynx, the female pore close behind the male pores, and the sucker slightly behind the middle, about 10 mm. from the anterior end.

Differential diagnosis: The color pattern is distinctive.

Holotype: USNM 28654, in alcohol.

***Pseudoceros ater*, new species**

Figure 9*d*

Material: The single specimen was taken by the Stanford team on Raeldil reef, Palau Islands, Sta. 254, Oct. 27, 1955. It was collected at night with a light on the outer reef flat among branching corals.

General characters: This is a small worm, measuring 9 by 7 mm. preserved, although evidently somewhat contracted, hence longer in

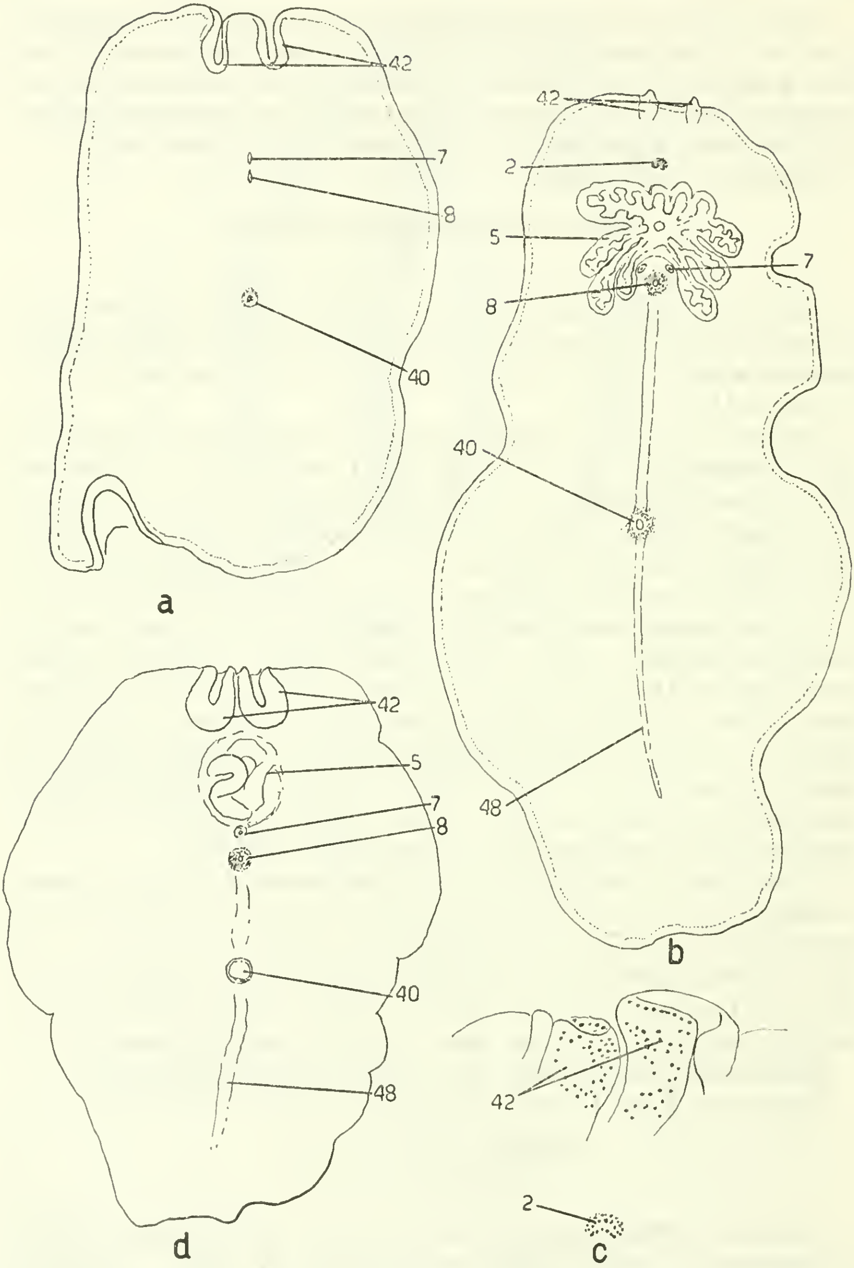

Figure 9.—*a*, *Pseudoceros caeruleocinctus*, entire animal. *b*, *c*, *P. ferrugineus:* *b*, entire animal; *c*, tentacles enlarged. *d*, *P. ater*. (Explanation on page 597.)

life. The form is an elongated oval (fig. 9*d*). The tentacular upfoldings are well preserved. Behind them is seen the small, compact ruffled pharynx of a few folds, and directly behind this occurs the single male gonopore, followed by the female pore. The sucker is situated somewhat posterior to the middle of the worm. Despite its small size the worm was fully mature and laid a small globular egg mass during the night in the jar in which it had been placed. The color is a uniform very dark grayish black, or practically black, without any markings. Because of the black color, eyes could not be seen.

DIFFERENTIAL DIAGNOSIS: There does not seem to be any previously described species of *Pseudoceros* that is small and uniformly of a dull black coloration. *Pseudoceros velutinus* (Blanchard) (1847) is uniformly black but the black is of a velvety texture and tinged with blue or violet; this species is further quite large, being still not fully mature at a length of 50 mm. *Pseudoceros bajae* Hyman (1953a) is also quite large, with a pair of male apparatuses.

HOLOTYPE: USNM 28655, in alcohol.

***Pseudoceros fulvogriseus*, new species**

FIGURE 10*a*,*b*

MATERIAL: One specimen was taken by the Stanford team in Geruherugairu Pass, Iwayama Bay, Palau Islands, Sta. 85, Aug. 12, 1955.

GENERAL CHARACTERS: The worm is a large, elongated species, 50 mm. long, preserved, 20 mm. across the widest part. The extensive ruffling of the margins indicates a much greater length when crawling, extended. The worm appears widest across the middle and tapers from this to the rounded anterior end, with typical tentacular foldings, and posteriorly to the pointed tail (fig. 10*a*). The shape is unusually elongated for the genus. An enlarged view of the tentacular foldings is shown in figure 10*b*, which also gives the eye distribution. Shortly behind the tentacles is found the group of cerebral eyes, forming a single large rounded cluster. Behind the cerebral eye cluster is seen the compact ruffled pharynx, surprisingly small for the size of the worm. Posterior to the pharynx are the two male pores, unusually close together, located 10 mm. from the anterior end. They are followed by the female pore, 13 mm. from the anterior end. The sucker is located at about the middle, 25 mm. from the anterior end. The worm appeared in breeding condition for the branched, anastomosing uterus (shown on one side only in figure 10*a*) was very evident in the cleared specimen.

