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Remington Kellogg,
Director, United States National Museum.

Circ.

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PROCEEDINGS OF THE UNITED STATES NATIONAL MUSEUM

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REVISION OF THE VITTATE SPECIES OF THE CHRYSOMELID BEETLE GENUS DISONYCHA FROM THE AMERICAS SOUTH OF THE UNITED STATES

By Doris Holmes Blake

Introduction

In an earlier revision of the chrysomelid beetles of the genus *Disonycha* [1] the species that occurred north of México were studied. In that publication the history as well as the characters of the genus were discussed in detail. Therefore it seems unnecessary to repeat this at such length here.

The generic name *Disonycha* first appeared in the Dejean Catalogue in 1837 with 31 species listed under it. In 1844 Chevrolat [2] defined the genus. The type of the genus was designated by the writer in 1933 as *D. collata* (Fabricius), a species with blue elytra, since it was the most definitely described species included by Chevrolat in the Catalogue. Many of the early species were described by Fabricius under the genera *Crioceris, Chrysomela,* and *Galleruca,* but he later referred them to *Galleruca.* Olivier placed them under *Altica,* which name Illiger with Germanic emendation called *Haltica.* Melsheimer was the first in America to use Chevrolat's name *Disonycha.* Most of the Mexican and Central American species were described by Jacoby in the Biologia Centrali-Americana, and he also described many South American species. Very little has been done with the genus

[1] Blake, Proc. U. S. Nat. Mus., vol. 82, art. 28, pp. 1–66, 1933.

[2] Chevrolat, in D'Orbigny, Dictionnaire universale d'histoire naturelle, vol. 5, p. 8, 1844.

in either Central or South America in the last 50 years, although Weise and Bryant, following von Harold's lead, have described a few species. At present Dr. A. da Costa Lima is publishing an article in which he is describing seven new species and a new subspecies of *Disonycha* from Brazil. He has sent me photographs of drawings of these but unfortunately I cannot recognize with certainty more than one species from these drawings, which do not show the sculpture or legs.

The vittate species of the genus *Disonycha* are, broadly speaking, pale yellow beetles with dark elytral stripes, usually sutural, median and marginal or submarginal. The head and prothorax are usually pale, with or without markings. A few species have entirely dark heads; none has an entirely dark prothorax. The antennae are almost uniformly dark with paler edged basal joints and occasionally paler terminal joints. In structure, the beetles have predominately a smooth head, inserted to the eyes, with few punctures except the large fovea or group of punctures near the eye. Only a few species, mostly with dark heads, are densely and coarsely punctate over the occiput. A rounded carina extends down the lower front of the head; its length is variable, as certain species have a short lower front. The antennae extend a little beyond the humeri, rarely nearing the middle of the elytra, with the third joint shorter than the fourth, the remainder being subequal. The shape of the prothorax is often diagnostic of the species. In general it is nearly as wide as the elytra and about twice as wide as long, with slightly curved sides, a narrow margin, and usually a broad apical angle and a deeply oblique basal angle. Its convexity varies; in some species there are swollen callosities on the sides, in most, a distinct depression over the scutellum, occasionally lengthening to a slight transverse basal depression. The shape, sculpture, and markings of the prothorax are most significant in specific differences. In fact it would seem as if the more or less uniform markings of the elytra were generic and the small but constant differences in the head and prothorax were specific in character. As a specific character, the shape of the aedeagus is also of prime importance.

In my earlier revision I stated that *D. stenosticha* Schaeffer resembled *D. militaris* Jacoby. Jacoby's specimen of *D. militaris* that I had in mind is probably not the same as the rest of his series and is either *D. stenosticha* or a closely related species, such as *Cacoscelis quinquelineata* (Latreille). In the present study I have referred *C. quinquelineata* (Latreille) to the genus *Disonycha*. *D. stenosticha* Schaeffer, as well as another very similar species, belong in this group and I see no reason for not including them in the genus. The same is true of a group of beetles from the Amazon that Jacoby referred to Harold's genus *Nephrica*. These do not have eyes any more reniform than the other species of *Disonycha*. They are like *C. quinquelineata* in that they are unusually large, and in their case broader than most but not otherwise separable from other smaller species of *Disonycha*.

Many of the groups of species represented in the United States by only one species, such as *D. glabrata* (Fabricius), are found in greater numbers in tropical America. *D. glabrata* itself extends with little variation all the way from New York to Argentina. Drawings have been made of the aedeagus from different localities in its long range which show little difference throughout. The food plant, as is the case of many species of *Disonycha* with blue elytra, is *Amaranthus*, a widespread weed. Related to *D. glabrata* are several Central American species, such as *D. dorsata* Harold and *D. nigrita* Jacoby, and another described in this publication. In South America is an even more closely related species, *D. vittipennis* Boheman from Perú.

On the other hand, the group of species that feeds on *Salix* is better represented in the northern temperate regions. *D. pluriligata* (Le Conte) and *D. latiovittata* Hatch of this group extend into México and Guatemala, and *D. teapensis* Blake is found only in México, but the group is not at all represented in South America to date.

The group with costate elytra that feeds on *Polygonum* has a representative in México and Central America, *D. recticollis* Jacoby, and four in South America, one species from Perú, two from Brazil, and one from Argentina, *D. bicarinata* Boheman, whose food habits have been carefully studied by Frers, who found it living on *Mühlenbeckia*, one of the Polygonaceae. The food habits of the three other species described in this publication are not known, but I venture to guess that they also feed on plants of that family.

The *discoidea* group is represented in México and Central America by *D. militaris* Jacoby, *D. leptolineata texana* Schaeffer, and *D. antennata* Jacoby, and in South America by *D. peruana* Jacoby.

In Argentina and adjacent countries occur a number of species with very wide dark vittae, of which *D. copulata* (Germar) is representative.

As in the United States, there are also many isolated species not at all like any others. In time others may be collected that are related to them. In working with so little material from such wide tropical regions of Central and South America one has the constant thought that only scattered specimens of a great genus are at hand.

Common to the United States and México and Central America are 12 species, of which 4 occur only in States bordering on Mexico. Common to Central America and South America are 6 species, half of which occur only as far as Panamá. I have described 8 new species from Central America and México, and 21 from South America.

The author wishes to acknowledge her gratitude to various institutions and people for lending material for this study, in particular to J. Balfour-Browne and G. E. Bryant, British Museum (Natural History) (BM); Mont A. Cazier and J. C. Pallister, American Museum of Natural History (AMNH); P. J. Darlington Jr., Museum of Comparative Zoology (MCZ); K. Delkeskamp, Zoologisches Museum, Humboldt-Universität, Berlin (ZMB); Hugh Leech and E. C. Van Dyke, California Academy of Sciences (CAS); René Malaise, Naturhistoriska Riksmuseet, Stockholm; F. Monrós, Fundación Miguel Lillo, Tucumán; as well as the United States National Museum.

Key to the vittate species of Disonycha from México and Central America[3]

1. Elytra with at most only faint traces of a median vitta, the vitta being either entirely absent or with traces at base or very pale 2
   Elytra with strong median vitta 7
2. Median vitta entirely absent, sutural vitta wide, a narrow marginal vitta (México) . . . . **trivittata** new species (p. 45)
   Median vitta present to some extent 3
3. Median vitta represented by spot at base (Panamá) **longipennis** new species (p. 42)
   Median vitta very pale 4
4. Prothorax entirely pale 5
   Prothorax spotted 6
5. Elytra without definite sutural, submarginal, or marginal vittae, median vitta very pale, often short (typical specimens without any vittae) (Florida Keys, México) . . . . **antennata** Jacoby (p. 28)
   Elytra with pale sutural and submarginal vittae, the median vitta having a short one beside it at apex (México, Central America) **brevilineata** Jacoby (p. 34)
6. Prothorax with two dark spots anteriorly; sutural, median, and submarginal vittae very pale (Arizona, México, Guatemala, Honduras, Costa Rica) **figurata** Jacoby (p. 22)
   Prothorax with median elongate diamond-shaped dark spot; elytra with a pale outline of median vitta, sutural edges dark (México) **högei** Jacoby (p. 36)
7. A short vitta near apex of median vitta (México, Central America) **brevilineata** Jacoby (p. 34)
   No short vitta near apex of median vitta 8
8. Elytra with traces of ridging, especially marked in the female either on the median vitta or more laterally near the apex 9
   Elytra with no trace of costation 13
9. Prothorax immaculate (México, Central America) . **recticollis** Jacoby (p. 11)
   Prothorax either spotted or banded 10

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[3] Three species of *Disonycha* are omitted from these keys, two of which are from the West Indies, consisting of *D. spilotrachela* Blake, from Cuba, Puerto Rico, and Haiti, and *D. gowdeyi* Bryant known only from Jamaica. The first, *D. spilotrachela*, (p. 39), has a 5-spotted pronotum, and the second, *D. gowdeyi*, (p. 40), has a 7-spotted pronotum. The third species, *D. megaspilota*, (p. 53), an unusually large one of 8.5 to 9 mm. in length, with three large dark pronotal spots, has no locality record.

10. Small (5–6 mm.); prothorax with wide dark fascia; head dark (United States, Honduras) . . . . **pensylvanica** (Illiger) (p. 9)
Larger (5.6–8 mm.); prothorax spotted; head not entirely dark 11
11. Elytra with median dark vitta wider than pale vitta (United States, México) **procera** Casey (p. 10)
Elytra with median dark vitta not wider than pale vitta 12
12. Aedeagus with broad tip not at all acute above (United States, México, Guatemala) . . . . **pluriligata** (LeConte) (p. 16)
Aedeagus with acute tip above (México) . . . . . **teapensis** Blake (p. 18)
13. Elytra with only sutural and median vittae and no marginal or submarginal vitta. 14
Elytra with sutural, median and marginal or submarginal vittae . . . 18
14. Median and sutural vittae very narrow and faint (typically colored specimens nonvittate) (Florida Keys, México) . . . . . **antennata** Jacoby (p. 28)
Median and sutural vittae normally colored 15
15. Prothorax with a submarginal vitta on each side and two spots anteriorly with a median line and two faint lateral spots (?Costa Rica, Panamá, Colombia, Perú) . . . . **peruana** Jacoby (p. 29)
Prothorax without submarginal vitta 16
16. Prothorax with two small dark spots, sometimes a faint trace of submarginal vitta at apex of elytra (New Mexico, Arizona, Texas, México) **tenuicornis** Horn (p. 25)
Prothorax immaculate 17
17. Elytral vittae unusually narrow (México, Central America) **militaris** Jacoby (p. 27)
Elytral vittae not unusually narrow (United States, México, Guatemala) **leptolineata var. texana** Schaeffer (p. 27)
18. Elytra with dark marginal vitta. 19
Elytra with dark submarginal vitta 25
19. Prothorax unspotted. 20
Prothorax spotted 23
20. Eyes unusually large, interocular space less than half width of head . . 21
Eyes not unusually large, interocular space half or more width of head. 22
21. Elytra distinctly punctate, occipital spot extending down front in a point (near Brownsville, Texas; Sinaloa, México) . . . . **barberi** Blake (p. 48)
Elytra very faintly punctate, head dark about eyes and over occiput down to tubercles (Panamá) . . . . **didyma** new species (p. 49)
22. Head and prothorax coarsely punctate (California, Nevada, México) **maritima** Mannerheim (p. 71)
Head and prothorax smooth and not coarsely punctate **glabrata** (Fabricius) (p. 43)
23. Head entirely dark (Panamá, Colombia, Venezuela) **venezuelae** Jacoby (p. 54)
Head not entirely dark 24
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25. Prothorax unspotted. 26
Prothorax spotted 32

26. Large (7–10.5 mm. in length) 27
Smaller (5–7 mm. in length) 29
27. Tarsal joints deep brown (México) . . . . . ***jalapensis***, new species (p. 32)
Tarsal joints pale 28
28. Elytral vittae moderately wide (Costa Rica)
turrialbensis, new species (p. 38)
Elytral vittae narrow (México, Central America, Colombia)
quinquelineata (Latreille) (p. 31)
29. Distinctly oval, prothorax short and broad (El Salvador) . ***ovata*** Blake (p. 35)
Oblong oval, prothorax not unusually short and broad 30
30. Head entirely pale (México, Guatemala, Honduras)
guatemalensis Jacoby (p. 21)
Head with a dark spot on occiput 31
31. Femora entirely dark, tibiae with pale band below base (México)
annulata, new species (p. 51)
Femora with a dark streak only, tibiae entirely dark (México, Central America) . . . . ***fumata*** var. ***labiata*** Jacoby (p. 23)
32. Antennae unusually long, extending well below humeri nearly to the middle of the elytra 33
Antennae not unusually long, not extending much below humeri . . . 34
33. Explanate margin on prothorax and elytra wide, prothorax usually with a broad Y-shaped median marking and a spot on each side (Costa Rica, Panamá, Colombia) . . . . **panamensis** Jacoby (p. 41)
Explanate margin not unusually wide, anterior pronotal spots rather closely set and not in a broad Y-shaped formation (México, Central America)
fumata (LeConte) (p. 23)
34. Margin of elytral vittae a deeper brown in color than rest of vittae (México, British Honduras) . . . . **brunneofasciata** Jacoby (p. 36)
Margin of elytral vittae uniform in color with rest of vittae 35
35. Prothorax and elytra rather coarsely punctate, anterior pronotal spots small and not closely set (United States, México) . . . . **arizonae** Casey (p. 19)
Prothorax and elytra not coarsely punctate, anterior pronotal spots not very small and not widely separate 36
36. Head dark on occiput (Pacific coast of Canada and United States, Baja California) . . . . **latiovittata** Hatch (p. 17)
Head without darkening on occiput 37
37. Anterior pronotal spots large and dark (México) . **knabi** new species (p. 25)
Anterior pronotal spots pale and faint and not large (México)
gracilis, new species (p. 37)

Key to the vittate species of Disonycha from South America

1. Median elytral vitta with a pale inner line 2
Median elytral vitta without a pale inner line 3
2. Pale line in median elytral vitta usually only in apical half; prothorax usually with two dark spots close together anteriorly (Amazon River, Brazil)
scissovittata, new species (p. 73)
Pale line in median elytral vitta extending most of the length of vitta; prothorax with two anterior dark spots widely separated (Argentina, southern Brazil) . . . . **interlineata** Berg (p. 72)
3. Median elytral vitta represented only in part by spots or short lines either at base or near apex, sometimes also medially 4
Median elytral vitta or vittae entire 5

4. Head coarsely punctate and with occipital dark spot; prothorax with two dark spots anteriorly, sometimes a short median line (Bolivia, Paraguay, Argentina) . . . . **caustica** Harold (p. 75)
   Head not coarsely punctate and without occipital spot; prothorax immaculate (Argentina) . . . . **suturalis** Bryant (p. 74)
5. Elytra with many pale vittae (Brazil) . . . **multivittata,** new species (p. 58)
   Elytra with the usual sutural, median, and often submarginal or marginal vittae 6
6. Head and prothorax coarsely and often rather densely punctate 7
   Head and prothorax not unusually densely or coarsely punctate 11
7. Head pale with dark occipital spot (Bolivia, Paraguay, and Argentina) **caustica** Harold (p. 75)
   Head entirely dark 8
8. Small (5–6 mm.), prothorax without spots or band, entirely pale (Argentina, Uruguay, Bolivia, Chile, Brazil) . . . . . . **argentinensis** Jacoby (p. 70)
   Large (7–10 mm.), prothorax spotted or banded 9
9. Elytra with longitudinal depression from humerus down side (Venezuela, Colombia, Canal Zone) . . . . **venezuelae** Jacoby (p. 54)
   Elytra without longitudinal depression down side 10
10. Fourth antennal joint twice as long as third, elytra very densely punctate (Bolivia) . . . . **cratera,** new species (p. 56)
    Fourth antennal joint not twice as long as third, elytra not so densely punctate (Paraguay) . . . . **aplicata,** new species (p. 55)
11. Elytra with very narrow sutural and median vitta not reaching base (Brazil) **crassicornis,** new species (p. 56)
    Elytra with the usual sutural, median, and submarginal or marginal vittae 12
12. Elytra more or less costate in median vitta, especially in female 13
    Elytra not costate 16
13. Prothorax with four or five spots 14
    Prothorax without spots 15
14. Spots on prothorax well defined and dark (Argentina, Chile, Paraguay) **bicarinata** Boheman (p. 12)
    Spots on prothorax pale and evanescent (Perú) **yurimaguensis,** new species (p. 15)
15. Elytra rather densely and coarsely punctate (Pará, Brazil) **varia,** new species (p. 14)
    Elytra not coarsely punctate (southeastern Brazil) **immaculata,** new species (p. 13)
16. Prothorax entirely pale, without spots or bands 17
    Prothorax more or less spotted or banded 26
17. Elytra with submarginal dark vitta 18
    Elytra with marginal dark vitta 22
18. Femora entirely pale 19
    Femora pale with a dark streak or dark apex 21
19. Median elytral vitta not unusually narrow (Venezuela) **elongata** Jacoby (p. 52)
    Median elytral vitta very narrow 20
20. Prothorax rectangular, approximately twice as wide as long with a small lateral callosity on each side (Colombia) . **colombiana,** new species (p. 33)
    Prothorax not rectangular, not twice as wide as long, without lateral callosities (México, Central America, Colombia) . **quinquelineata** (Latreille) (p. 31)

21. Median vitta very short, not reaching apical curve, explanate margin wide (Brazil) . . . . **explanata,** new species (p. 59)
   Median vitta of usual length, aedeagus with broad arrow-shaped tip (Perú) **imitans** (Jacoby) (p. 61)
22. Large (8–10 mm.) 23
   Smaller (5–7 mm.) 24
23. Head entirely dark, outer joints of antennae pale (upper Amazon) **nigrofasciata** (Jacoby) (p. 60)
   Head entirely pale, antennae entirely dark, unusually long ("St. Paulo") **paula,** new species (p. 62)
24. Head entirely pale (Bolivia) . . . . **manni,** new species (p. 47)
   Head with dark occipital spot 25
25. Eyes large, interocular space less than half width of head (Colombia) **tridyma,** new species (p. 49)
   Eyes not unusually large, interocular space at least half width of head (New York to Argentina) . . . . **glabrata** (Fabricius) (p. 43)
26. Elytra with submarginal dark vitta. 27
   Elytra with marginal dark vitta 33
27. Prothorax with a submarginal dark vitta (Panamá, Colombia, Perú) **peruana** Jacoby (p. 29)
   Prothorax without a submarginal dark vitta. 28
28. Prothorax with a broad dark median plaga extending from two anterior spots to base (Argentina, Paraguay, Brazil, Venezuela) **plagifera,** new species (p. 58)
   Prothorax without broad median plaga from two anterior spots to base . 29
29. Large (7–10 mm.) 30
   Smaller (5–6 mm.). 32
30. Prothorax with Y-shaped median spot and wide explanate margin (Colombia, Canal Zone, Costa Rica) . . . . **panamensis** Jacoby (p. 41)
   Prothorax without Y-shaped median spot and not unusually wide explanate margin 31
31. Elytral vittæ reddish brown (upper Amazon) . **juruensis,** new species (p. 63)
   Elytral vittæ dark piceous, elytra unusually broad (Amazon) **amplipennis,** new species (p. 63)
32. Prothorax with two small spots anteriorly (Paraguay) **sapucayensis,** new species (p. 20)
   Prothorax with five spots (Venezuela) . . . . . **pittieri,** new species (p. 38)
33. Prothorax with seven small distinct dark spots (Bolivia, Brazil, Argentina) **septemmaculata,** new species (p. 69)
   Prothorax with less than seven spots or the spots confluent 34
34. Prothorax with a broad band or confluent or nearly confluent spots . . 35
   Prothorax with three distinct, well separated spots. 37
35. Large (6.5–7.5 mm.), prothorax either broadly banded or with five large dark spots. Abdomen of male with round excavation near tip (Argentina, southern Brazil). . . . . **conjuncta** (Germar) (p. 64)
   Smaller (5.5–6.5 mm.), prothorax usually with brownish or piceous clouding or indistinct spotting, no excavation on abdomen of male 36
36. Prothorax with three very short but broad and nearly confluent spots, body beneath pale except the breast and legs (Bolivia) **trimaculata,** new species (p. 57)
   Prothorax with indefinite brownish area sometimes clouding most of pronotum, or subsiding to an indefinite median spot, body beneath mostly black (Perú) **vittipennis** Boheman (p. 46)

37. Prothorax with the middle spot wide. 38
Prothorax with the middle spot narrow. 39
38. Small (5–6.5 mm.), body beneath pale with dark legs (Argentina) **prolixa** Harold (p. 66)
Larger (6.5–7 mm.), body beneath often dark with pale femora (Colombia) **cordigera,** new species (p. 50)
39. Lateral pronotal spots stretched out in a narrow neck [toward] the median spot (Argentina, Paraguay, Chile, Brazil, Uruguay) **copulata** (Germar) (p. 67)
Lateral pronotal spots not stretched out towards median spot in a narrow neck 40
40. Legs entirely dark (Paraguay, Brazil). . . . **plaumanni** Costa Lima (p. 68)
Legs not entirely dark (New York to Argentina) **glabrata** (Fabricius) (p. 43)

Disonycha pensylvanica (Illiger)

Figure 2

Haltica pensylvanica Illiger, Mag. Insekt., vol. 6, p. 146, 1807.
?*Galleruca sexlineata* Olivier, Entomologie, vol. 6, p. 642, 1808 (Bengal).
Disonycha pensylvania Sturm, Catalogue, p. 283, 1843.—Blake, Bull. Brooklyn Ent. Soc., vol. 25, p. 210, 1930.
Disonycha pennsylvanica Crotch, Proc. Acad. Nat. Sci. Philadelphia, vol. 25, p. 64, 1873.—Horn, Trans. Amer. Ent. Soc., vol. 16, p. 202, 1889 (in part).
Disonycha pennsylvanica var. *parva* Blatchley, Journ. New York Ent. Soc., vol. 29, p. 16, 1922 (Knox County, Indiana).
Disonycha pensylvanica Blake, Proc. U. S. Nat. Mus., vol. 82, pp. 12, 13, 1933.

Between 5 and 6 mm. in length, elongate oblong oval, not very convex, shining, although faintly alutaceous; head, antennae, undersurface except pale tip of abdomen, and legs dark; prothorax with a broad dark spot or band; elytra with moderately wide sutural and submarginal vittae not quite uniting at apex or sometimes broadly uniting, and median vitta having a costa down it, sometimes in female with several costae.

Head dark, except for the pale area about antennal sockets, short and broad, the interocular space about half the width of head, occiput faintly alutaceous and smooth, with a cluster of coarse punctures about fovea on either side; carina short, acute and little produced. Antennae entirely dark, rather long. Prothorax twice as wide as long with nearly straight sides, and faintly depressed along base; shining although faintly alutaceous and finely and not densely punctate. Elytra not very convex, with a faint median costa in male, several in female, shiny, feebly alutaceous and with fine punctures, the dark sutural and submarginal vittae usually uniting at apex, sometimes not, median vitta moderately wide, epipleura with dark inner edge. Body beneath and legs entirely dark except the tip of abdomen and the sides of prosternum. Length 5 to 6 mm., width 2.8 to 3 mm.

TYPE: In ZMB, from Pennsylvania.

OTHER LOCALITIES: United States: From Massachusetts to Texas. Honduras: La Ceiba (one specimen).

REMARKS: Only one specimen is known from south of the border, but it is quite conceivable that the species, which is known to occur in Texas and which feeds on *Polygonum*, may extend all through Central America. It is one of the group with costate elytra, more apparent in the female, and is related to the Central American species *D. recticollis* Jacoby, but is smaller and darker with pronotal spotting.

Disonycha procera Casey

FIGURE 1

?*Haltica vicina* Kirby, Fauna Boreali Americana, vol. 4, p. 217, 1837 ("Lat. 65°," Canada; type lost).

?*Disonycha limbicollis* var. *pallipes* Crotch, Proc. Acad. Nat. Sci. Philadelphia, vol. 25, p. 64, 1873 (type locality not recorded, type lost).

Disonycha procera Casey, Contributions . . . , pt. 2, p. 182, 1884 (Milford, Delaware, type in USNM).

Disonycha pennsylvanica Horn, Trans. Amer. Ent. Soc., vol. 16, p. 202, 1889 (in part).

Disonycha pallipes Blake, Bull. Brooklyn. Ent. Soc., vol. 25, p. 212, 1930 (not Crotch?).

Disonycha nigriventris Schaeffer, Journ. New York Ent. Soc., vol. 39, p. 282, 1931 (Blitzen River, Oregon, type in USNM).

Between 6.5 and 7 mm. in length, elongate oblong oval, faintly shining, alutaceous; head black, with pale area about antennal sockets; prothorax pale with or without five dark spots; elytra pale with reddish brown to piceous sutural, median, and submarginal vittae not united at apex; body beneath dark, the tip of abdomen pale, legs sometimes entirely dark or sometimes the femora pale.

Head with interocular space more than half the width of head, short lower front, area between antennal sockets somewhat flat, moderately wide, a cluster of coarse punctures about fovea near eye; except for pale area over labrum and about antennal sockets, head dark. Antennae dark and rather long. Prothorax not quite twice as wide as long, with rounded sides, rather flat, a basal depression over the scutellum and a slight hump on either side with resulting depression below; surface finely alutaceous and finely punctate; pale yellow with five small dark spots, or entirely pale. Scutellum dark. Elytra faintly alutaceous, not very shiny, very finely punctate; a faint trace of median costa in the male, more developed in female, pale yellow with deep reddish brown to piceous vittae, the sutural and submarginal vittae not united at the apex, the median one wide. Epipleura pale. Body beneath mostly dark, the tip and sometimes sides of abdomen pale, the femora either pale or piceous, tibiae and tarsi dark. Length 6.5 to 7 mm.; width 2.5 to 2.7 mm.

Type: USNM 49223, from Milford, Delaware.

Other localities: United States: Maine to British Columbia and south to Texas. México: Tepic.

Remarks: Although the vittae of the single specimen from México examined are not quite so dark as is usual in specimens from the United States, it is possible that this specimen is immature and not fully colored. Since *D. procera* occurs in Texas it undoubtedly ranges southward into México and it may occur even farther south. It is one of the group with costate elytra that feeds on *Polygonum*.

Disonycha recticollis Jacoby

Figure 5

Disonycha recticollis Jacoby, Biologia Centrali-Americana, Coleoptera, vol. 6, pt. 1, p. 313, 1884.

Between 6 and 8 mm. in length, narrowly oblong, somewhat shiny, the elytra faintly alutaceous; pale yellow brown; a dark occipital band behind the eyes; a somewhat rectangular unspotted prothorax; the elytra with a narrow sutural vitta connecting feebly at apex with a narrow submarginal vitta, median vitta not very wide, and in female especially having a costa down the middle; body beneath with breast and part of abdomen usually dark, femora pale, tibiae at apex, sometimes entirely, dark, tarsi dark.

Head with interocular space more than half its width, smoothly rounded over occiput except for the fovea near eye, impunctate, frontal tubercles not well marked, often a depression between and above them, interantennal area flat and rather wide, not carinate, pale yellow, with dark mouthparts and a dark occipital band running across to behind the eyes. Antennae long, usually with the three basal joints paler than rest. Prothorax not twice as wide as long, with slightly curved sides, somewhat rectangular in shape, not very convex, feebly depressed over scutellum and on sides near base, shining, impunctate, immaculate. Elytra elongate and not very wide, with a costa down the median vitta in the female, less marked in male, finely alutaceous and finely punctate; pale yellow with a narrow dark sutural vitta uniting feebly or sometimes not at all with a very narrow submarginal vitta; median vitta not very wide. Epipleura pale. Body beneath with the breast and usually basal segments of abdomen dark, sometimes all but last segment dark. Femora pale, tibiae varying from being entirely dark to being dark only at apex, tarsi dark. Length 5.7 to 8 mm., width 2.5 to 3.5 mm.

Type: Not designated; cotypes in BM, also in MCZ (8) and USNM (2) from Costa Rica, van Patten collector; another specimen, in USNM, from Purulhá, Baja Vera Paz, Guatemala, Champion, a locality not mentioned by Jacoby.

Other localities: México: Cordova, Vera Cruz, F. Knab. Guatemala: Antigua, J. K. Aldrich; San José de Pinula, W. M. Mann; Livingston, Charles Deam; Tamahú, 3,500 ft., C. and P. Vaurie. Costa Rica: Paso Ancho, S. Sebastián, C. H. Ballou, on *Vernonia brachiata* Bentham; Waldeck, C. H. Ballou, on *Polygonum punctatum* Elliott; Hamburg Farm, Reventazón, Ebene Limón, F. Nevermann; San Pedro de Montes de Oca, C. H. Ballou, on *Lycopersicon esculentum* Miller; San Francisco de Ríos. Nicaragua: Chontales, T. Belt. Panamá: Porto Bello, A. Busck.

Remarks: This is another *Disonycha* with costate elytra related to *D. procera* Casey and *D. conjugata* (Fabricius) of the United States. It feeds primarily on *Polygonum*. It is a slender insect without pronotal spotting.

Disonycha bicarinata Boheman

Figure 9

Disonycha bicarinata Boheman, *in* Kongliga Svenska Fregatten *Eugenies* resa omkring jorden . . . , åren 1851–53, vol. 2, Zoologi, pt. 1, Insecta, p. 190, 1859.

Between 6.5 and 8 mm. in length, elongate oblong oval, alutaceous, somewhat shiny; pale yellow; a broad piceous band over back of head; 5-spotted prothorax; elytra with narrow sutural, median, and submarginal vittae, not uniting at apex, a costa down the median vitta, most pronounced in the female; body beneath mostly dark with the femora mostly reddish brown.

Head shining, usually impunctate except for the large fovea or group of punctures near eye, interocular space approximately half the width of head; frontal tubercles distinct, a broad flat interantennal area not much produced, a deep piceous band across the entire back of head, sometimes the front darkened, the mouthparts dark. Antennae long, deep brown to piceous, with the basal joints pale-edged. Prothorax twice as wide as long, not very convex, somewhat depressed over the scutellum and at the sides, surface shining, impunctate, not distinctly alutaceous, with five spots, the largest on the side, the median one elongate. Elytra elongate, a costa along the narrow median vitta, this most pronounced in the female, the narrow sutural vitta not uniting at the apex with the very narrow submarginal one; surface finely punctate and alutaceous, not very shiny. Epipleura with a brownish edge. Body beneath covered with a dense fine pale pubescence, the prosternum dark in the middle and with a large dark spot on either side, breast entirely dark, abdomen dark along edges and apex, sometimes along base of each segment, femora reddish brown with the tibiae and tarsi darker brown. Length 6.5 to 8 mm.; width 3.5 to 4 mm.

Type: In Naturhistoriska Riksmuseet, Stockholm, from Buenos Aires, Argentina.

Other localities: Argentina: Añatuya, Santiago del Estero, Monrós; Isla Martín García, Buenos Aires, M. Viana; Concordia, Entre Ríos, M. A. Cazier; Corrientes, N. Kisliuk; Flores, Buenos Aires; Formosa, A. Martínez; Pampas; Quinta; Reconquista, H. L. Parker; Río Santiago, Buenos Aires, Monrós; San Isidro, Buenos Aires, Monrós; San Pedro de Calalao, Trancas, Tucumán, Monrós; Santiago del Estero, Monrós; Tucumán, G. F. Moznette; Paysandú, P. A. Berry. Paraguay: Asunción, A. Martínez. Chile: Germain.

Remarks: This species belongs to that group of *Disonycha* having elytral costae that feeds on Polygonaceae. There are three other closely related species from South America and one (*D. recticollis*) from Central America as well as several from the United States. In all, the head markings are very much the same, the elytra have a tendency to have a costa or costae more pronounced in the female, and the aedeagi resemble each other markedly. In an article by Frers (Physis, vol. 4, pp. 565–567, 1919) the biology of *D. bicarinata* is given and the food plant is reported as *Mühlenbeckia sagittifolia* Meisner (Polygonaceae).

Disonycha immaculata, new species

Figure 7

About 7 mm. in length, elongate oblong, somewhat shining, although finely alutaceous and finely and rather densely punctate; pale yellow brown; dark band across the occiput behind the eyes, dark outer joints of the antennae; dark scutellum and slightly darkened sutural edges; elytra with a trace of a submarginal vitta, median vitta narrow; the body beneath with the breast and abdomen except at apex dark, legs pale, with the tarsi dark.

Head with interocular space more than half width of head, smooth over occiput except for the circle of punctures about fovea near eye, frontal tubercles visibly marked, space between antennal sockets broad, not much produced, lower front rather short, with a small dark labrum; a dark band across occiput behind the eyes. Antennae long, dark except the three basal joints that are pale-edged. Prothorax scarcely twice as broad as long, with curved sides, not very convex, a slight depression on each side at base and over the scutellum; surface faintly shining, finely alutaceous and finely punctate. Scutellum dark. Elytra pale with the sutural edges slightly darkened and a similar slight trace of submarginal vitta not extending to the apex, the median vitta narrow but clearly defined; other specimens darker with wider elytral vittae; surface finely alutaceous and finely punctate. Body beneath with the breast entirely dark and the abdomen having the first segments dark, becoming paler at apex; legs with the femora and tibiae pale, tarsi dark. Length 7.2 to 8.2 mm., width 3.4 to 4 mm.

TYPE: Male, MCZ 29043, from Rio Grande do Sul, Brazil.

OTHER LOCALITIES: Brazil: Santa Catarina Province, Corupá (Hansa Humbolt), Rio Vermelho, Rio Natal, Pinhal, all collected by A. Maller, in AMNH; Blumenau, "S. O. Brazil" (Reitter); Rio de Janeiro (2nd Jacoby collection); Santa Catarina, Lüderwaldt (1st Jacoby collection), Bahia (2nd Jacoby collection, Bowditch collection). In the British Museum (Fry collection) are specimens from Paraná and Rio de Janeiro and one from Rio de Janeiro, collected by C. Darwin.

REMARKS: These specimens all come from the southeastern part of Brazil. They are very similar to *D. bicarinata* Boheman from Argentina, but are in general a little stouter and always without pronotal spotting above or a darkening of the prosternum below. The abdomen tends to be darker than in *D. bicarinata*, and the tip of the aedeagus is wider although of the same general shape. The specimens from Santa Catarina province are darker and with wider elytral vittae than the single male from Rio Grande do Sul.

Disonycha varia, new species

FIGURE 8

Between 7 and 8 mm. in length, elongate oblong, alutaceous, moderately shiny; the elytra distinctly punctate and rather widely margined; head dark on occiput; prothorax entirely pale; elytra with dark sutural vitta joining at apex with narrow submarginal vitta, a moderately wide median vitta with a costa running down the middle; body beneath, except prosternum, more or less dark, femora pale, tibiae and tarsi deeper brown.