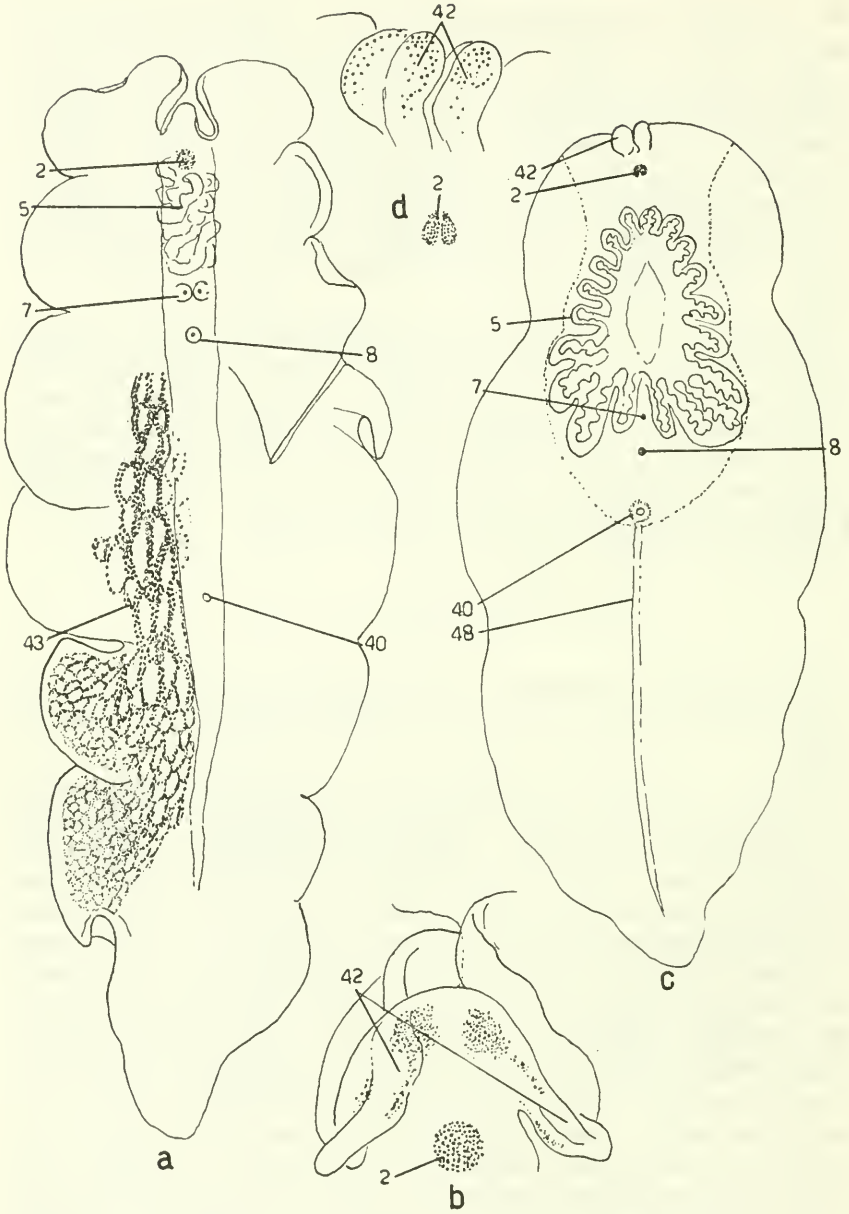

Figure 10.—*a, b, Pseudoceros fulvogriseus: a,* entire animal; *b,* tentacles enlarged. *c, d, P. fuscogriseus: c,* entire animal; *d,* tentacles enlarged. (Explanation on page 597.)

The preserved worm is of a uniform medium gray color, marked with dark reticulations, which probably actually are the uterine anastomoses. A color photograph taken by F. M. Bayer shows that in life the color is light gray flushed with yellowish brown. Along the center of the median ridge there runs a narrow light line flanked on each side by yellowish brown. The yellowish brown color deepens near the margin which is edged by a very narrow light line. The tentacles appear brown edged with a light margin. There is some suspicion in my mind that the tawny brown color may be caused, at least in part, by the presence of ripe eggs in the interior.

Differential diagnosis: The worm is characterized by the large size, elongated shape, small compact pharynx, and color pattern.

Holotype: USNM 28656, in alcohol.

***Pseudoceros fuscogriseus*, new species**

Figure 10*c*,*d*

Material: Two specimens were collected by the Stanford team in eel grass in the channel between Peliliu and Ngedebus, Palau Islands, Sta. 37, July 25, 1955.

General characters: The worms are of moderate size and general oval form, tapering posteriorly to a pointed tail (fig. 10*c*). The larger specimen measured, preserved, 23 by 10 mm., the smaller one, 16 by 8 mm. Both worms were bent in the pharyngeal region and ruptured there when straightened out, hence it did not appear profitable to section the copulatory region of one of them as this would probably be involved in the rupture. The anterior end of the larger specimen while cleared is shown in figure 10*d*. The tentacles, much distorted by preservation, are provided with numerous eyes and well behind them is seen the group of cerebral eyes, consisting of two oval clusters. The relatively large ruffled pharynx has the butterfly shape already mentioned in connection with *P. ferrugineus.* The single male pore is embraced by the posterior pharyngeal folds and shortly behind it is seen the female gonopore. The sucker of the larger worm is located at about 12 mm. from the anterior end. The usual middorsal ridge seen in pseudocerids is indistinct here. The main intestine could be seen in the posterior part of the worm.

Unfortunately, no information is available about the color in life but probably it was the same as in the preserved worms. They are dusky grayish brown in color with the anterior central part of a somewhat lighter shade. The extent of the light region is indicated by the dotted line in figure 10*c*. The line passes along the edge of the pharynx, slightly behind the sucker, and diverges at the anterior margin. The boundary between the lighter and darker shades of grayish brown is quite sharp.

Differential diagnosis: This species lacks very definite characteristics but the combination of paired cerebral eye clusters, large ruffled pharynx of the butterfly type, single male gonopore, and coloration should afford recognition.

HOLOTYPE: The larger specimen, USNM 28657.

Pseudoceros tristriatus, new species

FIGURE 11*a*

Pseudoceros concinnus, Stummer-Traunfels, 1933, p. 3565, fig. 9 on color pl.
Not *Proceros concinnus* Collingwood, 1876, p. 90, fig. 4, pl. 17.

MATERIAL: A single specimen was taken from beneath rocks on the seaward shore of Ella Islet, Ifaluk Atoll, western Carolines, Sept. 20, 1953, by F. M. Bayer under the auspices of the Pacific Science Board Atoll Research Program.

GENERAL CHARACTERS: The preserved worm (fig. 11*a*) is of oval form, measuring 12 by 5.5 mm., but a color photograph taken by F. M. Bayer shows that it is more elongated in life, about 4 times as long as broad. The preserved worm is entirely black but in life it is light blue with three longitudinal orange stripes. These stripes appear faintly bordered with black and extend from shortly behind the tentacles almost to the posterior end. The two lateral stripes are confluent posteriorly behind the median stripe. In the preserved worm the tentacular folds are fairly well retained and a few eyes can be seen upon them. Behind their bases is a rounded cluster of cerebral eyes but the eye arrangement could not be satisfactorily ascertained because of the dense black color of the preserved worm. The pharynx is of the butterfly type, that is, with pronounced lateral lobes increasing in length posteriorly where they slant backwards. Behind the pharynx the main intestine is conspicuous in the cleared worm, giving off numerous side branches that enter a dense black network of intestinal branches spread throughout the body. The sucker is located about 5 mm. from the anterior end in the preserved specimen. The worm is juvenile, being devoid of any traces of the reproductive system.

HOLOTYPE: USNM 28659, one whole mount.

REMARKS: Despite the immaturity of the specimen, the very distinctive color pattern justifies giving it a name. I believe this specimen is identical with the one figured in Stummer-Traunfels (1933, fig. 9 on col. pl. following p. 3596), which he identified as *Pseudoceros concinnus* (Collingwood). I believe this identification is erroneous, for Collingwood's colored figure gives an entirely different color pattern: cream with a blue border and blue middorsal stripe. I previously called attention to Stummer-Traunfels' error when I described as *P. concinnus* specimens from New Guinea (Hyman, 1954). Stummer-Traunfels' colored figure that I regard as identical with the

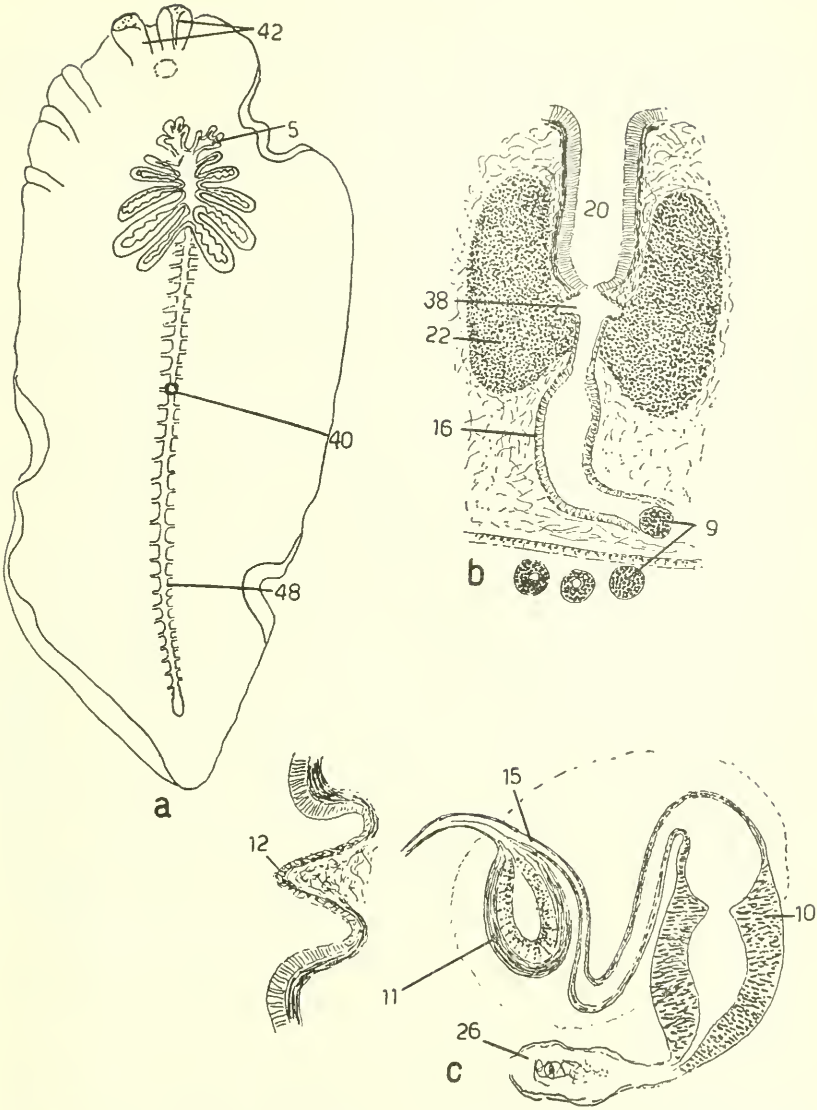

FIGURE 11.—*a, Pseudoceros tristriatus. b, c, Nymphozoon bayeri: b,* female copulatory apparatus, sagittal view; *c,* sagittal view of male copulatory apparatus. (Explanation on page 597.)

present species differs from it only in that the lateral orange stripes do not reach as far posteriorly, hence are not confluent behind the median stripe. This appears an insignificant difference. Stummer-Traunfels' specimen was part of the Semper material collected in the Philippines and the Palau Islands and not yet published; the colored figure was made from life by Mrs. Semper.