Head with interocular space about half its width, a darkening over occiput, the mouthparts darker, a cluster of punctures on either side of head near eye, tubercles not well defined, carina broad, little produced, lower front rather short. Antennae long, extending almost to the middle of the elytra, the three basal joints paler, the rest dark. Prothorax twice as wide as long, with curved, moderately wide explanate margin, depressed at sides of base and over the scutellum, entirely pale, shiny, only faintly alutaceous, very finely punctate. Elytra with a noticeably wide, pale, explanate margin, the dark sutural vitta joining with the submarginal vitta at apex, a moderately wide median vitta and in this a costa, more pronounced in the female;

surface alutaceous and moderately densely and coarsely punctate. Body beneath covered with short pale fine pubescence, in the one specimen examined the breast alone dark, the femora pale, the tibiae tending to be deeper brown and the tarsi brown. Length 7 mm., width 3.8 mm.

Type: Male, USNM 61808, from near Pará, Brazil, Miss H. B. Merrill.

Remarks: This is another of the species having costate elytra especially marked in the female. It is closely related to *D. bicarinata* Boheman and *D. immaculata* but is more densely and coarsely punctate. In the one specimen examined the undersurface is not so dark as in these other species, with only the breast dark.

***Disonycha yurimaguensis*, new species**

Figure 3

About 7 mm. in length, elongate oblong, alutaceous and feebly shining; yellow; a dark band across occiput; prothorax in one of the two specimens 5-spotted, the other immaculate, and in a series of five from Perú (in BM) all have immaculate prothorax; elytra with moderately wide sutural and median vittae, not joined with the submarginal vitta, body beneath with breast and basal part of abdomen dark, legs pale with a dark streak along sides of tibiae and dark tarsi.

Head with interocular space a little more than half width of head, smooth over occiput except for a circle of punctures about fovea near eye; frontal tubercles distinct, area between antennal sockets broad and rounded, not much produced, a dark band across occiput behind eyes, the labrum dark. Antennae long, dark, with the three basal joints pale edged. Prothorax about twice as wide as long with curved sides, slightly depressed at base, on sides, and over scutellum, not very convex, somewhat shiny, one specimen of the type series entirely pale, the other 5-spotted, the lateral spots being the largest, in a series from Perú (in BM) the prothorax entirely pale. Elytra elongate, finely alutaceous, not very shiny and very finely and densely punctate, a moderately wide, dark sutural vitta and a narrower submarginal one not reaching the apex, the median vitta with a trace of costa; epipleura in part dark. Body beneath with breast and base of abdomen dark, femora pale, tibiae darkened along sides, tarsi dark, the claw joint paler. Length 6.5–7.4 mm.; width 3.2–3.4 mm.

Type: Male, MCZ 29037, and paratype, male, USNM 61809, from Yurimaguas, Perú.

Other localities: A series of five specimens from Perú in BM.

Remarks: This is another species closely related to *D. bicarinata*

Boheman. Only males have been examined but there is a slight trace of costa in some of these. The coloring seems a little darker than in the Central American species *D. recticollis* Jacoby, and the aedeagus differs only slightly from the other South and Central American species of the group.

Disonycha pluriligata (LeConte)

Figure 15

?*Altica quinquevittata* Say, Journ. Acad. Nat. Sci. Philadelphia, vol. 4, p. 88, 1824 ("Missouri"; type lost).

Haltica pluriligata LeConte, Proc. Acad. Nat. Sci. Philadelphia, vol. 4, p. 27, 1858 (Kansas and Texas; type in LeConte collection, MCZ).

Disonycha pluriligata LeConte, Smithsonian Contr. Knowl., vol. 11, p. 25, 1859.—Blake, Proc. U. S. Nat. Mus., vol. 82, art. 28, pp. 25–28, 1933.

Disonycha capitata Jacoby, Biologia Centrali-Americana, Coleoptera, vol. 6, pt. 1, p. 316, 1884 (no type designated).

Disonycha quinquevittata Horn, Trans. Amer. Ent. Soc., vol. 16, p. 203, 1889 (in part).—Jacoby, Biologia Centrali-Americana, Coleoptera, vol. 6, suppl., p. 276, 1891.—Schaeffer, Journ. New York Ent. Soc., vol. 39, p. 279, 1931.

Between 6.5 and 7.5 mm. in length, elongate oblong oval, somewhat shining; pale; head with occiput, labrum, and often tubercles darker; pronotum usually 5-spotted, lateral spots sometimes evanescent; elytra with sutural, median, and submarginal vittae; metasternum, in part, and apex of tibiae and tarsi dark.

Head with interocular space slightly more than half its width; tubercles distinctly marked, carina not acute, broad and slightly produced; coarse punctures about fovea on each side of head near eye, but median space usually smooth; pale, with labrum, usually tubercles, and occiput darker. Antennae robust, dark, with paler basal joints, third joint shorter than fourth or fifth, which are subequal with the fourth longer. Prothorax not twice as wide as long, narrowed a little anteriorly, with only slightly arcuate sides, not very convex, a slight callosity on either side in basal half and a median basal depression; surface alutaceous and finely punctate; pale with five spots, sometimes lateral spots and median stripe evanescent. Scutellum dark. Elytra with parallel sides, somewhat convex, humeri well developed and an intrahumeral sulcus; on lateral apical half a trace of the ridges characteristic of the *pensylvanica* group, and slightly more developed than in *alternata:* surface alutaceous and finely punctate; vittae usually wider than in *alternata* except in the southwestern specimens, and the sutural and submarginal often rather feebly joined at apex. Body beneath densely and somewhat coarsely pubescent, pale, with metasternum in part, usually the middle, dark; apex of tibiae and tarsi dark. Length 6.8 to 7.8 mm., width 3.5 to 4.4 mm.

Type: In MCZ (LeConte collection), from Kansas.

Other localities: United States: Tennessee to Colorado and southwards, *D. pluriligata* var. *pura* (LeConte) in Arizona and California. México: Rosario, Sinaloa, J. A. Kusche; Los Mochis, Sinaloa, M. Marquis; Tamazunchale, San Luis Potosí, C. and P. Vaurie; Tuxpan, W. M. Mann; 5 miles south of Acaponeta, Nayarit, H. B. Leech; Cataviña, Baja California, Michelbacker and Ross.

Remarks: In my earlier treatment of *Disonycha* in the United States I synonymized *D. capitata* Jacoby with *D. pluriligata* var. *pura* (LeConte), basing this chiefly on the specimens from "North Sonora, Mexico" (really from Arizona) collected by Morrison that were in the Bowditch collection of Jacoby's material. Since then I have examined specimens from the other localities given above in México and believe that Jacoby must have had both the forms, as he gives also Tuxtla and Cosmaloapam, México, and El Zapote, Panzós, Guatemala. This species is allied to *D. latiovittata* Hatch, and is of the *alternata* group that occurs on willow.

Disonycha latiovittata Hatch

Figure 13

Haltica puncticollis LeConte, *in* Reports of explorations and surveys to ascertain the most practicable . . . route for a railroad from the Mississippi River to the Pacific Ocean, vol. 9, No. 1, Insects, p. 67, 1857 (=vol. 12, pt. 3, p. 67, 1860; type in LeConte collection, MCZ; not *Haltica puncticollis* Kirby, 1837).

Disonycha puncticollis Gemminger and Harold, Catalogus Coleopterorum, p. 3497, 1876.—Gentner, Canadian Ent., vol. 58, p. 149, 1926.

Disonycha quinquevittata Horn, Trans. Amer. Ent. Soc., vol. 16, p. 203, 1889 (in part).

Disonycha quinquevittata var. *puncticollis* Schaeffer, Journ. New York Ent. Soc., vol. 39, p. 280, 1931.

Disonycha latiovittata Hatch, Pan-Pacific Ent., vol. 8, No. 3, p. 108, 1932.—Blake, Proc. U. S. Nat. Mus., vol. 82, art. 28, pp. 23–24, 1933.

Between 6 and 7 mm. in length, broadly oblong oval, somewhat shiny, prothorax densely punctate; pale; head with labrum and often occiput dark; pronotum with 4 or 5 spots; elytra with sutural, median and submarginal vittae, usually metasternum in middle; apex of tibiae and tarsi dark.

Head with interocular space slightly more than half width of head; carina not acute, broad and produced, frontal tubercles somewhat swollen, well marked; coarsely and rugosely punctate; pale, with labrum, sometimes also tubercles and occiput, dark. Antennae stout, dark, with paler basal joints; third joint shorter than fourth or fifth which are subequal, the fourth slightly longer. Prothorax twice as broad as long, not very convex, with a callosity on each side on basal half and slight median depression near base; somewhat narrowed anteriorly with arcuate sides; surface alutaceous and densely punctate, not shiny; pale, generally with four spots, the median stripe usually either obsolete or reduced to a dot. Scutellum dark. Elytra broadly oblong, sides parallel, somewhat convex; humeri well marked, with a distinct intrahumeral sulcus; surface alutaceous, somewhat shining, moderately coarsely and densely punctate; sutural and submarginal vittae usually united at apex, vittae broad in Washington and Oregon specimens, but often rather narrow in the California specimens, and in these the median vitta sometimes interrupted. Body beneath densely pubescent, pale, usually with the middle of metasternum, apex of tibiae, and tarsi dark. Length 6 to 7.2 mm.; width 3.2 to 3.8 mm.

Type: In collection of M. H. Hatch, from Nisqually, Washington.

Other localities: Canada: British Colombia. United States: Washington, Oregon, California, Wyoming. México: Baja California, "N. Boundary, Godman-Salvin coll.," 1907.

Remarks: The synonymy of this species has been dealt with in my earlier revision of North American species of *Disonycha*. This species is closely related to *D. pluriligata* (LeConte) but is distinguished by having a more densely and coarsely punctate thorax.

Disonycha teapensis Blake

Figure 12

Disonycha teapensis Blake, Proc. U. S. Nat. Mus., vol. 82, art. 28, pp. 38, 39, 1933.
Disonycha horni Jacoby, Biologia Centrali-Americana, Coleoptera, vol. 6, suppl., p. 295, 1891 (in part).

About 7.5 mm. in length, elongate oblong, not shining; yellow; pronotum uneven and with two dark spots anteriorly; elytra with traces of costae in female, and with dark sutural, median, and submarginal vittae; undersurface with middle of metasternum and about coxae dark.

Head with interocular space about half width of head, smooth in the middle, with punctures on either side near eye; tubercles distinct, interantennal area somewhat produced, but not acutely so; pale, with narrow dark occipital band, somewhat darkened over tubercles and the labrum dark. Antennae extending about to the middle of the elytra, dark, with paler basal joints, fourth joint nearly twice as long as third. Prothorax not twice as wide as long, with arcuate sides; disk uneven, with lateral callosities; surface alutaceous, indistinctly punctate; pale, with two well-marked anterior dark spots. Scutellum dark. Elytra oblong, with parallel sides, humeri pronounced, with a short, deep intrahumeral sulcus; in female traces of costae in apical half of elytra; surface alutaceous, indistinctly punctate; sutural, median, and submarginal dark vittae not twice so wide as pale intervening vittae; the submarginal and sutural vittae sometimes uniting at apex. Body beneath finely pubescent, pale, the middle of the metasternum, area about coxae, and most of the tibiae and tarsi dark. Length 7.5 to 7.8 mm.; width 4 mm.

Type: Male, and three paratypes, USNM 43651, from Teapa, Tabasco, México, collected in March by H. H. Smith. Other paratypes from same locality in BM and in MCZ (Bowditch collection).

Other localities: México: Tamazunchale, San Luis Potosí, G. E. Bohart.

Remarks: Under *Disonycha horni* Jacoby are confused two species, of which one is *D. fumata* (LeConte) and the other this species. In my earlier account of this I discussed the specimens in the collections at length and disposed of the name *horni* as a synonym of *D. fumata* (LeConte). *D. teapensis* belongs to the *alternata* group, having a similar uneven pronotum and traces of elytral costae in the female. It most closely resembles *D. pluriligata* var. *pura*, a Sonoran form. *D. teapensis*, on the other hand, comes from the lowlands of southeastern México. It is more slender than *pluriligata*, the head is smoother, and the aedeagus has a broadly pointed tip, which is broader than in any of the other species in that group that possess an acute tip.

In the Bowditch collection are specimens from Jacoby's second collection with the locality Zacualtipán, Hidalgo, México, Höge collector, that are placed under *Disonycha horni* Jacoby but are Horn's *Disonycha tenuicornis*. No mention of this locality is given in the Biologia Centrali-Americana.

Disonycha arizonae Casey

Figure 33

Disonycha arizonae Casey, Contributions . . . , pt. 1, p. 52, 1884.

Disonycha glabrata Jacoby, Biologia Centrali-Americana, Coleoptera, vol. 6, pt. 1, p. 311, 1884 (in part).

Disonycha davisi Schaeffer, Journ. New York Ent. Soc., vol. 32, p. 141, 1924 (from New Jersey, type USNM 42426).—Blake, Proc. U. S. Nat. Mus., vol. 82, art. 28, pp. 29–30, 1933.

Between 4.5 and 6.5 mm. in length, oblong oval, feebly shining, with moderately densely punctate prothorax and elytra; pale; usually with a small dark spot on occiput and dark labrum, tubercles sometimes dark; two anterior spots on prothorax; sutural, median, and submarginal elytral vittae; apex of tibiae and tarsi dark.

Head with interocular space more than half the width of head; frontal carina not acute, broad and somewhat produced, tubercles well marked but flat; middle of occiput and front usually smooth, with some coarse punctures about fovea near eye; pale, with usually a small spot in middle of occiput, the tubercles frequently brown and the labrum always dark. Antennae short, dark with paler basal joints. Prothorax a little more than twice as wide as long, somewhat convex, a little narrowed anteriorly, with sides arcuate; surface more or less distinctly and quite densely punctate, alutaceous; pale, with two anterior dark spots not close together and somewhat oblique. Scutellum dark. Elytra broadly oblong oval, convex, with humeri not prominent and without intrahumeral sulcus; surface alutaceous, somewhat shining, densely and often coarsely punctate; sutural, median and submarginal vittae only moderately wide, the submarginal one uniting with sutural at apex. Body beneath usually finely and densely pubescent, but in Arizona specimens only sparsely pubescent; entirely pale, the apex of tibiae and tarsi brown, and sometimes the middle of the anterior femora with a brown marking. Length 4.6 to 6.5 mm., width 2.6 to 3.2 mm.

Type: Female, USNM 49225 (Casey collection), from Arizona, collected by H. K. Morrison.

Other localities: United States: From Maine to Arizona. It has been taken in shipments from México: one in purslane and another on vegetables, both taken at El Paso, Texas, and a third in a *Selaginella* plant from San Miguel de Guanajuata, taken at Laredo, Texas.

Remarks: It may be that this species occurs commonly in México although only the three specimens recorded above are known from there. The Biologia material labeled "N. Sonora, Mexico," Morrison collector, is really from Arizona. As stated in my earlier revision, this last was identified as *D. glabrata* (Fabricius), presumably by Jacoby.

Disonycha sapucayensis, new species

Figure 35

About 5 mm. in length, oblong oval, shining although finely alutaceous; pale yellow; the head with a dark occipital spot and usually dark tubercles and labrum; pronotum with two small spots anteriorly and traces of a median and sometimes two faint lateral spots; elytra with narrow sutural, median, and submarginal vittae not joined at apex; body beneath pale, with the tibiae and tarsi tending to be deeper brown.

Head elongate, the interocular space more than half the width of head, a somewhat produced moderately wide carina, the area under the antennal sockets deeply excavated, upper vertex with coarse punctures on either side, sometimes nearly across front, a dark spot on occiput, tubercles and also labrum tending to be dark. Antennae short and stout, with pale basal joints. Prothorax almost twice as broad as long, with curved sides and a slight depression over scutellum, moderately convex, faintly alutaceous, shiny, very faintly punctate, pale yellow with two dark spots anteriorly and traces of a median basal spot and sometimes one on each side laterally. Scutellum brown. Elytra faintly alutaceous and very finely punctate, shining, deep reddish brown or piceous sutural, median, and submarginal vittae, not uniting at apex, the sutural vitta scarcely reaching the apex. Epipleura pale. Body beneath and legs pale, the tibiae at apex and tarsi deeper brown. Length 5 to 5.5 mm., width 2.5 mm.

TYPE: Male, and one male and one female, paratype, USNM 61810, from Sapucai, Paraguay, collected in February by W. T. Foster; paratype, male, in MCZ.

REMARKS: This appears to be similar to the North American species *D. arizonae* Casey. The markings and aedeagus are similar, but it is a smooth and not coarsely punctate beetle.

Disonycha guatemalensis Jacoby

FIGURE 31

Disonycha guatemalensis Jacoby, Biologia Centrali-Americana, Coleoptera, vol. 6, pt. 1, p. 312, 1884.

Between 6 and 7 mm. in length, oblong oval, pronotum shining, nearly impunctate, elytra faintly alutaceous and finely punctate; pale yellow; dark antennae; unspotted pronotum; elytra with moderately narrow dark sutural vitta connecting with narrow submarginal vitta at apex, median vitta not very wide; body beneath and legs except sometimes tip of tibiae and tarsal joints pale.

Head with interocular space about half width of head, a circle of coarse punctures on either side of vertex, frontal tubercles marked by a median groove, carina broad and somewhat produced, lower front long, labrum brown, head otherwise pale except sometimes a faint brownish spot on occiput. Antennae short, dark, except for paler basal joints. Prothorax approximately twice as broad as long, moderately convex, slightly depressed over scutellum, shining, impunctate, without distinct spotting, although in some specimens very faint traces of 5 spots, the middle one elongate. Elytra shining although faintly alutaceous, finely but distinctly punctate, a narrow dark sutural vitta joining at apex with submarginal vitta, and a median vitta not very wide. Epipleura mostly dark. Body beneath entirely pale, legs pale, with apex of tibiae sometimes darkened, tarsi dark. Length 6 to 6.9 mm., width 2.8 to 3.4 mm.