Nymphozoon, new genus

Definition: Pseudoceridae with multiple female apparatuses, arranged in a midventral longitudinal row; sucker wanting; otherwise as in *Pseudoceros*.

Type species: *Nymphozoon bayeri*, new species.

Nymphozoon bayeri, new species

Figures 11*b*,*c*; 12*a*,*b*

Material: Two specimens were taken by the Stanford team, one on a reef flat at Iwayama Bay, Palau Islands, Sta. 133, Aug. 28, 1955; the other on shallow coral sand and eel grass in the same region, Sta. 85a, Oct. 29, 1955.

General characters: This is a very large, handsome, black-and-white pseudocerid of delicate consistency. The larger specimen is 70 mm. long by 55 mm. wide, preserved, the smaller one 50 mm. by 30 mm. From the ruffling of the margins one may surmise that a considerably greater length may be attained in life. A photograph of the smaller specimen in life shows it to have been about 75 mm. long. The shape is broadly oval tapering to a somewhat pointed posterior end (fig. 12*a*); anteriorly there are present the usual tentacular folds. Figure 12*a* attempts to depict the striking color pattern. There is a narrow, very black, sharply delimited band along the margin that also edges the tentacular folds. Medially there is a moderately broad black longitudinal band that tapers to a point behind the tentacular folds and narrows posteriorly, but it could not be followed completely here because of damage. Between the median band and the margin there is present on each side a broad lateral band of grayish black hue that also could not be followed to the posterior end. The remainder of the animal is pure white. The large ruffled pharynx with central mouth is drawn in figure 12*b*. The smaller specimen is definitely devoid of any indication of the reproductive system but the larger specimen is fully mature. As shown in figure 12*b*, there is a pair of male pores behind the pharynx and this is succeeded by a midventral longitudinal row of eight pores, somewhat unevenly spaced. The nature of these pores could not be ascertained without sections and these showed that they are female gonopores. A sucker is definitely wanting. Bayer took a clear kodachrome of the smaller specimen in motion viewed from the ventral surface; the lack of a sucker is at once noticeable.

Copulatory apparatus: It was unfortunately necessary to remove the anterior median part of the larger specimen for sectioning, as the nature of the row of midventral pores could not be determined otherwise. The sections showed the details of the male apparatuses and

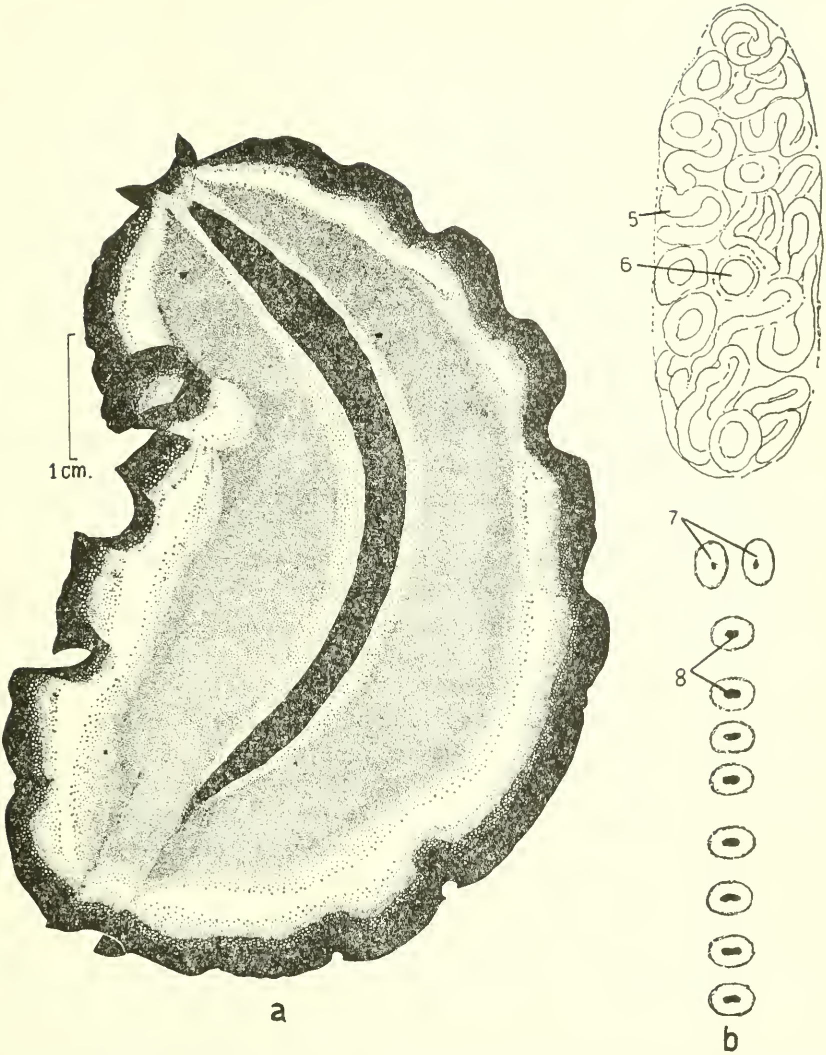

Figure 12.—*Nymphozoon bayeri: a*, entire animal drawn from a photograph of the living specimen by Mrs. Patricia Isham; *b*, anterior central region cleared specimen, showing pharynx and gonopores. (Explanation on page 597.)

of the row of eight female apparatuses. The sagittal plane of the sections is not very favorable for the study of the male apparatus as this is oriented at an angle to that plane. However, one of them fell in part nearly in the plane of the sections and forms the basis for figure 11*c*. The expanded spermiducal vesicle, containing masses of sperm, enters the proximal end of an elongated seminal vesicle that is bent upon itself. Its proximal half has a thick muscular wall of circular fibers. Distally the wall thins and the vesicle then makes a sharp bend, diminishing abruptly to a narrowed tube with thin muscular wall that parallels the thick muscular part. This tube then bends again and as a narrowed duct runs close to the oval prostatic vesicle, eventually coming in contact with the prostatic duct. The two ducts run in contact for some distance, then fuse to form an ejaculatory duct that passes to the surface. Seminal and prostatic vesicles are imbedded in a muscular area indicated by a dotted line in figure 11*c*. The ejaculatory duct could not be traced into the penis papilla, a nonmuscular conical elevation occupying a broad shallow male antrum and apparently devoid of the usual penis stylet characteristic of the Cotylea.

All eight female apparatuses are approximately identical and one of them is shown in sagittal view in figure 11*b*. The gonopore leads into a deep tubular female antrum having the same histological construction as the adjacent body wall. It is lined by an epithelium of tall narrow cells underlain by the usual muscle stratum. At its internal end the antrum enters the cement pouch of the vagina but the epithelium here appeared disrupted, whether normally or as a failure of fixation is not determinable. The cement pouch and the glandular tubular vagina leading inward from it receive a tremendous mass of cement glands on all sides. The vagina then expands and its wall, very thin in the glandular region, widens to a cuboidal epithelium of loose texture. The vagina then makes a bend, forward in some of the apparatuses, backward in others, and approaches a large cavity filled with eggs that appears to be a median uterus. Seemingly this species has a single median uterus in which the eggs collect rather than the usual paired uteri. All eight vaginas are directed towards this median uterus but none could be followed directly into it although some contained an egg or two. The uterus is bounded by a definite epithelial wall in which no openings could be found. However, one must suppose that, at the time of spawning, eggs are discharged from the uterus through all eight vaginas and out of all the gonopores. The absence of a sucker is presumably associated with the multiplication of female apparatuses that extend into the area where the sucker would normally occur.

HOLOTYPE: The larger specimen (USNM 28660) in alcohol is made the holotype, plus the removed anterior median part as sagittal serial sections (31 slides).

REMARKS: The multiplication of male apparatuses is common in polyclads but the multiplication of female apparatuses is rare. Apart from anomalies the only comparable case of which I know is that of *Cestoplana polypora* Meyer (1921), in which also there is present a midventral longitudinal row of female apparatuses ranging in number from 5 to 30 in different individuals. As only one sexual specimen of *Nymphozoon bayeri* is available it cannot be stated whether the number of female apparatuses shows individual variation. The lack of a sucker is unusual but not unique in Cotylea. A sucker is absent from *Amakusaplana ohshimai* Kato (1938a), and this author mentions two other cotyleans reported as devoid of a sucker; but it must be admitted that the sucker is very often difficult to see in preserved specimens.

The color pattern of the present species somewhat resembles that of *Pseudoceros gratus* Kato (1937), reported as common off the Palau Islands (Kato, 1943) but not recovered in the present material. Kato's species differs from *Nymphozoon bayeri* in that the margin has a mere black line rather than a band, in the much narrower lateral black stripes, and in attaining sexual maturity at a length of 50 mm. Kato makes no statement about the sucker but declares there is a pair of male copulatory apparatuses. The female apparatus is not mentioned. As already indicated, it appears to me that *Pseudoceros gratus* is identical with *Eurylepta striata* Schmarda (1859) rather than, as supposed by Kato, with "*Stylochoplana*" *meleagrina* Kelaart (1858), in which the stripes are purplish and the tentacles are "occipital," meaning, no doubt, nuchal.

Genus *Acanthozoon* Collingwood, 1876

DEFINITION: Pseudoceridae with dorsal surface covered with small papillae or tubercles; otherwise as in *Thysanozoon*.

TYPE SPECIES: *Acanthozoon armatus* (Kelaart) (1858).

Acanthozoon nigropapillosus, new species

FIGURE 13

MATERIAL: One specimen found swimming off the reef edge at Falarik Islet, Ifaluk Atoll, Sta. 616, collected by Migel, a native of Sonsorol, Oct. 18, 1953, under the auspices of the Pacific Science Board Atoll Research Program.

GENERAL CHARACTERS: The worm is of broadly oval shape (fig. 13), measuring 15 by 14 mm., preserved. It is black with a pale yellowish border, present in only a few places as the margin is damaged. The dorsal surface is covered with low rounded black papillae tipped with white, hence to the naked eye the dorsal surface appears black dotted with white. This appearance is depicted in a small area on figure 13. At the middle of the anterior end the tentacular folds are evident but eyes could not be seen because of the black color. Behind the tentacles an oval area houses the ruffled pharynx of which only a few folds were detectable. The mouth opening, posterior to the pharynx middle,

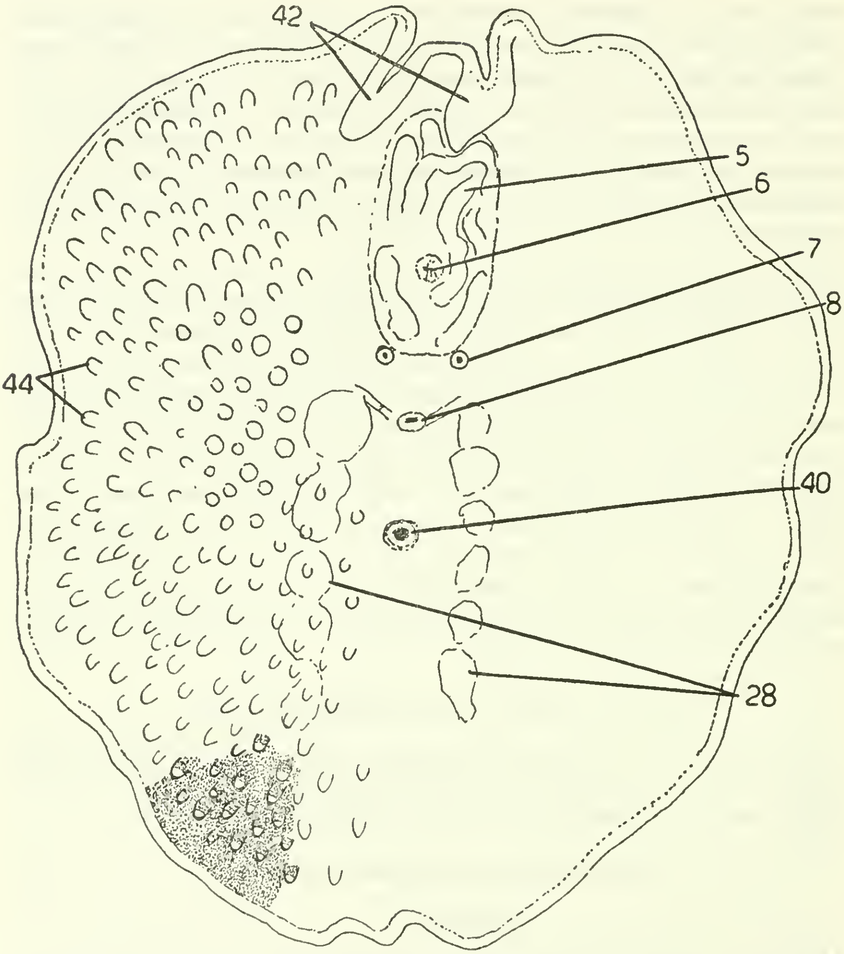

Figure 13.—*Acanthozoon nigropapillosus*, entire worm. (Explanation on page 597.)

is evident. Behind the pharynx are plainly seen the two male pores on hillocks, followed by the median female pore. The sucker, larger than the hillocks around the gonopores, is conspicuous, located slightly posterior to the middle. The convolutions of the uteri are seen to either side in the postpharyngeal region.

Differential diagnosis: The black color with black white-tipped papillae is distinctive.

Holotype: USNM 28661, in alcohol.

Remarks: Marcus (1950) recommended revival of *Acanthozoon* for pseudocerids with low dorsal elevations. Eveline Marcus (1955) reduced *Acanthozoon* to a subgenus of *Pseudoceros*. However, if *Pseudoceros* be defined as Pseudoceridae with a smooth dorsal surface

(Hyman, 1953a), *Acanthozoon* cannot become a subgenus of *Pseudoceros* but would more logically be made a subgenus of *Thysanozoon*, which would then include all pseudocerids with dorsal elevations. In fact, one may anticipate that difficulty must eventually arise in determining when the elevations are low enough to fit into *Acanthozoon* and when tall enough to fit into *Thysanozoon*. This dilemma has not yet arisen. Eveline Marcus (1955) has listed the species to be transferred to *Acanthozoon* and this information therefore need not be given here. I favor retaining the genus *Acanthozoon* for the species listed by Marcus.

Acanthozoon albopapillosus, new species

FIGURE 14*a,b*

MATERIAL: One damaged specimen collected July 22, 1954, in the Palau Islands. No other data available.

GENERAL CHARACTERS: The specimen is nearly circular but the posterior part is missing, hence the shape of the intact worm was probably oval. The sides are also damaged. The tentacular folds are poorly preserved. A pair of eye clusters can be seen in the tentacular region and behind them is a single oval cluster of cerebral eyes. The ruffled pharynx is large and voluminous, so much so that damage and rupture are suggested. Behind the pharynx is seen the sucker whose pointed shape is probably unnatural. There are no indications of any part of the reproductive system, hence this must be a large worm when intact and mature. Because of extensive damage the dimensions of the specimen are of little value. In the longitudinal axis it measures 26 mm., in width 25 mm. anteriorly, 35 mm. posteriorly. Despite damage the specimen is worth naming because of the distinctive color pattern. It is black with flesh-colored marginal band and rounded pinkish buff areas all over the dorsal surface. These areas are in general smaller towards the periphery. The pattern is indicated on the right side of figure 14*a*. The entire dorsal surface is thickly strewn with small rounded white papillae, hence this surface appears dotted with white to the naked eye. These papillae are indicated in the upper left of figure 14*a*. The ventral surface is pale except for a wide black band subtending the pale margin. This black band is shown on an upturned fold in the lower left of figure 14*a*. It is quite conspicuous when the worm is viewed from the ventral side.