TYPE: Not designated by Jacoby; cotypes in BM, also one in the Jacoby material in MCZ (Bowditch collection), from Zapote, Guatemala.

Other localities: México: Río Antonio, Oaxaca, F. E. Knab; Puente de Ixtla, Morelos, Wickham; Río Balsas, Guerrero, Wickham; two specimens taken at border in shipments of pineapple from México. Honduras: Minas de Oro, Comayagua, 4,000 ft., J. B. Edwards. British Honduras: Manatee District, Peck. Guatemala: Antigua, J. E. Melhus.

Remarks: This is one of the oblong-oval species and resembles somewhat *D. admirabilis* Blatchley of North America, although larger and more polished. The aedeagus is much like that of *D. arizonae* Casey, but the beetle itself lacks the coarse punctation and the dark pronotal spots.

Disonycha figurata **Jacoby**

Figure 42

Disonycha figurata Jacoby, Biologia Centrali-Americana, Coleoptera, vol. 6, pt. 1, p. 314, 1884.

From 6 to 8 mm. in length, oblong oval, faintly shining, finely alutaceous, finely punctate; pale yellow; the antennae dark with paler basal joints, femora darkly streaked, apex of tibiae and tarsi dark; prothorax usually with two dark spots anteriorly; elytra usually with faint, washed-out, narrow sutural and submarginal vittae, joined at apex, and a median vitta, sometimes these vittae are normally piceous; sometimes the breast is dark in the middle.

Head with widely separated eyes, polished over occiput, a fovea near each eye with a circle of punctures about it, frontal tubercles distinct, carina broad and rounded, pale yellow with the mouthparts often and tubercles sometimes brown. Antennae dark, with paler basal joints. Prothorax not twice as broad as long, with arcuate sides, faintly depressed over scutellum and on sides, rather shiny and indistinctly punctate, usually with two dark spots anteriorly, occasionally with only very faint traces of these spots, sometimes traces of lateral spotting. Scutellum washed-out, grayish. Elytra distinctly alutaceous and finely punctate, pale with pale grayish, not very distinct vittae, the sutural one joining with the submarginal one at the apex, and a median vitta, sometimes these vittae fully colored and piceous. Body beneath densely covered with a yellowish pubescence, usually entirely pale but sometimes with a reddish brown area in the middle of the breast, femora with a deep brown or piceous streak, the hind ones more heavily darkened, tibiae dark at apex, tarsi dark. Length 6 to 8 mm., width 3.2 to 4.3 mm.

Type: Not designated; cotypes in BM, also in MCZ (Bowditch collection, 4), and in USNM (2), from Capetillo, Guatemala, Champion.

Other localities: México: Cerro Azul, Estadode, Vera Cruz; Cerro de Plumas, Höge; Chapala, Jalisco, Lattimore; Volcán de Colima, Jalisco, L. Conrad; Chihuahua, Wickham; Chilpancingo, Guerrero, 4,400 ft., H. H. Smith; Guerrero, R. Miller; Xantipa, Guerrero, H. H. Smith; Xucumanatlán, Guerrero, 7,000 ft., H. H. Smith; Rio Balsas, Guerrero, Wickham; Cuernavaca, Morelos, Wickham, also collected there by N. L. H. Krauss on *Eupatorium adenophorum* Sprengel; Joyutla, Puente de Ixtla, Morelos, Wickham; Guadalajara, Buller; Jalapa, William Schaus; San Angel, D. F. Wickham; Teapa, Tabasco, H. H. Smith; Tepetlapa, Oaxaca, 3,000 ft., H. H. Smith; Tuxtepec, Oaxaca, J. Camelot; Oaxaca, Höge and L. O. Howard; Ventanas, 2,000 ft., Forrer; Monclova, Coahuila, E. Palmer. Guatemala: Antigua, E. G. Smith, Yepocapa, H. T. Dalmat. Honduras: Minas de Oro, Comayagua, 4,000 ft., J. R. Edwards; San Luis, Comayagua, 2,500 ft., J. R. Edwards. Costa Rica: Alajuelita, on *Crotalaria mucronata* Desvaux, C. H. Ballou. United States: Arizona: Mount Washington, near Nogales.

Disonycha fumata (LeConte)

Figures 10, 11

Haltica fumata LeConte, Proc. Acad. Nat. Sci. Philadelphia, vol. 4, p. 86, 1858.
Disonycha alternata var. *fumata*, Gemminger and Harold, Catalogus Coleopterorum, p. 3496, 1876.
Disonycha crenicollis Horn, Trans. Amer. Ent. Soc., vol. 16, p. 204, 1889.—Jacoby, Biologia Centrali-Americana, Coleoptera, vol. 6, pt. 1, p. 316, 1884 (in part; not *Altica crenicollis* Say).
Disonycha alternata Jacoby, Biologia Centrali-Americana, Coleoptera, vol. 6, pt. 1, p. 311, 1884 (in part).
Disonycha horni Jacoby, Biologia Centrali-Americana, Coleoptera, vol. 6, supple., p. 275, 1891 (in part; type, in BM, from Puebla, México).
Disonycha fumata Schaeffer, Journ. New York Ent. Soc., vol. 27, p. 334, 1919. Blake, Proc. U. S. Nat. Mus., vol. 82, Art. 28, pp. 36–42, 1933.
Disonycha labiata Jacoby, Entomologist, vol. 34, p. 148, 1901. (type, in BM, from México).

Between 5.5 and 8 mm. in length, oblong oval, faintly shining, finely alutaceous; pale yellow; dark antennae, a narrow dark occipital band; thorax from 2- to 5-spotted, sometimes immaculate; elytra with a narrow sutural vitta uniting narrowly at apex with submarginal vitta, the median vitta not very wide; body beneath with breast and apex of femora and tibiae and tarsi usually dark; antennae long.

Head with interocular space about half width of head, smooth, shining, with a circle of punctures about fovea near eye, sometimes with light pubescence, the frontal tubercles marked by a median depression, area between antennal sockets rather wide, not produced, somewhat flat, the head with a dark band at base, sometimes the tubercles darkened and mouthparts dark. Antennae longer than usual, dark, with the three basal joints pale edged. Prothorax scarcely twice as wide as long, moderately convex, with rounded sides, not much evidence of basal depression; finely alutaceous, pale, with from two to five more or less distinct dark spots, or in some specimens the spots very indistinct or lacking. Elytra moderately convex, less oblong and more rounded than in many species, finely alutaceous, a narrow dark sutural and submarginal vitta uniting at apex more or less distinctly, the median vitta not very wide; epipleura usually dark edged. Body beneath with breast usually dark and a dark streak on femora, or the apex dark, tibiae and tarsi dark. Length 5.5 to 8 mm., width 2.8 to 3.8 mm.

Type: In MCZ (LeConte collection), from Texas and New Mexico.

Other localities: United States: Alabama, Missouri, Texas, Arizona. México: Cuernavaca, Morelos, Wickham; Chiapas, Wickham; Delicias, Chihuahua, C. and P. Vaurie; Mexico City, Höge; Paso de Telago, San Rafael, Jicaltepec; Vera Cruz; Tabasco; Tuxpan, Jalisco; Villa Lerdo, Durango, Höge; Las Parras, Baja California, W. M. Mann; 20 miles north of Comondú, Baja California, Mickelbacher and Ross. Guatemala: Acatenango, Antigua, I. E. Melhus; Chimaltenango, Nebaj, 6,000 ft., C. and P. Vaurie; Quiriguá, W. P. Cockerell; Salamo, C. and P. Vaurie; Senahú, Alta Verapaz, Paul Haase; Yepocapa. Honduras: La Ceiba, F. J. Dyer; Tegucigalpa, F. J. Dyer. Costa Rica: Cartago, Agua Caliente, F. Nevermann; Guayabillos, southwest slope of Volcán Irazú, 2,200 m., F. Nevermann; Navarro, W. R. Maxon; San José, F. Nevermann, Schild and Burgdof, M. Valerio; San Pedro de Montes de Oca, C. H. Ballou, on *Jacaranda*.

Remarks: In my earlier revision of the species of *Disonycha* north of México, I wrote at length of the confusion concerning the name for this species, and of Jacoby's treatment of it. Jacoby appears never to have recognized LeConte's species and to have confused the various color forms as much as did Schaeffer. One of these color forms that I did not treat in my earlier revision because I did not have access to the type is the one that Jacoby described as *Disonycha labiata*. Mr. J. Balfour-Browne has sent me a specimen he has compared with the type, a male; it is a pale form of *D. fumata* LeConte without pronotal spots but otherwise corresponding. The determining characters of this slender oval species are the long antennae, the long narrow head with dark labrum, and the long narrow prothorax. The head is often sparsely pubescent above, a condition rather unusual in the genus.

Disonycha knabi, new species

FIGURE 14

From 4.8 to 5.5 mm. in length, oblong oval, moderately shining although finely alutaceous, very finely punctate; pale yellow; deep reddish brown antennae, occiput, frontal tubercles, and tarsal joints; two large dark reddish brown pronotal spots more or less combined anteriorly; dark brown narrow sutural and submarginal elytral vittae not united at the apex, and a moderately broad dark median vitta.

Head with interocular space a little more than half the width of the head, the lower front somewhat elongate, carina long, broad, slightly produced, frontal tubercles swollen and well marked, usually dark, occiput deep reddish brown, polished, a cluster of coarse punctures on either side near eye, labrum dark, one specimen with a fovea in the middle of the occiput. Antennae deep reddish brown, rather short, the distal joints broad. Prothorax not twice as broad as long, moderately convex, with rounded sides and little trace of basal depression over scutellum, shining, impunctate, pale yellow with two large piceous spots anteriorly, sometimes coalescing and usually with a deep brownish area between them and below them, sometimes faint traces of a smaller pale brown lateral spot on each side. Scutellum dark. Elytra somewhat shiny although finely alutaceous and very finely punctate, pale, with a narrow dark sutural vitta and a submarginal vitta not united at apex and a moderately broad median vitta. Epipleura pale. Body beneath and femora and tibiae pale, the tarsal joints deep reddish brown. Length 4.8 to 5.5 mm., width 2.5 to 2.8 mm.

TYPE: Male, and two paratypes, female, USNM 61811, and one paratype, MCZ, all taken by Frederick Knab at Acapulco, México, on July 27.

REMARKS: In its oval shape and markings on the pronotum this species somewhat resembles *D. fumata* LeConte, but *D. knabi* is a smaller and paler species with shorter antennae. The aedeagus is somewhat like that of *D. fumata*.

Disonycha tenuicornis Horn

FIGURE 17

Disonycha tenuicornis Horn, Trans. Amer. Ent. Soc., vol. 16, pp. 201, 208, 1889.—Blake, Proc. U. S. Nat. Mus., vol. 82, art. 28, p. 32, 1933.

Between 6 and 7 mm. in length, oblong oval, somewhat shiny, elytra finely alutaceous; pale yellow; a small dark spot on either side of base of head; two small dark spots anteriorly on the prothorax; very narrow sutural and median elytral vittae, sometimes a trace of a submarginal vitta near apex; legs pale, a dark streak on femora and tibiae, broader at apex on hind femora; antennae unusually long.

Head with interocular space a little more than half width of head, the carina broad and rounded, lower front short, tubercles distinctly marked, a cluster of punctures on either side near eye, the color pale, with a dark mark at extreme base of occiput on either side, often fading into reddish brown behind the eyes, mouthparts deeper in color. Antennae unusually long and slender, extending to the middle of the elytra, dark with the basal joints pale edged. Prothorax about twice as wide as long, moderately convex, with a slight depression over scutellum, the sides rounded; pale yellow with two small dark spots anteriorly, surface shiny, almost impunctate. Scutellum pale or edged with dark. Elytra not as shiny as prothorax, faintly alutaceous, almost impunctate, pale yellow with very narrow sutural and median dark vittae, often only the sutural edges darkened, and this not to base, sometimes at apex a trace of a submarginal dark vitta. Epipleura pale. Body beneath usually pale but in certain Mexican specimens a deepening in color on some abdominal segments, femora and tibiae with a dark streak above, widening on the hind femora at apex, and sometimes a dark spot on the outside of hind femora; tibiae also with a dark streak and tarsi dark. Length 6 to 7.3 mm., width 3 to 3.5 mm.

Type: In Academy of Natural Sciences of Philadelphia (Horn collection), from southern Arizona, H. K. Morrison.

Other localities: United States: New Mexico: Alamogordo, Organ Mountains; Arizona: Chiricahua Mountains, Cochise County; Texas: McKelligon Canyon, near El Paso, larvae feeding on *Salvia vinacea* Wooton and Standley, H. S. Barber. México: Zacualtipán, Hidalgo, Höge; Jacala, Hidalgo, 4,500 ft., Ralph Haag, 1939.

Remarks: H. S. Barber collected this rare species in numbers on *Salvia vinacea* near El Paso, Texas. Previously it had been known only from Arizona and New Mexico. Under *D. horni* Jacoby in the Jacoby material in the Bowditch collection are three specimens collected by Höge at Zacualtipán, Hidalgo, México, that are a little darker than the more northern specimens but clearly *D. tenuicornis* Horn. The long slender antennae, the 2-spotted prothorax, and the narrow elytral vittae coupled with the shape of the aedeagus characterize this species. It is not closely related to any other. *D. figurata* Jacoby has somewhat the same markings in the darker specimens with dark vittae, but is a more slender beetle and the vittae are wider.

Disonycha leptolineata var. *texana* Schaeffer

FIGURE 16

Disonycha abbreviata var. *leptolineata* Blatchley, Canadian Ent., vol. 49, p. 143, 1917 (Dunedin, Florida, cotype in USNM).

Disonycha texana Schaeffer, Journ. New York Ent. Soc., vol. 27, p. 339, 1919 (Brownsville, Texas, type in USNM).

Disonycha leptolineata var. *texana* Blake, Proc. U. S. Nat. Mus., vol. 82, art. 28, p. 45, 1933.

From 6.5 to 8 mm. in length, elongate oblong oval, smooth, shining, faintly alutaceous, impunctate; pale yellow; the head and pronotum without dark spotting; elytra with sutural and median vittae; body beneath pale with the breast often dark, femora pale, tibiae with dark streak, tarsi dark.

Head with interocular space more than half its width, smooth, impunctate except for the large fovea near eye, tubercles not prominent, space between antennal sockets wide and rounded, head usually entirely pale except for a deepening in the color of mouthparts. Antennae with the three basal joints pale, the rest dark. Prothorax about twice as wide as long, not very convex, slightly depressed over scutellum, faintly alutaceous, impunctate and without markings. Elytra also rather flat, faintly alutaceous, pale with sutural and median vittae. Epipleura pale. Body beneath usually pale with the breast sometimes dark, femora pale, tibiae with a dark streak, tarsi dark. Length 6.7 to 8 mm.; width 4 mm.

TYPE AND PARATYPE: USNM 42422, from Brownsville, Texas.

OTHER LOCALITIES: United States: From southern Virginia to Texas and west to Arizona. México: Volcán de Colima, Jalisco, L. Conrad; Izamal, Yucatán, Townsend; Tehuantepec, Oaxaca, F. Knab; Puente de Ixtla, Morelos, Wickham; Sierra de Durango; also on shasta daisy, lettuce, tomato, peppers, turnips, and other vegetables from México, intercepted at the border. Guatemala: Antigua, E. Melhus; El Quiché.

REMARKS: This is a more heavily marked species than *D. militaris* Jacoby, with wider vittae, and apparently more northern in range. It is very difficult to find any real structural differences between the members of this group which extend from Pennsylvania to Perú.

Disonycha militaris Jacoby

FIGURE 4

Disonycha militaris Jacoby, Biologia Centrali-Americana, Coleoptera, vol. 6, pt. 1, p. 314, 1884.

From 6 to 8.5 mm. in length, elongate oblong oval, faintly shining, very finely alutaceous, pale yellow; dark antennae, a dark streak on tibiae, and dark tarsi; elytra with a very narrow dark median and sutural vitta; body beneath pale.

Head usually entirely pale, smooth, shining, a fovea near eye, frontal tubercles rather faintly marked, carina narrowly produced, lower front not long, interocular space more than half the width of the head. Antennae with the basal joints pale, apical one sometimes paler than the dark ones preceding it. Prothorax about twice as wide as long, with arcuate sides, rather depressed over the scutellum, smooth and impunctate, faintly alutaceous, entirely pale. Scutellum pale. Elytra pale, with a very narrow dark sutural and median vitta, finely alutaceous and very indistinctly punctate. Body beneath entirely pale, femora pale, the tibiae with a dark outer streak, tarsi deep brown or piceous. Length 6 to 8.8 mm., width 3 to 4.2 mm.

Cotypes: In BM and MCZ (Bowditch collection).

Other localities: México: San Pedro; specimens in banana debris from México. Guatemala: "Cacao Trece Aguas," Alta Verapaz, Schwarz and Barber; Panzós, 100 ft., C. and P. Vaurie; Panamá, Suchitepequez, 2,500 ft., C. and P. Vaurie; 14 miles up Los Patos River, Suchitepequez; Zapote, Champion; in banana debris from Guatemala. Honduras: La Ceiba, F. J. Dyer; also in banana debris from Honduras. El Salvador: San Andrés, E. J. Hambleton. Nicaragua: In banana debris. Canal Zone: Cristóbal, N. L. H. Krauss, A. H. Jennings. Colombia: one specimen in banana debris.