PAPILLAE: A small bit of the worm was removed and sectioned to see the structure of the papillae. The histology of the papillae of *Acanthozoon* was given by Kato (1934) for *A. micropapillosus* and by Eveline Marcus (1955) for *A. hispidus*. Both find that the papillae are elevations of the mesenchyme covered with a cuboidal epithelium

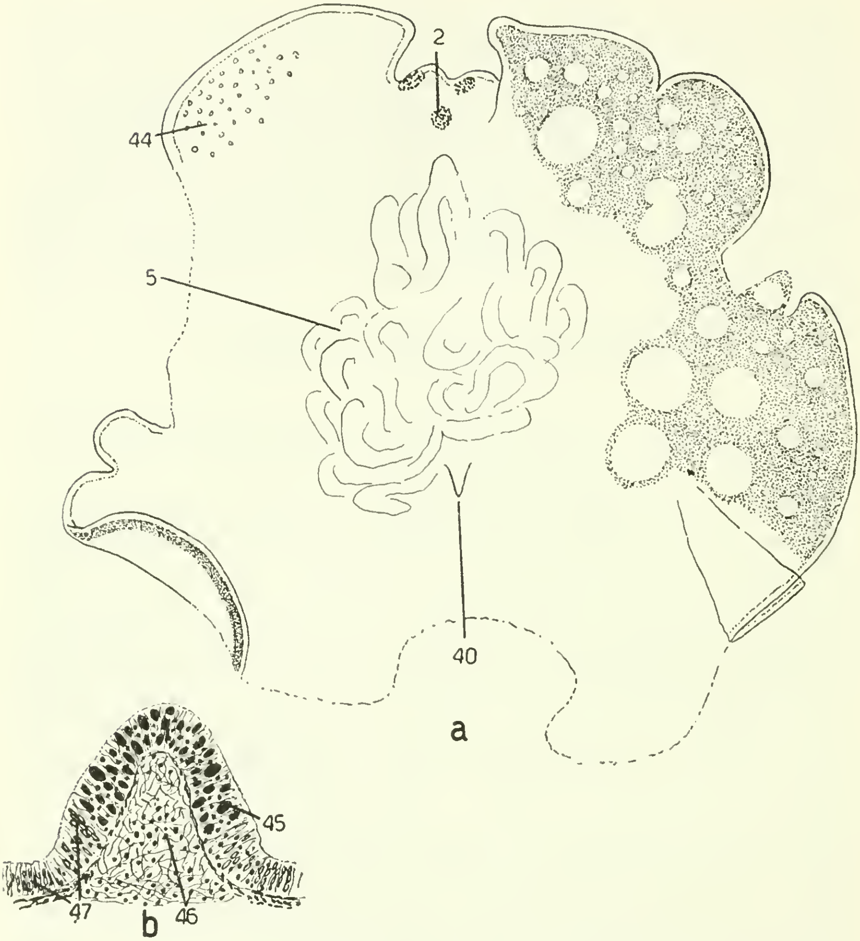

Figure 14.—*Acanthozoon albopapillosus: a,* entire worm; *b,* section through one of the papillae. (Explanation on page 597.)

containing eosinophilous granules. In the present species the papilla is covered with an epithelium much taller than that of the adjacent body wall (fig. 14*b*). Rhabdites are present only basally and the muscle layer is much reduced in the papilla. Distally the epithelium contains large eosinophilous droplets. Hence it appears that the papillae are secretory, probably productive of adhesive material.

Differenital diagnosis: *A. albopapillosus* differs from other species of *Acanthozoon* in the distinctive color pattern of pinkish buff areas on a black ground, pale marginal band subtended ventrally by a black band, and numerous white papillae over the dorsal surface.

Holotype: The specimen, in alcohol, is deposited in the American Museum of Natural History.

Family EURYLEPTIDAE

***Acerotisa rugosa*, new species**

FIGURES 15*a–c*; 16*a*

MATERIAL: Six specimens were taken by the Stanford team in the Palau Islands at Stations 28, 69, 92 (two lots), 220A, and 236 during July, August, and October 1955.

GENERAL CHARACTERS: The form is oval (fig. 15). Three of the specimens (from Stations 69, 92, and 236) were extremely small, less than a millimeter in length. These are devoid of any signs of reproductive organs and have an eye pattern typical of juvenile *Acerotisa*. The specimen from Sta. 92 is shown in figure 15*a*. It is 0.9 mm. long, has one large and one small eye in each marginal group, and four eyes in each cerebral group, of which three form a row immediately in front of the pharynx. An identical eye pattern occurs in the specimen (also 0.9 mm. long) from Sta. 69 except that each marginal group includes an additional small eye. The smallest specimen, from Sta. 236, measures 0.6 mm. in length and also has four cerebral eyes on each side, but the group of three is in front of the single eye; there are four marginal eyes on each side. The three remaining specimens are all of larger size and show increase in eye number and varying degrees of sexual maturity. The specimen from Sta. 28 is shown in figure 15*b*. It is 1.4 mm. long and has seven to eight cerebral eyes on each side and five eyes in each marginal group. The female gonopore and the male copulatory apparatus are evident in this specimen; the latter is seen under the posterior half of the pharynx in the figure. Another worm of about the same size, 1.5 mm. long, from Sta. 220A, has eight cerebral eyes on one side, 10 on the other, and a total of about 30 marginal eyes, distorted out of their normal positions. Finally, the largest specimen, from Sta. 92, measures 5 by 3.5 mm. It is fully mature and presumably represents the maximum size of the species. Its cerebral clusters contain 9 eyes on one side and 11 on the other, and there are about 17 eyes in each marginal group (fig. 15*c*).

All specimens have a rugose dorsal surface caused by bundles of rhabdites which tend to form little pointed projections, as shown in the small turned back fold on the upper left of figure 15*c*. There are also evident in the largest specimen flask-shaped glands along the periphery, although these are not as regularly and closely arranged as in *Acerotisa multicelis* Hyman (1955a).

The small specimens appear colorless or pale but the largest one is reddish brown. The position of the sucker is shown in the figures; it was much distended in the specimen depicted in figure 15*b*. The

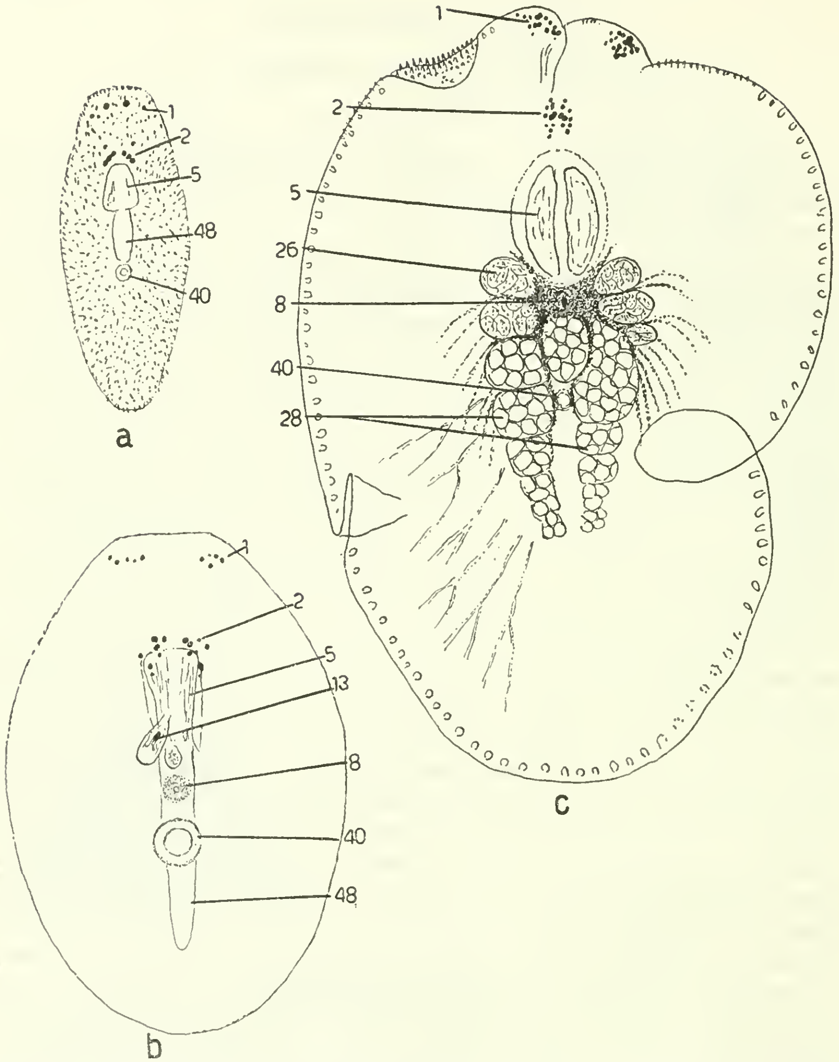

Figure 15.—*Acerotisa rugosa: a*, very small specimen; *b*, specimen of medium size; *c*, mature worm. (Explanation on page 597.)

branches of the intestine, of which a few are shown in the lower left of figure 15*c*, do not anastomose, at least not to any extent.

Reproductive system: As there is only one fully mature specimen, I have forborne to section it. However, most of the details of the reproductive system could be ascertained in the cleared, mounted worm. The female gonopore, encircled by radiating cement glands, is located just behind the root of the pharynx (fig. 15*c*). To each side of it are seen the coils of the spermiducal vesicles. Extending backwards from it on each side occur the coils of the two uteri, filled with large eggs. The male copulatory apparatus underlies the left side of the pharynx and the male gonopore lies at the anterior margin of the pharyngeal cavity (fig. 16*a*). At the posterior end of this cavity coils of the spermiducal vesicles can be seen approaching the proximal end of the long fusiform seminal vesicle which is nearly as long as the pharynx in the specimen, underlying the left side of this organ. The seminal vesicle is provided with a coat of circular muscle fibers and is filled with a dense mass of sperm. At its distal end the seminal vesicle narrows to a duct that underlies the oval prostatic vesicle, in which the radiations of the glandular interior are clearly visible. At the distal end of the prostatic vesicle is seen the short penis stylet with truncate tip. Other details are not discernible in the whole specimen. The fact that the male apparatus lies under the posterior half of the pharynx in the medium sized specimen (fig. 15*b*) is rather puzzling and seems to indicate a forward migration of this apparatus with sexual maturity.

Differential diagnosis: *Acerotisa rugosa* is distinguished by the rugose dorsal surface, anterior position of the male gonopore, and short truncate penis stylet. Of other species with a similar anterior position of the male gonopore, *A. inconspicua* (Lang) (1884) has very few eyes, *A. meridiana* (Ritter-Zahony) (1907) has the intestinal branches anastomosed to a network, and *A. californica* Hyman (1953a) has a long pointed penis stylet.

Holotype: USNM 28662, whole mount. The other five specimens (USNM 28663–USNM 28667) are also whole mounts.

Remarks: Marcus (1947) listed and gave characters of the seven valid species of *Acerotisa* known at that time. In the same article he described three new species of *Acerotisa: piscatoria*, *leuca*, and *bituna*. Since then there have been named: *A. arctica* Hyman (1953a), *californica* Hyman (1953a), and *multicelis* Hyman (1955a). Mention should also be made of *Oligocladus albus* Freeman (1933), which probably belongs to *Acerotisa*, but the one specimen is so imperfectly known that decision is impossible at present.

Family Prosthiostomidae

***Prosthiostomum exiguum*, new species**

Figures 16*b,c;* 17*a*

Material: Two specimens were taken by D. Reish on Eniwetok Atoll, on coral rock on the inner reef flat, Sta. E–8, Aug. 21, 1956. A third specimen, taken in the same locality and type of habitat at Sta. E–2, was so distorted and broken that it was discarded as useless.

General characters: This is a very small species, with the two

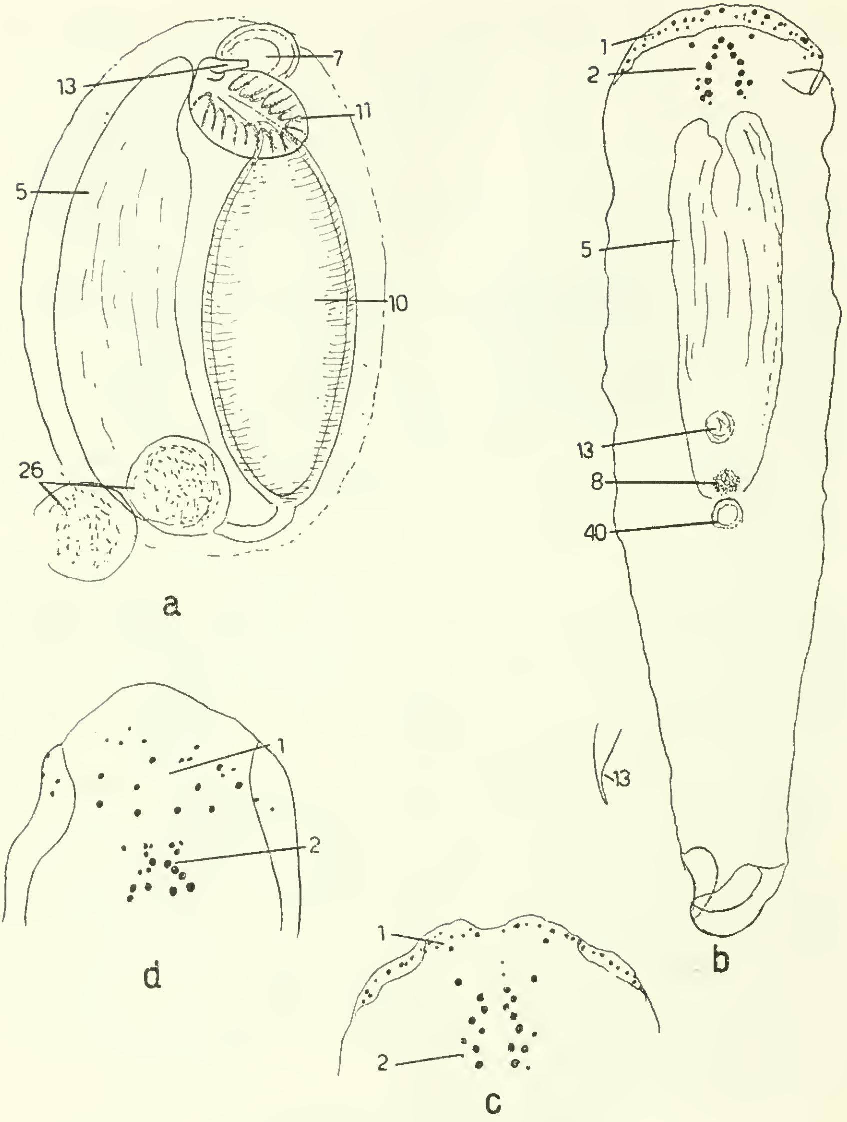

Figure 16.—*a*, *Acerotisa rugosa*, copulatory apparatus as seen from above in whole mount. *b*, *c*, *Prosthiostomum exiguum: b*, entire animal; *c*, eyes enlarged; *d*, *P. griseum*, anterior end enlarged. (Explanation on page 597.)

specimens measuring 4 mm. and 5 mm. in length (fig. 16*b*). The species is of the usual slender shape, broader anteriorly with rounded anterior margin, tapering behind the pharynx to a blunt posterior end. The color appeared to be a dirty white. The eye arrangement is shown in figure 16*b*, and enlarged in 16*c*. Along the anterior margin is a band of small eyes, not definitely divided at the middle, numbering about 35 in the 4-mm. specimen (fig. 16*b*), about 40 in the 5-mm. specimen (fig. 16*c*). The cerebral eyes are large and relatively few in number, ranging from 8 to 12 on each side, in the two specimens. A marked feature of the eye pattern is the presence of a single isolated eye on each side at the level of the anterior end of the cerebral groups. Such a pair of eyes set apart from the cerebral groups is known in a number of species of *Prosthiostomum* and therefore is not diagnostic. Some authors speak of this pair of eyes as ventral but in my material the pair appears on the same level as the other cerebral eyes. The large tubular pharynx, often partly protruded or discarded on fixation, has remained in situ in the smaller specimen but was missing from the larger one There appeared to be no median intestinal branch above the pharynx. Beneath the posterior end of the pharynx is seen the terminal part of the male apparatus, at the attached end of the pharynx is located the female gonopore, and shortly behind the latter occurs the sucker.