Remarks: This is another of the group to which *D. abbreviata* Melsheimer and *D. leptolineata* Blatchley belong. Unlike the others, except the Florida form of *D. leptolineata*, this has very narrow elytral vittae. Unlike *D. leptolineata* var. *texana* Schaeffer, the breast is not dark. Jacoby gives México, Guatemala, and Panamá as localities for this species. Representing his material in the Bowditch collection is a specimen from David, Chiriquí, Panamá, collected by Champion, that is without a submarginal elytral vitta. There are also three others in the Bowditch collection from Guatemala, one a female with a submarginal vitta and a differently shaped scutellum and prothorax, and another a female from Comitán with a similar submarginal stripe. Both of them are slightly larger and paler and I believe they are *Disonycha* (*Cacoscelis*) *quinquelineata* (Latreille).

Disonycha antennata Jacoby

Figure 18

Disonycha antennata Jacoby, Biologia Centrali-Americana, Coleoptera, vol. 6, pt. 1, p. 35, 1884.

Disonycha albida Blatchley, Canadian Ent., vol. 56, p. 169, 1924 (Big Pine Key, Florida).

Between 6 and 8 mm. in length, elongate oblong oval, somewhat shiny, very faintly alutaceous; pale yellow; dark antennae, a dark outer streak on tibiae, and dark tarsi; rarely with faint traces of a median elytral vitta.

Head with interocular space more than half the width of head, smooth over occiput, a fovea on each side near the eye, frontal tubercles distinct, carina rounded, head entirely pale. Antennae short, robust, with the three basal joints tending to be paler and sometimes the apical joint pale, the rest dark. Prothorax not twice as wide as long, with arcuate sides, a slight median depression at base over the scutellum, surface shiny, faintly alutaceous, impunctate, entirely pale. Scutellum pale. Elytra entirely pale except in two specimens of a series of 24 from Tuxtepec, México, in which is discernible a faint trace of a reddish brown median vitta on each elytron; surface impunctate, faintly alutaceous, somewhat shiny. Body beneath entirely pale, sparsely pubescent, femora pale, tibiae with a dark outer streak, tarsi dark. Length 6.3 to 8 mm.; width 3 to 4 mm.

Cotypes: In BM, also in MCZ (Bowditch collection, 2), one from Panistluahuaca, the other from Jalapa, México, Höge.

Other localities: United States: Big Pine Key, Florida. México: Atoyac, Vera Cruz, H. H. Smith; Volcán de Colima, Jalisco, L. Conrad; Capulalpan, Cuernavaca, Morelos, H. H. Smith; Amula, Guerrero, 6,000 ft., H. H. Smith; La Venta, Guerrero, 300 ft., H. H. Smith; Río Balsas, Guerrero, Wickham; Tuxtla, Oaxaca; Tuxtepec, Oaxaca, J. Camelot and M. Fraire; many specimens intercepted at the border in banana trash.

Remarks: Although this is normally an entirely pale species, there are two examples in a series of typically pale specimens with a trace of reddish brown median vittae. The aedeagus is very similar to others of the group to which it belongs (a group which includes *D. leptolineata* Schaeffer, *D. militaris* Jacoby, and *D. peruana* Jacoby, and the more northern species *D. abbreviata* Melsheimer).

Disonycha peruana Jacoby

Figures 21, 22

Disonycha peruana Jacoby, Proc. Zool. Soc. London, vol. 1, p. 402, 1904.

About 7.5 mm. in length, elongate oblong oval, moderately shiny, faintly alutaceous; pale yellow; head with a dark occipital spot extending down front and widening over frontal tubercles; pronotum with a dark margin and a lateral dark marking curving up behind the eye, also a dark lateral spot and two dark spots anteriorly sometimes joined with an elongate median one; elytra with a narrow dark sutural vitta, a median vitta, sometimes a marginal vitta joining at apex with the sutural; body beneath and femora pale, tibiae and tarsi more or less dark.

Head pale except for the narrow dark mark extending from the occiput down to the frontal tubercles and widening over the tubercles, smooth, with only a large fovea near the eye, frontal tubercles distinctly marked, interocular space a little more than half the width of the head, carina (in cotype) with a dark streak, a little produced, lower front rather short. Antennae with the basal joints either partly pale or pale edged, the rest dark, apical joint light brown. Prothorax approximately twice as wide as long, not very convex, a little depressed over the scutellum, pale with a dark explanate margin, or a lateral darkening, curving up behind the eye, a lateral spot on each side and two anterior spots sometimes confluent with a median elongate mark; surface faintly alutaceous and impunctate. Elytra likewise faintly alutaceous and impunctate, somewhat shiny, pale with a narrow dark sutural vitta uniting at apex with a marginal vitta when the latter is present, median vitta narrow. Epipleura pale in specimens lacking marginal vitta, otherwise dark or with darkened edge. Body beneath entirely pale, shiny, lightly pubescent, femora pale, tibiae dark or with a dark streak, tarsi dark. Length 6.8 to 7.7 mm., width 3.5 to 4 mm.

Cotypes: In BM (2), from Perú.

Other localities: Colombia: one specimen from the Jacoby material in MCZ (Bowditch collection); one from "R. Dagna," W. Rosenberg; one, in USNM, taken alive in orchids from Colombia. Venezuela: La Providencia, Maracay, L. F. Martorell. Canal Zone: Red Tank, Nathan Banks; Barro Colorado Island, J. Zetek. Costa Rica: Chiriquí.

Remarks: Because of the small number of specimens examined, I hesitate to try to differentiate between those from North and South America. The cotype from Perú examined, a male, has a dark elytral margin and an aedeagus that has a longer tip than that of a single male from Costa Rica. The aedeagus of a specimen from the Canal Zone, although the specimen is paler and lacks the dark marginal vitta, is more like that of the Peruvian male. This species belongs to the group to which *D. militaris* Jacoby and *D. leptolineata* Schaeffer also belong. The aedeagi of all are very similar, and the markings of the beetles vary so that it is very difficult to draw a line between the pale specimens of *D. peruana* and the typically marked specimens of *D. militaris.* Jacoby in his description of *D. militaris* mentioned two varieties, one with and the other without submarginal vittae, and I presume he had specimens similar to the one from the Canal

Zone. Whether *D. peruana* and *D. militaris* are of varietal or specific status seems at present impossible to determine.

In regard to the label Chiriquí, Costa Rica, I have found a number of specimens so labeled that belong elsewhere, for example *Disonycha spilotrachela* Blake, known only from the West Indies, and *Disonycha bicarinata* Boheman, from Argentina. Therefore I believe this specimen may also be wrongly labeled.

Disonycha quinquelineata (Latreille)

FIGURE 29

Altica quinquelineata Latreille, *in* Humboldt and Bonpland, Voyage aux regions equinoxiales du nouveau continent fait en 1799, 1800, 1801, 1802, 1803, et 1804, vol. 1, No. 9, Insectes, p. 232, 1811.

Cacoscelis quinquelineata Dejean, Catalogue de la collection de Coléoptères . . . , ed. 3, p. 414, 1837.

Between 7.5 and 10.5 mm. in length, elongate oblong, shining, finely and obsoletely punctate; antennae dark; pronotum unspotted; elytra with narrow dark sutural, submarginal, and median vittae not uniting at apex; tarsal joints deeper brown or piceous.

Head with interocular space fully half the width of head, smooth, shining, impunctate except for a fovea or cluster of punctures near the eye, frontal tubercles faintly marked, carina narrow, a little produced, lower front moderately long. Antennae dark except for the three basal joints, rather long. Prothorax not twice as wide as long, often with anterior angles somewhat notched (although this is variable), sides rounded, disc not very convex and depressed over scutellum, surface shining, minutely punctate, entirely pale. Scutellum varying from pale to entirely dark. Elytra shining, very finely and obsoletely punctate, pale, the sutural edges darkened in paler specimens or a narrow sutural vitta in more heavily marked specimens, a narrow submarginal one and a narrow median vitta, none uniting at apex. Epipleura pale. Body beneath and legs pale, the tarsi frequently deeper in coloring. Length 7.5 to 10.7 mm.; width 4 to 5 mm.

TYPE: Whereabouts not known; described from "L'Amerique equinoxiale."

OTHER LOCALITIES: México: Almoloya, Oaxaca, F. Knab; Tampico, E. A. Schwarz; Tenosique, Tabasco; Guerra; Tabasco, Palmer. Guatemala: Mocá, Suchitepequez, 3,000 ft., C. and P. Vaurie. Costa Rica: Hamburg Farm, Reventazón, Ebene Limón, Nevermann; San Carlos, Zarcero, Schild and Bergdof. Nicaragua: Managua. Canal Zone: Barro Colorado Island, J. Zetek; Tobago Island, A. Busck; Toro Point, E. A. Schwarz; Gatún, A. H. Jennings; Red Tank, N. Banks. Colombia: Aracataca; Santa Marta; Sevilla, Magdalena

Province, P. J. Darlington. Many miscellaneous specimens intercepted at the border on bananas from México, Guatemala, Honduras, Costa Rica, and Panamá.

REMARKS: This species has long been classified under the genus *Cacoscelis*. There is, however, no generic character that I can find to separate it from the vittate Disonychas. There is no emargination of the middle or hind tibiae such as occurs in some species classified under the genus *Cacoscelis*. Latreille in his original description wrote that *quinquelineata* had a great affinity with *Disonycha caroliniana* (Fabricius). I believe that it is simply an unusually large species of *Disonycha* but not much larger than *D. militaris* or species of the *alternata* group. At least one specimen has been confused by Jacoby with *D. militaris* Jacoby (see note under *D. militaris*). This and the following species, as well as *D. stenosticha* Schaeffer from Brownsville, Texas, belong to a group of closely related species.

Disonycha jalapensis, new species

FIGURE 28

Between 8 and 9 mm. in length, elongate oblong, shining; pale yellow; antennae, tarsal joints, and tibiae (more or less) deep reddish brown; very narrow reddish brown sutural, median and submarginal elytral vittae.

Head with interocular space a little more than half width of head, entirely pale, polished over occiput to antennal sockets, a fovea or cluster of punctures on either side near eye, frontal tubercles not very clearly marked, carina somewhat produced and extending down front with the area beneath antennal sockets depressed, lower front moderately long. Antennae moderately long and slender, the three basal joints paler, the rest deep reddish brown. Prothorax not twice as broad as long, the sides rounded, smooth, without depressions, flat rather than depressed over the scutellum, front angles not unusually prominent or notched, entirely pale, shining. Scutellum pale reddish brown. Elytra smooth, polished, very obsoletely and faintly punctate, pale yellow with reddish brown sutural edges and thin median and submarginal vittae, the last two not reaching the apex, epipleura pale. Body beneath and femora entirely pale, tibiae in part, at least, and tarsal joints deep reddish brown. Length 8 to 9.4 mm.; width 3.8 to 4.3 mm.

TYPE: Male, and paratypes, 2 females and 1 male, in AMNH, and male, USNM 61812, from Jalapa, México, W. Schaus.

OTHER LOCALITIES: One specimen in MCZ (Bowditch collection, 1st Jacoby collection), from Vera Cruz, México, Sallé.

Remarks: This is very close to *Disonycha quinquelineata* (Latreille) and only the difference in the aedeagus makes me regard it as separable. There are three minor differences—the tibiae and tarsi are deep reddish brown instead of being pale yellow, and there is a difference in the shape of the anterior angles of the prothorax, these being smaller and less deeply notched than in *D. quinquelineata.* The third small difference is in the relative length of the third and fourth antennal joints. In the Jalapa specimens the fourth joint is not twice as long as the third, whereas in the case of *D. quinquelineata,* the third joint is shorter and about half as long as the fourth. In general the Jalapa specimens are not quite so large. Possibly this is the same as *D. stenosticha* Schaeffer described from Brownsville, Texas. The basal angles of the prothorax do not appear as oblique as in that species. But since *D. stenosticha* is known from only two specimens, both females, this specific question cannot be settled at this time.

***Disonycha colombiana*, new species**

Figure 27

Between 7 and 8 mm. in length, elongate oblong oval, shining, elytra very faintly punctate; prothorax short, broad, and with nearly straight sides and wide anterior angles; pale yellow; head and prothorax without dark markings; elytra with very narrow sutural, median, and submarginal reddish brown vittae, not joined at apex; body beneath entirely pale, anterior tibiae with a dark streak.

Head entirely pale, polished over occiput, a coarse puncture or two on either side near eye, frontal tubercles outlined, carina rather narrow and short, although the lower front is long, with excavations under antennal sockets on each side; interocular space approximately half width of head. Antennae long, slender, the fourth joint not quite twice as long as third; basal joints paler, rest of joints reddish brown. Prothorax twice as wide as long, with nearly straight sides and wide anterior angles, a slight callosity on each side near base and a slight basal depression over the scutellum; surface shiny, nearly impunctate, pale yellow, one of the two specimens with a faint trace of pronotal spotting. Scutellum pale. Elytra broad and widely margined, shining, very faintly punctate, pale yellow with narrow reddish brown sutural, median and submarginal vittae not joined at apex. Epipleura pale. Body beneath entirely pale, the anterior tibiae with a dark outer streak, tarsal joints reddish brown. Length 7.3 to 8 mm., width 4 mm.

Type: Female, MCZ 29038, and paratype, female, USNM 61813, from Aracataca, Magdalena Province, Colombia, P. J. Darlington.

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REMARKS: This is about the same size as *D. quinquelineata* (Latreille) and resembles it in being entirely pale except for the antennae and the narrow elytral vittae, but unlike *quinquelineata* it has a dark streak on the anterior tibiae. The prothorax is quite different in shape, being short and broad and with wide apical angles, and resembles that of the group of species represented by *D. nigrofasciata* (Jacoby). Unfortunately the only two specimens are females.

Disonycha brevilineata Jacoby

FIGURES 23, 25

Disonycha brevilineata Jacoby, Biologia Centrali-Americana, Coleoptera, vol. 6, pt. 1, p. 317, 1884.

Disonycha brevicollis Jacoby, Proc. Zool. Soc. London, vol. 1, no. 13, p. 188, 1902.

From 6 to 7 mm. in length, broadly oblong oval, moderately shiny, densely punctate; pale yellow; head sometimes with a small dark occipital spot; prothorax without dark spots; elytra with a very narrow sutural darkening and a narrow marginal one uniting usually at the apex, and a narrow median vitta with a short one beside it near the apex and towards the margin, sometimes coalescing in darker specimens; body beneath with the breast usually more or less dark, apex of hind femora often dark and tarsi dark.

Head with interocular space more than half its width, alutaceous and with coarse punctures across front and about eyes, frontal tubercles distinctly defined and the space between antennal sockets broad and a little produced, sometimes a dark occipital spot but frequently the head except for the dark mouthparts entirely pale. Antennae dark with paler edged basal joints, rather short. Prothorax about twice as broad as long, moderately convex, with a slight depression over the scutellum, faintly alutaceous and usually rather densely punctate; usually entirely pale, although in one specimen two faint spots anteriorly. Elytra broad, rather convex, shining, densely and moderately coarsely punctate with finer punctures intermixed, pale yellow, usually with a very narrow sutural vitta, often just the sutural edges darkened, a narrow marginal or submarginal vitta and a median vitta with a short one near the apex, occasionally in a darker specimen the vittae broader and the margin dark, in some specimens the short vitta entirely absorbed into the median vitta, giving it a club-shaped tip; epipleura pale except in specimens with a dark margin. Body beneath usually with the breast more or less dark, the hind femora with dark apex, and the tibiae often darker at apex, tarsi dark. Length 6 to 7 mm., width 3.5 to 3.8 mm.

TYPE: In BM, from Capulalpam, México, Sallé. The type of *D. brevicollis* Jacoby is not designated, but Jacoby stated that he had two specimens from Ventanas, México. One of these may be the specimen in MCZ (Bowditch collection) that bears the name label and also "Ventanas, Durango, Höge, Jacoby 2nd collection." In some unnamed material lent me by the British Museum are three other specimens of this series from Ventanas; they bear the label (?Jacoby's) "*Disonycha* sp. nov."

Other localities. México: Chapala, Jalisco, R. B. Lattimore; Cuernavaca, Morelos, Sallé. Guatemala: Yepocapa, H. T. Dalmat; Tucurú, 1,600 ft., C. and P. Vaurie; Chiquimula, 1,000 ft., C. and P. Vaurie. Honduras: Tegucigalpa, F. J. Dyer. El Salvador: Dr. Vera Wellborn.

Remarks: Jacoby failed to recognize certain pale specimens of this species in which the short apical line is very faint and described them as *D. brevicollis* nearly twenty years after he had described *D. brevilineata*. All these specimens from Ventanas are very pale but on close examination one can discern the short apical vitta.

Disonycha ovata Blake

Figure 24

Disonycha ovata Blake, Bull. Brooklyn Ent. Soc., vol. 26, p. 79, 1931.

About 5 mm. in length, oval, shining, elytra distinctly punctate; pale yellow; deeper orange head, prothorax, and legs; narrow dark sutural, median, and submarginal elytral vittae not uniting at the apex; antennae and tarsi deeper brown.

Head with interocular space half width of head, the occiput and mouthparts deeper in coloring, smooth except for the circle of punctures near eye, frontal tubercles well marked, carina rounded and moderately wide. Antennae with basal three or four joints and sometimes apical joint pale, rest brownish. Prothorax a little more than twice as wide as long at base, with nearly straight sides narrowed anteriorly, somewhat convex, a slight transverse basal depression over scutellum and at sides, surface faintly alutaceous and very finely punctate. Elytra moderately convex, shining, distinctly and rather densely punctate, pale yellow, with narrow dark sutural vitta not uniting with narrow submarginal vitta, a narrow median vitta; epipleura pale. Body beneath pale, shining beneath the fine pubescence, legs pale except the dark brown tarsi and brownish apices of tibiae. Length 4.8 to 5.3 mm., width 2.7 to 2.9 mm.