Copulatory apparatus: Both specimens are sexually mature. The larger specimen was sectioned sagittally, and a sagittal view of the copulatory structures is shown in figure 17*a*. The male and female gonopores and the sucker lie close together but the distance between the two gonopores is slightly greater than the distance between the female gonopore and the sucker. The male gonopore leads into a long tubular antrum, slanted forward so as to lie almost parallel to the ventral body wall. At the anterior end of the male antrum is seen the penis, an oval body containing the usual penis stylet, whose tip is protected by the penis sheath projecting into the antrum as a slight elevation. Details of the penis were not very clear in the sections; the usual eosinophilous granulation, indicative of prostatic secretion, appeared present in the wall around the stylet. The proximal end of the penis receives the ejaculatory duct and the ducts of the two accessory vesicles. The latter are the usual round muscular bodies with small lumen and thick wall of circular fibers. They occur one behind the other. The more posterior one lies just behind the level of the proximal end of the seminal vesicle; the other is located on the other side of the seminal vesicle at a level just below the posterior end of the latter. The seminal vesicle is retort-shaped, curved on itself; its proximal end is rounded with a thick wall of muscle fibers paralleling its contours; distally, as the vesicle curves posteriorly parallel to itself, the muscular wall thins. The entrance of the sperm ducts into the seminal vesicle could not be followed. The spermiducal vesicles swollen with sperm are obvious alongside the seminal vesicle. They have been omitted from figure 17*a* to avoid complicating it. One occurs above the seminal vesicle and the other below, but the usual

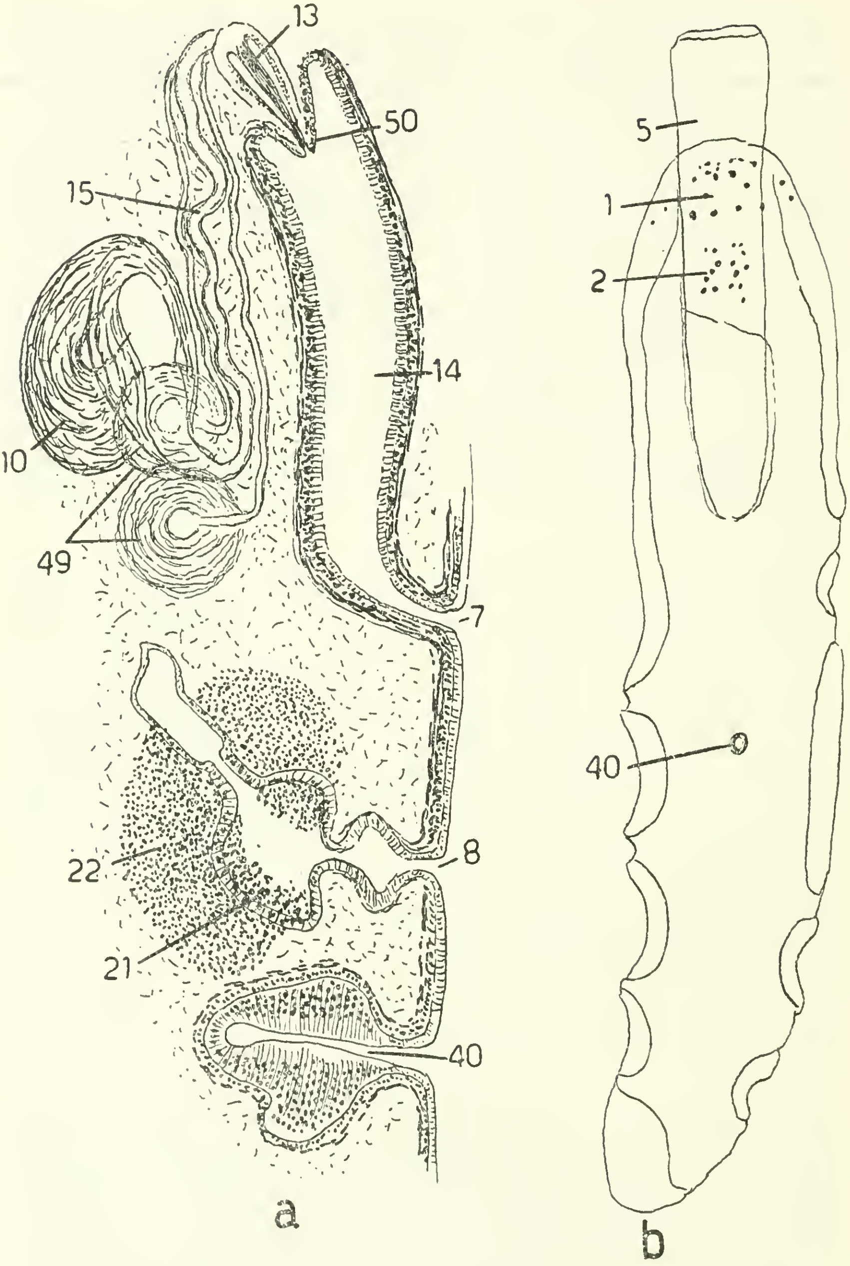

Figure 17.—*a*, *Prosthiostomum exiguum*, sagittal view of copulatory complex, male system above. *b*, *P. griseum*, entire worm. (Explanation on page 597.)

sperm ducts from the spermiducal vesicles into the seminal vesicle could not be found. The ejaculatory duct issues ventrally from the thinned distal end of the seminal vesicle, turns forward, and pursues a sinuous course to the proximal end of the penis, accompanied above by the duct of the more anterior accessory vesicle, below by the duct of the more posterior one. The penis stylet as seen in the whole specimen before sectioning is shown to the left of the posterior part of figure 16*b*. The male antrum is lined by an epithelium of tall, narrow cells, outside of which occur considerable layers of circular and longitudinal muscles. These layers continue along the ventral body wall to the female pore.

The female gonopore leads by a short tubular female antrum into a vaginal chamber lined by an epithelium of tall, narrow cells, with very little muscular investment. This again leads by a short narrow passage into a larger chamber, the glandular vagina, or cement pouch. The cement pouch is lined by an epithelium of less narrowed cells, penetrated by the outlets of the cement glands. The latter surround the cement pouch as a mass of eosinophilous granules in which cells are not detectable. The cement pouch lacks musculature. From its anterodorsal side the vagina continues as a tube that receives the uteri about on a level with the posterior accessory vesicle of the male system.

Behind the female apparatus is seen the sucker, forming a rather large deep pouch lined by an epithelium of exceedingly long narrow cells underlain by a muscular investment about equal to that of the ventral body wall with which it is continuous.

DIFFERENTIAL DIAGNOSIS: Marcus (1949, 1950, 1952) listed the described species of *Prosthiostomum*, with authors and references, and in the 1952 article added one new species, making a total of 53 members of the genus. Since then there have been described *P. latocelis* Hyman (1953a) and *P. multicelis* Hyman (1955a). As the members of the genus are all very much alike, specific identification poses a difficult problem. The main characters are the eye pattern and number and details of the copulatory apparatuses. A few species have a distinctive color pattern but most are white or pale. To determine the status of the present specimens, all the original descriptions were inspected (except those of Stimpson, 1857, probably unrecognizable) but none could be found agreeing with their characters. In its small size at sexual maturity *P. exiguum* differs from most of the described species. A pair of eyes set off from the cerebral clusters occurs in *P. siphunculus*, *P. monosora*, *P. drygalskii*, *P. parvicelis*, *P. sonorum*, *P. vulgare*, *P. delicatum*, *P. notoensis*, and *P. nozakensis*, but other details of eye pattern and number differ from those of *P. exiguum* except in *P. drygalskii* and *P. vulgare*. In these two species eye number and arrangement are identical with those of *P. exiguum* and, in fact, for some time it was thought the present specimens might be *P. vulgare* Kato (1938b), but the details of the copulatory apparatus are irreconcilable between the two. *P. exiguum* is then distinguished by the following combination of characters: small size at sexual maturity, uniform pale coloration, eye pattern (fig. 16*b*,*c*), long cylindrical male antrum almost horizontally oriented, retort-shaped seminal vesicle, issuance of ejaculatory duct posteriorly and ventrally, and female apparatus of two successive chambers.

HOLOTYPE: USNM 28668, the larger specimen as whole mount. The smaller specimen (USNM 28687) is deposited as sagittal serial sections (one slide).

Prosthiostomum griseum, new species

FIGURES 16*d*; 17*b*

MATERIAL: One specimen collected by D. Reish at Parry Island, Eniwetok Atoll, on the lagoon side in September 1956.

GENERAL CHARACTERS: This is a very small worm, 4 mm. long, of the slender shape characteristic of the genus (fig. 17*b*). It is of a uniform dark gray coloration. The eye pattern (fig. 16*d*) is very unusual in the genus. The marginal eyes, relatively few in number and rather large, are not arranged in the usual marginal band but are scattered over the anterior end between the cerebral eyes and the anterior margin. The cerebral eyes occur in the usual two groups of 8–10 eyes each. The tubular pharynx is partly protruded. The sucker occurs unusually far posterior to the pharynx, about 0.8 mm. behind the root of the latter. The specimen is juvenile with only the beginnings of gonads and no indication of copulatory apparatuses. It has such distinctive characters, however, that giving it a specific name appears justified.

DIFFERENTIAL DIAGNOSIS: The scattering of the marginal eyes over the anterior end is seen in only one other of the 56 described species of *Prosthiostomum;* namely, in *P. latocelis* Hyman (1953a). The latter, however, is pale, with numerous cerebral eyes, and with the sucker close to the root of the pharynx. The present species is readily distinguished by the gray color, scattering of the marginal eyes over the anterior end, and posterior position of the sucker.