Type and paratypes: USNM 43363, from San Salvador, El Salvador, August 16, 1905, Frederick Knab. Another specimen from Santa Tecla, no other data.

Remarks: The small oval shape and short prothorax of this species are its distinctive characters. It is smaller than *D. brevilineata* Jacoby but similar in the shape of the prothorax.

Disonycha högei Jacoby

FIGURE 26

Disonycha högei Jacoby, Biologia Centrali-Americana, Coleoptera, vol. 6, pt. 1, p. 315, 1884.

Between 7 and 8 mm. in length, elongate oblong oval, shining; pale yellow; dark antennae, a small dark spot on occiput; median elongate diamond-shaped spot on pronotum; dark scutellum; elytra with faint paler lines as if marking the edge of a median vitta; body beneath and legs except tarsi pale.

Head with interocular space just half the width of head, a small dark dot on occiput, smoothly rounded, a fovea near eye, tubercles small, well marked, a bit swollen, carina produced, lower front moderately long, labrum reddish brown. Antennae long, slender, black except that the three basal joints are pale edged and the apical joint deep reddish brown. Pronotum just about twice as wide as long, with wide anterior angles, sides nearly straight, disc slightly depressed over scutellum, entirely pale except the dark diamond-shaped spot in the middle, impunctate, faintly alutaceous. Scutellum dark. Elytra pale, with only the sutural edges darkened, two faint lines that are paler on each elytron, as if outlining the edges of a median vitta, surface shining, impunctate. Body beneath pale except the darkened apices of the tibiae and dark tarsi. Length 7.7 mm., width 4 mm.

TYPE: Not designated; cotype, female, in MCZ (Bowditch collection), from Cerro de Plumas, México, Höge; others probably in British Museum.

REMARKS: Only one specimen has been examined. The pale yellow coloring with very faint paler lines outlining an elytral vitta is unusual and distinctive.

Disonycha brunneofasciata Jacoby

FIGURE 36

Disonycha brunneofasciata Jacoby, Biologia Centrali-Americana, Coleoptera, vol. 6, pt. 1, p. 317, 1884.

About 7 mm. in length, oblong oval, shining; pale yellow; sometimes with a deep brown occipital spot; usually with five reddish brown pronotal spots more or less marked; elytral vittae usually reddish brown edged with deeper brown, the wide sutural vitta joining the narrower submarginal one at apex, the median one moderately wide; antennae with deeper brown outer joints; tarsi deeper brown.

Head with interocular space slightly wider than half the width of head, occiput polished and smoothly rounded down to the smooth, poorly marked frontal tubercles, these sometimes deeper brown, a cluster of coarse punctures or fovea on either side near eye, space between antennal sockets wide and flat, not much produced, lower front rather short, mouthparts and, in darker specimens, a spot on occiput deeper brown. Antennae moderately long, with the four basal joints pale in paler specimens, rest reddish brown. Prothorax approximately twice as broad as long, shining, impunctate, moderately convex, yellow brown, with five more or less distinct reddish brown spots, the two anterior ones the most deeply marked. Elytra alutaceous and very finely punctate, somewhat shining, pale yellow, with wide sutural and median vittae, the sutural one at apex joining with a narrow submarginal one, all these vittae edged with deeper brown. Legs and undersurface pale, in darker specimens edge of abdomen and legs mostly dark, tarsi always darker brown. Length 6.6 to 7.5 mm.; width 3.5 to 4 mm.

TYPE: Not designated by Jacoby, who stated that he had 10 specimens and gave the habitat as Hondo River, British Honduras, Blancaneaux collector. In MCZ (Bowditch collection) are four specimens from the type locality, and one from Acapulco, México, Höge collector, a locality not mentioned by Jacoby. The rest of the type series is in the British Museum.

OTHER LOCALITIES: México: San Luis Potosí, two specimens taken by the inspector of vegetables at Nogales, Arizona.

REMARKS: The pale reddish brown elytral vittae are edged with deeper brown, a feature not present in related species. The two specimens from San Luis Potosí have nearly as dark vittae as usual, but upon careful examination the deeper colored edge can be discerned.

Disonycha gracilis, new species

FIGURE 37

About 6 mm. in length, elongate oblong oval, faintly shining, finely alutaceous and finely punctate; pale yellow; reddish brown to piceous antennae and tibiae and tarsi; faint brownish areas on prothorax; narrow dark sutural, submarginal, and median elytral vittae not united at apex.

Head with interocular space more than half the width of head, lower front not long, with short, broad carina, well developed tubercles, a double row of punctures from the large fovea near eye down to antennal sockets, head pale in one specimen, in the other with a small dark spot on the occiput. Antennae long, varying from pale to deep reddish brown. Prothorax considerably less than twice as broad as long, with rounded sides and faint basal depression over the scutellum, pale yellow, with two dark spots anteriorly and fainter reddish brown areas on either side; surface finely alutaceous. Scutellum dark. Elytra elongate, pale yellow, with narrow sutural, median, and submarginal vittae not united at the apex; surface faintly shining, finely alutaceous and finely punctate. Epipleura with dark edge. Body beneath and femora entirely pale yellow, tibiae and tarsi reddish brown, the first tarsal joint in the anterior pairs of legs much enlarged in the male. Length 5.6 to 6.2 mm., width 2.3 to 2.5 mm.

Type: Male, USNM 61814 (from the Biologia Centrali-Americana material), Jalapa, México, Höge collector. A male in BM (Fry collection) is labeled Truqui, México.

Remarks: The striking characteristics of this species, represented by only two specimens, are its slender, elongate shape and the unusual shape of the aedeagus, with its darkly chitinized areas. The type specimen, evidently from the Biologia material, has been dissociated from its original arrangement so that I cannot tell under which species Jacoby placed it. There was also a specimen among the unidentified material sent me from the British Museum.

Disonycha turrialbensis, new species

Figure 34

About 8 mm. in length, elongate oblong oval, shining, pronotum impunctate, elytra very finely and shallowly punctate; deep yellowish brown; elytra with deeper reddish brown sutural, submarginal, and median vittae not joined at apex.

Head with interocular space approximately half width of head, moderately elongate, with a somewhat produced but not very wide carina, frontal tubercles only feebly defined, head polished, impunctate except for a couple of deep foveae on either side near eye, yellowish brown, the labrum a bit darker. Antennae missing. Prothorax not twice as wide as long, moderately convex, with rounded sides and a slight depression over scutellum, shiny, mirror smooth, entirely yellowish brown. Scutellum deep reddish brown. Elytra very shiny and finely punctate, with a somewhat irregular reddish brown sutural vitta and deeper brown submarginal vitta not united at apex, the median vitta moderately wide. Body beneath and legs entirely yellowish brown. Length 7.8 mm., width 3.8 mm.

Type: Male, MCZ 29044, from Turrialba, Costa Rica.

Remarks: This species, represented by only one specimen which lacks antennae and parts of the legs, is not closely related to any other.

Disonycha pittieri, new species

Figure 4

About 6 mm. in length, oblong oval, moderately shiny although faintly alutaceous; head without definite dark occipital spot; pronotum with two round deep brown spots anteriorly, and in one specimen three other very faint spots, two lateral and one elongate median spot; elytra with narrow dark brown sutural vitta joining at apex with narrow submarginal one, also a narrow median vitta; the body beneath and legs entirely pale.

Head entirely pale except the deeper reddish brown mouthparts and faint occipital spot, interocular space more than half the width of the head, occiput smooth and shiny, a circle of punctures on either side of vertex, frontal tubercles deeply marked by a median groove, carina short and broad. Antennae deep brown with the three basal joints paler. Prothorax twice as wide as long, not very convex, with a faint depression over the scutellum, surface moderately shiny, very finely punctate, two deep brown roundish spots anteriorly and traces of two lateral round ones and a median elongate one. Elytra broad and not very convex, faintly alutaceous and very finely punctate, pale yellow, with a narrow, deep brown sutural vitta joining at the apex with a narrow lateral one, also a narrow median one, epipleura pale, sometimes with brownish edge. Body beneath entirely pale with moderately dense pale pubescence; legs pale, the tarsal joints deep brownish. Length 5.8–6 mm.; width 3 mm.

Type: Male, and one paratype, female, USNM 61815, collected on savannas at Acarigua, Portuguesa Province, Venezuela, by H. Pittier; one paratype, male, in MCZ.

Remarks: There are only three specimens of this small pale species known. The aedeagus resembles somewhat that of *D. spilotrachela* Blake of the West Indies. A single specimen, a female, in BM (Fry collection), from Bahia, Brazil, may be this species.

Disonycha spilotrachela **Blake**

Figure 6

Disonycha spilotrachela Blake, Bull. Brooklyn Ent. Soc., vol. 23, p. 96, 1928.

Between 5 and 6 mm. in length, oblong oval, somewhat shiny although faintly alutaceous, elytra finely punctate; pale yellow; head with a pointed dark occipital spot; prothorax 5-spotted; elytra with a narrow sutural and submarginal vitta, united at apex, and a median vitta; the body beneath and femora pale, anterior femora dark streaked and the tibiae darker at tip, tarsi and antennae dark.

Head with interocular space fully half width of head, pale with a dark and usually pointed occipital spot and dark mouthparts, a circle of coarse punctures on either side of front near eye, tubercles well marked, a broad, rounded, but short carina. Antennae dark, with the three basal joints with a pale edge. Prothorax about twice as wide as long, somewhat convex with a slight depression over scutellum, smooth, impunctate, somewhat shiny, pale with four dark spots arranged in a semicircle over pronotum, and a small median basal spot. Elytra faintly alutaceous, very finely punctate and somewhat shiny, pale yellow with a narrow sutural vitta uniting at apex with a narrow submarginal vitta, also a moderately wide median vitta; epipleura brownish with a pale edge. Body beneath entirely pale, covered with pale pubescence, femora pale, the anterior ones dark streaked, tibiae usually dark along edges and at apex and tarsi dark. Length 4.8 to 6.2 mm., width 2.5 to 2.8 mm.

Type and paratype: In USNM 40977, from San Juan, Puerto Rico, collected by W. A. Hoffman.

Other localities: Puerto Rico: Mayagüez, Lago Tortuguera, Boquerón, Aguadilla, (last three collected by Stuart T. Danforth in March 1929); Algarroba, Santurce, C. G. Anderson. Cuba: Camagüey, July 29, 1923, J. Acuña. Haiti: Port de Paix, E. C. and G. M. Leonard; Mon Fleri, 1924, W. A. Hoffman; Cape Haïtien, W. M. Mann. Isle of Pines.

Remarks: This small West Indian species is rather widely dispersed over the islands of Cuba, Puerto Rico, and Haiti. It is strongly suggestive of the Venezuelan species, *D. pittieri*, but is more slender and with dark head markings.

Disonycha gowdeyi Bryant

Figure 39

Disonycha gowdeyi Bryant, Ann. Mag. Nat. Hist., ser. 9, vol. 14, p. 250, 1924.

Between 7.5 and 8 mm. in length, oblong oval, very shiny, impunctate, not alutaceous; pale; the head with a dark oblong spot on occiput, darkened tubercles and dark mouthparts; pronotum 7-spotted; elytra with the dark vittae sometimes shining with a violet luster, a wide sutural vitta, not joined at apex with a narrow submarginal vitta, and a wide median vitta; body beneath pale, femora dark at apex, tibiae pale in the middle, tarsi dark.

Head smooth except for the fovea on each side near eye, shining, pale, the lower front rather elongate and narrow, deeply excavate under antennal sockets, carina moderately narrow, interocular space about half the width of the head, tubercles darkened and a dark spot on occiput and dark mouthparts. Antennae unusually long and slender, with the three basal joints paler than the dark outer joints. Prothorax twice as wide as long, with wide anterior angles and straight sides, not very convex and depressed along base over the scutellum, impunctate, shiny, pale yellow, with seven moderately large dark spots. Elytra very shiny, impunctate, with wide dark sutural and median vittae, often shining with a violet luster, and narrow pale vittae, the submarginal dark vitta not so wide and not joining with the sutural vitta at apex. Epipleura dark, with a pale margin. Body beneath entirely pale, femora pale with the apex dark, tibiae bicolored, tarsi dark. Length 7.5 to 8 mm., width 3.2 to 3.4 mm.

TYPE AND PARATYPES: In BM, collected at Runaway Bay, Jamaica, April 10, 1905, by Lord Walsingham, and at Hill Gardens, Jamaica, July 6, 1923 by C. C. Gowdey.

OTHER LOCALITIES: Jamaica: Clydesdale, W. G. Lynn; Stony Hill, Chapin and Blackwelder.

REMARKS: The only other vittate *Disonycha* from the West Indies is *D. spilotrachela* Blake, a much smaller species, found in Cuba, Puerto Rico, and Hispaniola but not yet found in Jamaica.

Disonycha panamensis Jacoby

FIGURE 40

Disonycha panamensis Jacoby, Biologia Centrali-Americana, Coleoptera, vol. 6, pt. 1, p. 313, 1884.

From 7 to 8 mm. in length, elongate oblong oval, faintly alutaceous and moderately shining, densely and distinctly punctate; pale yellow; the head with a broad dark occipital band sometimes extending to frontal tubercles; prothorax often with a Y-shaped median spot composed of three spots, varying in width, and a small lateral spot on each side; elytra with sutural vitta uniting at apex with submarginal vitta, a broad median vitta; body beneath dark, with prosternum, apex of abdomen, and femora pale; an unusually wide explanate margin on prothorax and elytra.

Head with interocular space more than half width of head, a circle of punctures about fovea near eye, frontal tubercles well defined, area between antennal sockets wide, rounded, and slightly produced, head pale with broad dark band on occiput usually coming down to tubercles, mouthparts dark. Antennae moderately long, dark, basal joint edged with pale. Prothorax about twice as wide as long, not very convex but flattish with a wide, curved explanate margin, somewhat depressed over scutellum, surface faintly alutaceous and moderately shiny, very finely punctate, pale with a dark median marking consisting of three more or less confluent spots forming a Y, and two small lateral spots, in one specimen all the spots more or less united into a confluent band. Elytra elongate, with wide explanate pale margin, surface faintly alutaceous and moderately shiny, more distinctly punctate than prothorax, pale, with broad dark sutural vitta uniting with moderately broad lateral vitta, also a broad median vitta; epipleura pale. Body beneath covered with pale pubescence, dark, with the prosternum and tip of abdomen pale, femora reddish, tibiae and tarsi dark. Length 7 to 8 mm., width 3.6 to 4 mm.

TYPE: Not designated; cotypes, in BM, MCZ (Bowditch collection, 7), and USNM (1), from Volcán de Chiriquí, Panamá, 2–3,000 ft., Champion.

OTHER LOCALITIES: Costa Rica: San Pedro de Montes de Oca, C. H. Ballou. Panamá: Porto Bello, on *Polygonum*, E. A. Schwarz and August Busck; La Chorrera; El Valle del Antón, G. C. Wood; Ciricito, Canal Zone. Colombia: Colegio, E. A. Chapin.

REMARKS: The wide explanate margin and usually Y-shaped pronotal marking distinguish this species. The type specimens have deep reddish brown marking, but other specimens both from the Canal Zone and Colombia have the usual piceous vittae.

***Disonycha longipennis*, new species**

FIGURE 38

About 7 mm. in length, elongate oblong oval, shining, mirror smooth; pale yellow; a dark band across occiput, dark tubercles, and brownish mouthparts; prothorax 5-spotted; scutellum dark; elytra with sutural edges and margin narrowly dark, wider at apex, a spot at middle of base representing median vitta; body beneath with breast and legs dark.

Head with interocular space less than half the width of head, eyes large, not at all reniform, a dark band across occiput behind the eyes and a brownish spot over tubercles, a fovea on either side of front near eye and a few punctures on front, tubercles well defined, carina short and narrow, lower front not long, mouthparts brownish. Antennae not unusually long, dark except the paler edging of the three basal joints and the three apical joints lighter brownish. Prothorax twice as wide as long, with wide anterior angles and slightly curved sides, disc rather flat and depressed over scutellum, surface shining, very faintly punctate, pale yellow with five small brownish spots. Scutellum dark. Elytra elongate, not very convex, pale yellow with the sutural edges darkened and the margin narrowly dark, more broadly so at the apex, a spot in the middle of the basal margin representing a trace of the median vitta, epipleura dark. Body beneath pale, with the breast and legs dark. Length 7.2 mm., width 3 mm.

TYPE: Female, USNM 61816, from Summit, Canal Zone, Panamá, collected by N. L. H. Krauss in September 1946.

REMARKS: Although this may be a pale form of a species having an entire dark median elytral vitta, it does not agree with any known species with the usual vittation. The elytra are very elongate, without any costation. In the Bowditch collection are two specimens that bear a certain resemblance to this in their elongate shape, although the markings are different. One of these bears a type label and the name *Nephrica terminata* Jacoby, from the upper Amazon. The eyes of this species are not at all reniform.

Disonycha glabrata **(Fabricius)**

Figures 58, 59

Crioceris tomentosa Fabricius, Systema entomologiae, p. 122, 1775 (not *Chrysomela tomentosa* Linnaeus, 1758).

Crioceris glabrata Fabricius, Species insectorum, vol. 1, p. 156, 1781 (in Africa aequinoctiali).

Chrysomela glabrata Fabricius, Mantissa insectorum, vol. 1, p. 76, 1787.

Altica vittata Olivier, *in* Encyclopédie méthodique, vol. 4 (vol. 1, Insects), p. 105, 1789.

Galleruca glabrata Fabricius, Entomologia systematica, vol. 1, pt. 2, p. 25, 1792; Systema Eleutheratorum, vol. 1, p. 494, 1801.

Altica glabrata Olivier, Entomologie, vol. 6, p. 685, 1808.

Altica alternata Latreille, *in* Humboldt and Bonpland, Voyage aux régions equinoxiales du nouveau continent, fait en 1799–1804, vol. 2, No. 2, Insectes, p. 39, 1833 (not *Haltica alternata* Illiger).

Disonycha glabrata Chevrolat, *in* Dejean, Catalogue de la collection de Coléoptères . . ., ed. 3, p. 414, 1837.—Crotch, Proc. Acad. Nat. Sci. Philadelphia, vol. 25, p. 64, 1873.—Harold, Coleopterologische Hefte, vol. 15, p. 4, 1876.—Jacoby, Biologia Centrali-America, vol. 6, pt. 1, p. 311, 1884.—Horn, Trans. Amer. Ent. Soc., vol. 16, p. 207, 1889.—Blake, Proc. U. S. Nat. Mus., vol. 82, art. 28, pp. 49–51, 1933.

Disonycha horticola Chevrolat, *in* Dejean, Catalogue de la collection de Coléoptères . . ., ed. 3, p. 414, 1837 (México).

Disonycha albicollis Sturm, Catalogue . . . , p. 283, 1843 ("Amer. bor.").

Between 5 and 6.5 mm. in length, elongate oblong oval, polished; pale yellow; darkened occiput; dark median pronotal spot, this sometimes lacking, or occasionally three pronotal spots; broad black sutural, median, and marginal or submarginal elytral vittae; undersurface pale, sometimes darkened in middle of metasternum and abdomen.

Head with interocular space about half width of head, smooth, with a few punctures about fovea on each side near eye, frontal tubercles well marked, carina narrowly produced, pale, with occiput and sometimes tubercles and labrum dark. Antennae dark, with pale basal joints, third joint much shorter than fourth and fifth. Prothorax approximately twice as broad as long, convex, somewhat narrowed anteriorly, with arcuate sides, shining, very faintly punctate, pale, with a median dark diamond-shaped spot, sometimes two smaller lateral spots, or occasionally immaculate. Scutellum black. Elytra convex, with the humeri marked by a short intrahumeral sulcus, sides parallel, surface shining, shallowly punctate, in some specimens (from Arizona and Texas) punctation very indistinct, pale, with broad sutural, median, and usually marginal vittae, in some specimens from

Arizona and Texas the margin is not darkened and there is a narrow submarginal vitta. Sutural and marginal vittae united at apex. Body beneath finely pubescent, variably colored, sometimes the metasternum and middle of abdomen dark, in other specimens sometimes entirely pale beneath. Apex of femora and tibiae and tarsi dark, epipleura usually dark. Length 5.3 to 6.3 mm., width 3 to 3.5 mm.

TYPE: Whereabouts not known; a Fabricius specimen in BM (Banks collection) bears the locality data "h. in Africa aequin."

OTHER LOCALITIES: United States: New York to Florida, west to Arizona. México: Córdoba, Vera Cruz, F. Knab; Santa Lucrecia, Vera Cruz, F. Knab; Cuantla, W. L. Tower; Cuernavaca, Morelos, W. L. Tower; Joyutla, Morelos, W. L. Tower; Matamoras, W. L. Tower; Osorio, Tamaulipas, D. L. Crawford; Progreso, Yucatán, F. Knab; Río Balsas, Guerrero, Wickham; Venta de Peregrino, Guerrero; Sierra de Durango; Tapachula, Chiapas, Höge; Tuxtepec, Oaxaca, J. Camelot. Guatemala: Cacao Trece Aguas, Alta Verapaz, Barber and Schwarz; Escuintla, F. Knab; Mocá, Suchitepequez, 3,000 ft., C. and P. Vaurie; Quiriguá, S. F. Blake; Rabinal, C. and P. Vaurie; Yepocapa, H. T. Dalmat. Honduras: Zamorano, Francisco Morazán, 2,600 ft., on rice and beans, T. H. Hubbell; La Ceiba, F. J. Dyer; San Juan Pueblo, W. M. Mann. Costa Rica: Bataan, O. L. Cartwright; Muelle de San Carlos, on *Amaranthus spinosus* Linnaeus, C. H. Ballou; Puerto Limón, F. Knab; Santiago, C. H. Ballou; San Pedro de Montes de Oca, C. H. Ballou. Nicaragua: Chanandega, Baker. Panamá: Ancón; Cristóbal, N. L. H. Krauss; Gamboa, H. F. Dietz and J. Zetek; La Sabanas, Panamá [city], on *Amaranthus spinosus* Linnaeus; Limón Plantation, Chagres River, H. Dietz, J. Zetek; Summit; Volcán de Chiriquí, 2–3,000 ft., Champion; Tobago Island. Colombia: Armero to Lima, V. Velsco, injuring cotton; Atlántico, F. L. Gallego; Baranquilla, Brother Genes; Cali Valle, B. Losada; Palmira, R. Roncalle; Aracataca, Río Frío, Seville, Magdalena Province, P. J. Darlington; Puerto Colombia, Atlántico, M. Hebard. Venezuela: Caracas; Catache, Rene Lichy; El Valle, C. H. Ballou, on *Amaranthus dubius* Martius; Maracaibo, Merida. Trinidad: Port of Spain, Dr. Rendall, A. Busck. French Guiana: Cayenne. Brazil: Ceará, D. D. Rocher; Mato Grosso; Pará, Rio Madeira, Mann and Baker; Santa Anna, Rio de Janeiro, in rice field, E. C. Green; Viçosa, Minas Gerais, B. T. Snipes. Bolivia: Coroico, Riberalta, Rurrenabaque, W. M. Mann; Tiguipa, G. L. Harrington, Villa Montes, G. L. Harrington. Ecuador: Guayaquil, C. H. Fagan. Argentina: El Quemado, Jujuy, G. L. Harrington; Salta, G. L. Harrington. Perú: Peruvian Amazons, Bartlett; Satipo, Popryski.

REMARKS: Throughout its wide distribution from North America to Argentina this species shows little variation. The aedeagus varies somewhat in the shape of the tip, but it is doubtful whether this slight variation is of much importance. The food plant appears to be always *Amaranthus*.

Fabricius (1775) originally applied the Linnaean name *tomentosa* to a species that he described in contradiction to Linnaeus' "elytris subtomentosis" as having the "elytra in rostro glabra, nitida." He gave the locality in this first description as "America." In 1781, repeating his shorter diagnostic description of this species, he gave it the name *glabrata* and quoted the Linnaean description of *tomentosa* with a question. The locality this time he gave as "Africa aequinoctialis" (not, as Harold stated, "America aequinoctialis"). In 1787, Fabricius again published the same short description of *glabrata*, without mentioning Linnaeus' *tomentosa* and without locality. In 1792 the original long description under the name *glabrata* was repeated, with the locality this time given as Jamaica, and in his treatment of *glabrata* in 1801 Fabricius again gave the locality as Jamaica. From the original description (1775) it is plain that Fabricius had before him something quite different from Linnaeus' *Chrysomela tomentosa*, which is probably some species of *Galerucella*. The original description of *glabrata* applies in every way to the *Disonycha* to which the name *glabrata* is now given.

Disonycha trivittata, new species

FIGURE 60

About 6 mm. in length, oblong oval, shining, mirror smooth; pale yellow; head with a tiny dark occipital spot; pronotum with a faint reddish brown median streak; elytra with a wide sutural and narrow marginal vitta uniting narrowly at apex; body beneath pale, femora and tibiae at apex dark, tarsi dark.

Head with interocular space about half its width, rounded over occiput, a cluster of punctures near eye, tubercles swollen, carina narrow and sharp, lower front long, pale except for a small dark occipital spot and a dark labrum. Antennae moderately long and dark, with the three basal joints pale edged, apical joint tending to be reddish brown. Prothorax nearly twice as broad as long, with arcuate sides, moderately convex, without depressions, shiny, pale yellow, a faint reddish brown median stripe. Scutellum dark. Elytra shining, smooth, very faintly punctate, pale, with a wide dark sutural vitta tapering to a narrow dark sutural edge at apex, this joined with a narrow dark marginal vitta, epipleura dark. Body beneath pale, with the femora and tibiae dark at the apex, tarsi dark. Length 6 mm., width 3 mm.

Type: Female, USNM 61817, taken on a plane from México at Houston, Texas, December 5, 1947. One male in BM without locality label.

Remarks: This species so closely resembles *D. glabrata* (Fabricius) except for the missing median elytral vitta, that I believed it merely a color form until I dissected a male sent me from the British Museum. This showed an aedeagus quite distinct from that of *D. glabrata*. Besides lacking the median elytral vitta, the head is paler and the breast not darkened as in *glabrata*. It clearly belongs to the *glabrata* group, however.

Disonycha vittipennis Boheman

Figure 61

Disonycha vittipennis Boheman, *in* Kongliga Svenska Fregatten *Eugenies* resa omkring jorden . . ., åren 1851–53, pt. 1 Insecta, p. 190, 1859.

Between 5.5 and 6 mm. in length, oblong oval, mirror smooth; yellow; dark antennae, dark occiput; usually a deep reddish brown to piceous clouding over most of the pronotum, leaving only margins yellow, although in one specimen pronotum nearly pale and with only faint reddish brown spotting; elytra with a sutural vitta, uniting with a marginal vitta, and a moderately wide median vitta, these often with a bluish or purplish tinge; undersurface and legs mostly dark except along margin of abdomen and apex of femora.

Head with interocular space half its width, shining, occiput dark, a fovea or circle of punctures near eye, tubercles prominent, sometimes darkened, carina a little produced, lower front long, mouthparts dark. Antennae dark, with the three basal joints reddish brown. Prothorax about twice as wide as long with no distinct depression, shining, very faintly punctate, pale, with a deep reddish brown area usually covering most of disc, although in one specimen there is only a trace of it in the form of a median reddish brown spotting. Elytra shining, the dark sutural and marginal vittae uniting at apex, the median vitta wide, these dark vittae often with a metallic blue or violet lustre, epipleura dark. Body beneath mostly dark, the sides of the abdomen pale, legs mostly dark, with apex of hind femora pale. Length 5.5 to 6.2 mm., width 2.8 to 3.1 mm.

Type: Female, in Naturhistoriska Riksmuseet, Stockholm, from Insula Puna, Perú.

Other localities: Five specimens in BM, four from Fry collection labeled Perú and one from "N. Perou, Prov. Tumbez, C. A. Baer."

Remarks: Aside from the type specimen, which Dr. René Malaise kindly sent me for examination from Stockholm, I have seen only the five from the British Museum. This species is closely related to *D. glabrata* (Fabricius), which it resembles in elytral markings and in the structure of the head although in *D. vittipennis* there is often a bluish metallic lustre and the pronotum and the body beneath are usually darker. The aedeagus is shaped much as in *D. glabrata*, but differs in the position of the orificial opening on the dorsal side.

Disonycha manni, new species

Figure 63

From 5.5 to 6.5 mm. in length, oblong oval, shining, mirror smooth; pale yellow; deeper orange on occiput; immaculate prothorax; elytra with broad dark sutural vitta, not united at apex with narrow marginal vitta, and a broad median vitta; antennae unusually long and slender; body beneath with prosternum and abdomen pale, breast and legs tending to be mostly dark.

Head deep orange above down to tubercles, without dark occipital spot, pale, shining, mirror smooth except for large fovea or circle of punctures near eye, lower front long and narrow, paler frontal carina rounded, a little produced, tubercles well marked, interocular space scarcely half width of head, mouthparts brownish, not at all piceous. Antennae long and slender but not extending half way down elytra, brown with the basal joints pale edged and frequently the two distal joints paler. Prothorax about twice as wide as long, with wide anterior angles and nearly straight sides, not very convex and with a slight basal depression, mirror smooth and without definite spotting although in some specimens a faintly deeper coloring suggesting two lateral spots and an elongate median one. Elytra mirror smooth, a broad dark sutural vitta not uniting at apex with the narrow marginal vitta, a broad median vitta. Epipleura dark. Body beneath shining, finely pubescent, the prosternum pale, abdomen mostly pale, usually the breast and legs dark, sometimes the middle of the breast and coxae pale. Length 5.5 to 6.5 mm., width 2.8 to 3 mm.

Type: Male, USNM 61818, and one paratype, MCZ, from Tumupasa, Bolivia, Mulford Biological Expedition 1921–22, W. R. Lopez and W. M. Mann, collectors.

Other localities: Bolivia: Isiamas, one specimen, W. M. Mann, December; Rurrenabaque, Río Beni, one specimen, W. M. Mann, October, Mulford Biological Expedition 1921–22.

Remarks: This species is somewhat like *D. glabrata* (Fabricius) except that it has an entirely pale head and dark legs. The aedeagus is not at all like that of *D. glabrata* or, in fact, of any other species.

Disonycha barberi Blake

FIGURE 66

Disonycha barberi Blake, Journ. Washington Acad. Sci., vol. 41, p. 327, 1951.

From 5.4 to 6.6 mm. in length, oblong oval, shining; eyes unusually large; pale yellow; head with a broad dark occipital band extending in a point down the front and sometimes about eyes and sides, antennae with the basal and two apical joints pale; pronotum entirely pale; elytra with a sutural and marginal dark vitta, uniting at apex, and a median vitta; legs dark at apex of femora, the tibiae and tarsi entirely dark, the breast and sometimes abdomen at tip and sides dark.

Head shining, the broad dark occipital band finely punctate on the occiput and front, the dark extending down front in a point, sometimes about eyes and sides, the mouthparts dark, eyes unusually large, interocular space less than half the width of the head, a fovea on each side composed of punctures, tubercles well marked, carina not wide and lower front short. Antennae dark with the 3 basal and 2 apical joints paler. Prothorax about twice as wide as long with slightly arcuate sides, wide anterior angles and a faint transverse depression across base, entirely pale yellow, shining, very finely and faintly punctate. Scutellum dark. Elytra shining, more distinctly punctate than pronotum, pale yellow, with a wide dark sutural vitta uniting with a marginal one at apex, median vitta moderately wide, epipleura dark. Body beneath shining, lightly pubescent, the breast dark and sometimes tip of abdomen and sides dark. Femora pale with dark apex, tibiae and tarsi dark. Length 5.4 to 6.6 mm., width 3 to 3.3 mm.

TYPE: USNM 61130, and twenty paratypes, one in MCZ and one in BM, originally collected at Brownsville, Texas, on *Condalia obovata* Hooker and later reared from *Phaulothamnus spinescens* A. Gray.

OTHER LOCALITIES: United States: Texas: San Bonita and Sebastian. México: on plane from México; Los Mochis, Sinaloa, C. T. Dodds; Mazatlán, Sinaloa, Van Dyke collection.

REMARKS: Although this was originally described from Brownsville, Texas, both Mr. Barber and I always felt that it was not native there. I recall Mr. Barber saying that he believed it was imported from tropical America. Therefore when I found in some material from the California Academy of Science two specimens from different localities in Sinaloa, México, collected in different years, I suspected that the real habitat of this species is on the Pacific coast in that region, and that it had been introduced into southern Texas in some shipments of fruit or vegetables, or possibly had come in by plane.

***Disonycha didyma*, new species**

FIGURE 65

Between 5.5 and 6.5 mm. in length, broadly oblong oval, shining, mirror smooth; eyes large; head dark with lower front pale; prothorax entirely pale; elytra with sutural and marginal dark vittae united at apex, median vitta moderately wide; body beneath with breast, apices of femora, tibiae, and tarsi dark.

Head dark and polished over occiput down to antennal sockets, with a large fovea on either side near eye, tubercles slightly bulging and with a groove between, interocular space less than half width of head, eyes large, carina a bit produced, lower front long and narrow, labrum dark, the dark from the occiput extending about back of eye and below it. Antennae long, dark, the three basal joints having a pale edge. Prothorax fully twice as wide as long, with wide anterior angles and nearly straight sides, depressed along the base, in some specimens almost a groove, shining pale yellow, not distinctly punctate. Elytra wide, shining, very faintly and finely punctate, pale with dark sutural vitta uniting at apex with marginal vitta, a moderately wide median vitta. Epipleura dark. Body beneath shining, very finely pubescent, the breast dark; legs with apices of femora, tibiae and tarsi dark. Length 5.5 to 6.5 mm.; width 3. to 3.3 mm.

TYPE: Female, and one paratype, also female, USNM 61819, from Summit, Canal Zone, collected by N. L. H. Krauss in October 1944; paratype, female, in MCZ.

REMARKS: This species is not easily distinguished from *D. barberi* Blake, described from Brownsville, Texas. It has much the same coloring and structure, but the elytra are not quite so distinctly punctate and the head markings are not quite the same. Unfortunately no male has been examined.

***Disonycha tridyma*, new species**

FIGURE 64

Between 6 and 7 mm. in length, elongate oblong oval, shining; pale yellow; dark markings on the occiput; entirely pale pronotum; elytra with a sutural and a marginal dark vitta, uniting at apex, and a moderately wide median vitta; body beneath pale, femora dark at apex, tibiae and tarsi more or less dark.