HOLOTYPE: USNM 28669, a whole mount.

REMARKS: Kato (1938a) created the genus *Amakusaplana* for a prosthostomid identical with *Prosthiostomum* except that all eyes are scattered over the anterior end and a sucker appears wanting. The species *Prosthiostomum latocelis* and *P. griseum* constitute forms intermediate between typical *Prosthiostomum* and *Amakusaplana* in that their marginal eyes are scattered but their cerebral eyes remain in definite clusters. The intermediate character of these two species gives grounds for doubt that *Amakusaplana* can be maintained as a distinct genus.

Collecting Stations

Following is a list of stations at which polyclads were collected in the Palau Islands by a team composed of R. R. Harry and H. A. Fehlmann of Stanford University and F. M. Bayer of the U. S. National Museum. Geographical coordinates of each locality based upon Hydgrographic Office charts are noted in parentheses. Numbers of traverses and islands in Iwayama Bay follow the work of Abe (1937) and of Abe, Eguchi, and Hiro (1937).

Sta. 28. July 21, 1955. Outer reef at eastern end of Urukthapel Island, about 1½ miles north of Pkulasuch Point: 7°16′13″ N., 134°27′35″ E. (H. O. 6103, 1st. ed., 1944). Depth 2–4 ft., in breakers; bottom covered with *Turbinaria* (*Acerotisa rugosa*, n. sp.; Leptoplanidae, juv.)

Sta. 30. July 22, 1955. Iwayama Bay, between south shore of Kaibakku (Island xxix) and Kogai-hantô, Auluptagel Island (traverse xi): 7°19′12″ N., 134°29′37″ E. (H. O. 6076, 2d ed., 1944). Depth 0–3 ft.; sand, coral, with vegetation consisting mainly of *Enhalus* and *Caulerpa*. (*Asolenia deilogyna*, n. sp.)

Sta. 37. July 25, 1955. Middle of channel between Peleliu and Ngedebus Islands: 7°2′57″ N., 134°16′20″ E. (H. O. field chart 4007). Depth 4–8 feet; bottom sand with massive coral heads and vegetation of *Enhalus acoroides*. (*Pseudoceros fuscogriseus*, n. sp.)

Sta. 47. July 28, 1955. Iwayama Bay, in cove formed by west arm of Kogaihantô, around Islands xxxiii and xxxiv: 7°18′58″ N., 134°29′32″ E. (H. O. 6076, 2d. ed., 1944). Depth, 0–10 ft.; bottom sand with living and dead coral with *Enhalus* growing in sand and *Padina* on rocky areas. (Leptoplanidae, juv., from sponge washings.)

Sta. 60. Aug. 5, 1955. North shore of Koror Island, west of Ebadul's Pier: 7°20′48″ N., 134°28′12″ E. (H. O. 6076, 2d. ed., 1944). Sand flat; occasional coral heads, with *Enhalus* growing on sandy areas, *Sargassum* attached to rocks. (Leptoplanidae, juv.)

Sta. 64. Aug. 7, 1955. Small bay at southern end of Meherehar (the lagoon of Eil Malk): 7°9′23″ N., 134°21′48″ E. (H. O. 6078, 1st ed.). Depth 6–20 ft.; bottom limestone, little sand and scant coral; among sponges, hydroids, and tunicates. (*Latocestus pacificus* Laidlaw.)

Sta. 69. Aug. 8, 1955. Lagoon margin of reef extending north between east end of Urukthapel Island and Malakal Pass: 7°16′10″ N., 134°27′26″ E. (H. O. 6103, 1st ed., 1944). Depth 3–4 ft.; living and dead coral, rubble; pot holes with sand. (*Pseudoceros izuensis* Kato; *Acerotisa rugosa*, n. sp.)

Sta. 77. Aug. 10, 1955. Bay in southernmost coast of Auluptagel Island; in mouth of bay and narrow pass at its middle: 7°17′52″ N., 134°29′20″ E. (H. O. 6105, 1st ed.). Depth 1–12 ft.; bottomsand, some coral rubble and limestone; vegetation of eel-grass, *Caulerpa*, and *Halimeda*. (*Pseudoceros caeruleocinctus*, n. sp.)

Sta. 85. Aug. 12, 1955. Iwayama Bay, between south shore of Kaibakku (Island xxix) and Kogai-hantô, Auluptagel Island: 7°19′12″ N., 134°29′37″ E. (H. O. 6076, 2d ed., 1944). (Approximately the same locality as Sta. 30 but a few feet west.) Depth 5–6 ft.; sand and coral, with vegetation of *Enhalus*, *Caulerpa*, and *Halimeda*. (*Pseudoceros fulvogriseus*, n. sp.)

Sta. 92. Aug. 14, 1955. Iwayama Bay; south end of Gua-zima (Island xv): 7°20′00″ N., 134°29′37″ E. (H. O. 6076, 2d ed.). Depth 0–20 ft.; sandy flat and fringing reef, with vegetation of *Enhalus*, *Halimeda*, *Padina*. (*Acerotisa rugosa*, n. sp.)

Sta. 133. Aug. 28, 1955. Iwayama Bay: south shore of Island ii (traverses viii, ix, x), 7°19′20″ N., 134°29′15″ E. (H. O. 6076, 2d ed.). Reef flat covered with 2–3 feet of water at mean low tide, with pool about 15 ft. deep; bottom coral and sand, with *Enhalus*, *Halimeda*, and *Padina*. (*Nymphozoon bayeri* n. sp.)

Sta. 220. Oct. 12, 1955. Iwayama Bay: east side of Oyster Pass (Kaki-suidô) between Island xxix and east end of Koror. 7°18′57″ N., 134°30′09″ E. (H. O. 6076, 2d ed.). Bottom limestone, with living and dead coral, depth, 3–20 ft. (*Aquaplana pacifica*, n. sp.; Leptoplanidae, juv.)

Sta. 220A. Oct. 22, 1955. Locality as for Sta. 220. (*Acerotisa rugosa*, n. sp.)

Sta. 236. Oct. 18, 1955. Iwayama Bay, somewhat north of position of Sta. 220: 7°19′00″ N., 134°30′11″ E. (H. O. 6076, 2d. ed.). Limestone shelf with living and dead coral, depth 3–20 ft. (*Acerotisa rugosa*, n. sp.)

Sta. 236A. Oct. 20, 1955. Locality as for Sta. 236. (*Pseudoceros ferrugineus*, n. sp.)

Sta. 254. Oct. 27, 1955. Outer reef (called Raeldil) south of Ngaremediu, east cape of Urukthapel Island: 7°14′37″ N., 134°27′11″ E. (H. O. 6078, 1st ed.). Reef flat with sand patches among living and dead coral, depth 2½ to 3½ ft. (awash at spring tides); collected by the light of gasoline lanterns, just before midnight. (*Plehnia tropica*, n. sp.; *Pseudoceros ater*, n. sp.).

Sta. 258. Nov. 2, 1955. East side of Urukthapel Island, in small bay north of Ngaremediu Peak, at end of trail leading to Palau Lighthouse (not functional): 7°15′57″ N., 134°26′55″ E. (H. O. 6103 xx ed.). Bottom sand and limestone, with living and dead coral; *Enhalus* and *Halimeda*. (*Leptoplanidae*, juv.).

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Explanation of Numbered Parts on Figures

1, marginal eyes
2, cerebral eyes
3, frontal eyes
4, brain
5, pharynx
6, mouth
7, male gonopore
8, female gonopore
9, eggs
10, seminal vesicle
11, prostatic vessel
12, penis papilla
13, penis stylet
14, male antrum
15, ejaculatory duct
16, vagina
17, entrance uterus
18, duct of Lang's vesicle
19, Lang's vesicle
20, female antrum
21, glandular vagina
22, cement glands
23, sperm ducts
24, cerebrotentacular eyes
25, bulbous vagina
26, spermiducal vesicle
27, tentacle
28, uteri
29, spermiducal bulbs
30, common sperm duct
31, muscular vagina
32, thorns
33, teeth
34, bursa
35, black dots
36, tentacular eyes
37, cirrus sac
38, cement pouch
39, common gonopore
40, sucker
41, median ridge
42, tentacular folds
43, uterine network
44, papillae
45, eosinophilous droplets
46, nuclei
47, rhabdites
48, main intestine
49, accessory vesicles
50, penis sheath
51, cirrus papilla
52, gland pocket of male antrum

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(New genera, species, etc., are printed in *italics.* Page numbers of principal entries also in *italics*)