Head with interocular space less than half the width of the head, eyes large, area between antennal sockets narrowly produced, frontal tubercles well marked, head polished, impunctate except for the large fovea near eye, a dark band across the base of occiput extending narrowly down front to tubercles and around the back of eyes to the mouthparts, which are dark. Antennae with the three basal joints pale edged, remainder dark. Prothorax about twice as wide as long, with wide anterior angles and nearly straight sides, mirror smooth, shiny, pale yellow without markings, depressed across base, almost a groove. Scutellum dark. Elytra with sutural and narrow marginal vitta united at apex, a moderately wide median dark vitta; surface shining, nearly impunctate, epipleura dark, sometimes pale down the middle. Body beneath entirely pale, femora dark at apex, tibiae sometimes entirely dark, more often dark at apex, tarsi dark. Length 6 to 7 mm., width 3 to 3.5 mm.

Type: Male, and three paratypes, MCZ 29039, and paratype, USNM 61820, all taken at Aracataca, Magdalena Province, Colombia, by P. J. Darlington.

Other localities: Río Frío and Seville, Magdalena Province, Colombia, P. J. Darlington; three specimens in BM, one, a male, with the old label "*Carthagina, D. incognita dej.*," another labeled Santa Marta, Pascoe Coll., and a third with no locality label.

Remarks: Aside from slight color differences in the head, this species is like *D. didyma*, from the Canal Zone. Both resemble *D. barberi* Blake, although the aedeagi of *D. tridyma* and *D. barberi* are very different.

***Disonycha cordigera*, new species**

Figure 71

Between 6.5 and 7 mm. in length, elongate oblong oval, shining, nearly impunctate; pale yellowish brown; dark antennae; a large dark occipital spot; pronotum usually 3-spotted, the middle spot largest; elytra with dark sutural and marginal vittae, joined at apex, and moderately wide median vitta; body beneath usually pale although sometimes with the breast darkened on the sides, femora usually pale with a dark streak but occasionally entirely dark, tibiae usually dark in apical half, tarsi dark.

Head with interocular space about half the width of the head polished, impunctate except for the fovea near eye; frontal tubercles clearly marked, carina sharp, narrow and slightly produced, lower front long and narrow, eyes large; pale yellow, with a large round spot on occiput occasionally expanding to form a band across and extending down to the tubercles, labrum dark. Antennae with the three basal and also terminal joint slightly paler than the dark intermediary joints. Prothorax not twice as wide as long, with well developed anterior angles and nearly straight sides, mirror smooth and depressed over the scutellum and on sides near the base, pale yellow with three dark spots, the middle the largest. Scutellum dark. Elytra shiny, very finely punctate, pale, with a sutural vitta joined at apex with a narrow lateral-marginal vitta and a moderately wide median vitta. Epipleura dark. Body beneath usually pale but often with the middle or sides of the breast and sometimes sides of prosternum darkened. Femora usually pale with a dark streak, in some specimens almost entirely dark except at base, tibiae usually dark in apical half, tarsi dark. Length 6.5 to 7 mm., width 3.2 to 3.9 mm.

Type: Male, and four paratypes, MCZ 29042, one paratype, USNM 61821, and one paratype, BM, all from Aracataca, Magdalena Province, Colombia, P. J. Darlington.

Other localities: Canal Zone: Red Tank, N. Banks; Barro Colorado Island, J. Zetek. In MCZ (Bowditch collection) are four specimens, of which the first is labeled *Disonycha prolixa*; two of these are in the Donchier collection and are from "Colombie," and two are without locality labels.

Remarks: The markings of this species are somewhat similar to those of *D. prolixa* Harold described from Argentina, but *D. cordigera* is slightly larger and is darker beneath, usually with paler legs. The aedeagus does not at all resemble that of *D. prolixa*.

***Disonycha annulata*, new species**

Figure 62

About 6 mm. in length, broadly oblong oval, shining, not at all alutaceous, finely punctate; pale yellow; head with a dark marking; pronotum entirely pale; elytra with sutural and narrow submarginal vittae, not quite joining at apex, and a wide median vitta; body beneath with breast and abdomen mostly dark, legs dark except middle of tibia.

Head with a dark occipital spot extending narrowly down to tubercles and covering tubercles, a dark spot behind the eyes extending on the outside about neck, carina more or less dark, labrum except the edge dark, tubercles and carina rather prominent, a fovea on each side near eye, head with interocular space half width of head. Antennae dark, with the basal joints pale edged, shining, moderately long. Prothorax approximately twice as wide as long, not very convex, a slight oblique depression on each side near base, entirely pale, shining, very faintly punctate. Elytra broad and somewhat convex, shining, finely punctate, a moderately broad dark sutural vitta not quite connecting with a narrow submarginal one, median vitta broad and widening a little at apex, epipleura entirely pale. Body beneath with breast and abdomen except about the extreme edges dark, coxae palish, femora dark and shiny, the posterior ones with coarse scattered punctures and sparse pubescence, tibiae with a pale ring near the base, tarsi dark. Length 6 mm., width 2.8 mm.

TYPE: Male, USNM 61822, taken at Brownsville, Texas, March 9, 1949, in a shipment of tomatoes from México.

REMARKS: Only one specimen of this is at hand, and this without any definite locality label. It is more robust than *D. glabrata* (Fabricius) and with darker markings beneath, a submarginal instead of marginal vitta, and no thoracic spotting. The aedeagus bears a certain resemblance to that of *D. glabrata*, but is more acutely tipped and when viewed from the side not curved as in *D. glabrata*. It does not have the large, well developed anterior angles on the prothorax of *D. barberi* Blake, nor is there a basal depression on the prothorax typical of that group. I believe it falls into the *glabrata* group.

Disonycha adumbrata Clark

Disonycha adumbrata Clark, Journ. Ent., vol. 2, p. 401, 1865.

TYPE: In BM, from Pará, Brazil, collected by Bates.

There is apparently only one specimen of this, the type, which I have examined at the British Museum. In my notes on that specimen I questioned whether it was a species of *Disonycha*. The eyes are very large and rather deeply emarginate, the antennal joints not quite typical, in that the second and third joints are short and the fourth at least twice as long as the third. The anterior angles of the prothorax are obliquely cut. There is a faint sulcus at the base of the pronotum with limited ends. The single reddish brown elytral vitta from the humerus fades out at the apical curve. I could not find any spur on the hind tibia and the claws are not typical of *Disonycha*. At that time I did not attempt to place it in any other genus and feel that without further examination I should not do so now.

Disonycha elongata Jacoby

FIGURE 20

Disonycha elongata Jacoby, Proc. Zool. Soc. London, 1902, pt. 1, p. 187.

"Elongate and subdepressed, testaceous, the terminal joints of the antennae fuscous; thorax impunctate; elytra not perceptibly punctured; a very narrow sutural and a sublateral stripe and a broader longitudinal band at the disc, black.

"Length 9 mm.

"Head impunctate, the clypeus with an acutely raised central ridge; eyes reniform, rather deeply emarginate; antennae extending to the middle of the elytra, rather robust, fuscous, the lower four joints testaceous, the fourth joint nearly twice as long as the third; thorax about one-half broader than long, the sides nearly straight with a narrow margin, the posterior angles strongly oblique, anterior angles obliquely truncate; scutellum black; elytra rather flattened, not perceptibly punctured, testaceous, very shining, the suture very narrowly and a slightly wider stripe close to the margins black, another much broader band extends from the middle of the base nearly to the apex; below and the legs testaceous, the apex of the posterior tibiae obscure fuscous.

"Habitat: Venezuela."

Remarks: I have examined the only specimen of this known, which is in the British Museum, but made no detailed description or drawing of it at the time. The drawing for this paper was made from a photograph sent me by J. Balfour-Browne of the British Museum (Natural History). *D. elongata* Jacoby is a lustrous yellow brown beetle with very narrow sutural and submarginal vittae and broader median one. Beneath, the body is entirely pale. It compares in size with *D. quinquelineata* (Latreille) but is narrower and with a wider median elytral dark vitta.

Disonycha megaspilota, new species

Figure 41

Between 8.5 and 9 mm. in length, elongate oblong, prothorax shiny, elytra finely alutaceous; pale yellow; dark antennae; dark labrum, a dark spot on occiput; three large pronotal spots; elytra with a narrow sutural and submarginal vitta, not united at the apex, and a wider median vitta; body beneath and legs except the dark tarsal joints mostly pale.

Head with interocular space about half its width, smooth over occiput except for a circle of fine punctures about the fovea near eye, frontal tubercles distinct, carina short and narrowly produced, lower front short, labrum dark, a broad median spot on occiput. Antennae, except the paler basal joints and a reddish brown terminal joint, dark, moderately long. Prothorax not twice as wide as long, with rounded sides, moderately convex and with a slight depression over scutellum and on sides near the base; surface polished, impunctate, with three large reddish brown spots, the median one rounded anteriorly and tapering towards base. Elytra finely alutaceous and finely punctate, with a faint trace of costa in the median vitta, sutural and submarginal vittae narrow and not joined at apex, median vitta moderately wide, epipleura dark. Body beneath mostly pale, in one of the two specimens a faint brownish tinge in middle of the breast, legs pale except for the dark tarsal joints in one specimen, in the other the tibiae darkened towards apex. Length 8.5 to 8.8 mm.; width 4 mm.

Type: Female, MCZ 29048; paratype, also female, USNM 61823.

REMARKS: These two specimens bear no locality labels, simply an old name label, "*Dis. 4 vittata.*" *Altica quadrivittata* Illiger from Brazil has been wrongly assigned to the genus *Disonycha* for over one hundred years, from the Dejean catalog to Heikertinger in the Junk catalog. Illiger described it as one of the Oedipodes (with swollen claw joint), shaped like a *Lema* with small head and prothorax and pubescent, striate punctate elytra. These two specimens with the large dark pronotal spots and shiny, glabrous surface, are comparable in size but not in structure with the specimens of the *alternata* group.

Disonycha venezuelae Jacoby

FIGURES 55, 56

Disonycha venezuelae Jacoby, Entomologist, vol. 34, p. 148, 1901.

Between 8.5 and 10 mm. in length, elongate oblong oval, somewhat shining although finely alutaceous, densely and moderately coarsely punctate; head, undersurface, and legs black; antennae, except the three or four basal joints that are pale with dark edging, piceous; prothorax pale with either a broad band or three to five small dark spots across the middle; elytra with a moderately wide dark sutural vitta uniting at apex with a narrow dark marginal vitta, median vitta very wide, a distinct depression from below humerus down the side of elytron.

Head with a short lower front and interocular space more than half the width of head, eyes small, head entirely dark, faintly shining and feebly alutaceous, moderately coarsely and irregularly punctate over occiput and front, frontal tubercles well marked, a short, blunt, little produced carina. Antennae piceous except the pale basal joints that have dark edges. Prothorax not twice as wide as long, not very convex, a little depressed over scutellum and at sides, with other small depressions, not shiny, distinctly alutaceous and densely and moderately coarsely punctate; pale reddish yellow with a broad dark band or with from three to five small dark spots across the middle. Elytra with a depression running from below humeri down the side and a resulting crease or costa above the margin, alutaceous and moderately coarsely and densely punctate, a wide dark sutural vitta uniting at apex with a dark marginal vitta, and a broad median vitta. Epipleura dark. Undersurface and legs entirely dark, with a fine pale pubescence. Length 8.4 to 10 mm., width 4 to 6.8 mm.

TYPE: ?In BM, described from Venezuela, from three specimens. One specimen in MCZ (Bowditch collection) is labeled simply Venezuela, second Jacoby collection; it may be a cotype. Two other specimens are in the Bowditch collection from Caracas, Venezuela.

Other localities: Venezuela: Caracas, El Valle, D. F., C. H. Ballou, on *Cajanus bicolor.* Colombia: Río Frío, Magdalena Province, P. J. Darlington. Panamá: Alhajuelo, A. Busck; Bocas del Toro, W. Robinson; El Valle, N. L. H. Krauss; Tobago Island, H. F. Dietz; XX Plantation, H. F. Dietz and J. Zetek; Canal Zone, C. H. Richardson; Summit, N. L. H. Krauss; Juan Mina Plantation, H. F. Dietz and J. Zetek; Paraíso, E. A. Schwarz.

Remarks: This species is of the same group as *D. aplicata* and *D. cratera* from farther south in South America. All three species have in common a large size, dark coloring, and coarsely punctate surface. Specimens from Venezuela have a dark banded pronotum, those from Colombia and the Canal Zone appear to be simply spotted on the pronotum. The specimens from the Canal Zone, representing possibly a subspecies, are considerably smaller than those collected by Dr. Darlington in Magdalena Province, Colombia. All, however, unlike *D. aplicata* or *cratera*, have the distinguishing longitudinal depression down the side of the elytra with a crease above the margin.

Disonycha aplicata, new species

Figure 53

About 7 mm. in length, elongate oblong oval, not very shiny, alutaceous and rather densely and coarsely punctate; head, undersurface, and legs entirely dark; prothorax pale with a broad dark band; elytra with wide dark sutural and median vittae and narrow marginal vitta joining sutural vitta at apex.

Head with interocular space more than half the width of head, lower front short, entirely dark, moderately densely and coarsely punctate over occiput, frontal tubercles a little swollen and smooth, area between antennal sockets bluntly produced. Antennae dark except the three pale-edged basal joints. Prothorax not quite twice as broad as long, with curved sides, moderately convex, a slight depression on the sides near base, alutaceous and moderately densely and coarsely punctate; a broad piceous band extending across nearly to the margin. Elytra elongate, surface alutaceous, moderately coarsely and densely punctate, a wide dark sutural vitta and a median vitta, a narrow marginal one joining at apex rather widely with the sutural vitta. Body beneath and legs entirely dark and covered with fine, short, pale pubescence. Length 7.3 mm., width 3.7 mm.

Type: Male, MCZ 29045 (Bowditch collection, 2nd Jacoby collection), bearing the label Paraguay.

Remarks: This is very similar in markings to *D. venezuelae* Jacoby but does not have the lateral depression on the elytra as in that species. The aedeagus is wholly unlike that of *D. venezuelae.*

Disonycha cratera, new species

FIGURE 57

About 7.5 mm. in length, oblong oval, feebly shining, alutaceous, coarsely and densely punctate; head, legs, and undersurface except prosternum dark, prothorax with a dark irregular fascia; elytra with broad dark sutural vitta uniting at apex with narrow marginal vitta, a wide median vitta.

Head with interocular space more than half width of head, lower front short, entirely dark, without depressions over occiput and front, with punctures unevenly distributed, alutaceous except the shiny frontal tubercles, carina broad and rounded. Antennae dark except for the pale edging of the three basal joints, fourth joint twice as long as third. Prothorax not quite twice as wide as long, moderately convex, with a slight basal depression over scutellum and on sides, alutaceous and densely but not very coarsely punctate, pale, with a broad transverse fascia having lobed margin as if composed of confluent spots. Elytra feebly shining, alutaceous and strongly and densely punctate, a broad dark sutural vitta uniting at apex with a narrow marginal vitta, a broad median vitta. Epipleura dark. Body beneath and legs dark except for the pale prosternum, clothed with very short fine pale pubescence, the ridging on the tibiae not as sharply prominent as in many species. Length 7.5 mm., width 4 mm.

TYPE: Female, USNM 61824, collected at Tumupasa, Bolivia, in December, by M. R. Lopez, Mulford Biological Expedition 1921–22.

REMARKS: This is very much like *D. aplicata* from Paraguay but is somewhat broader and has more densely and coarsely punctate elytra. Unfortunately there is no male. It does not have the lateral depression on the elytra found in *D. venezuelae* Jacoby, but is similarly marked. Unlike *D. aplicata* the fourth antennal joint is twice as long as the third.

Disonycha crassicornis, new species

FIGURE 44

About 7.5 mm. in length, oblong oval, finely alutaceous, the elytra finely and rather densely punctate; pale yellow brown; antennae, except four basal joints, dark; thin dark sutural and median vitta, neither reaching base nor apex.

Head entirely pale, the interocular space at least half the width of the head, space between antennal sockets broad and little produced, lower front rather short, tubercles well marked, occiput and front smooth except for a circle of punctures about fovea near eye. Antennae stout, first two joints pale with outer edges dark, third and fourth joints pale at apex, remainder dark. Prothorax not twice as broad as long, rather convex, sides rounded, a slight depression over scutellum, feebly alutaceous, pale with indefinite pale brownish areas possible indicating spots in a more heavily marked specimen. Scutellum pale. Elytra with a narrow dark sutural vitta not extending about scutellum to base or reaching the apex and with a very narrow median vitta not reaching the base, surface alutaceous and feebly shining, finely and rather densely punctate. Body beneath entirely pale, the claws only darker in coloring. Length 7.5 mm., width 3.8 mm.

TYPE: Male, MCZ 29046, a single specimen with an old label bearing the locality Brazil and the name "*Caeporis?* nov. sp."

REMARKS: This pale beetle with extremely narrow elytral vittae that do not extend to the base resembles some specimens of the *militaris* group, but the stouter antennae and very different aedeagus sufficiently differentiate it.

Disonycha trimaculata, new species

FIGURE 54

About 6 mm. in length, oblong oval, antennae and legs unusually long; mirror smooth, pale yellow; the head deeper colored with a black occipital spot; thorax with a short dark transverse median spotting; elytra with a sutural vitta, uniting at apex with a narrow marginal vitta, and a broad median vitta; body beneath with breast and legs in part dark, prosternum and abdomen and underside of anterior femora pale.

Head deep orange above with an occipital dark spot, paler below, the mouthparts dark, interocular space a little less than half the width of head, coarsely and rugosely punctate about eyes and on vertex below the dark spot, tubercles well marked and a narrow frontal carina extending to labrum, not much produced but well rounded, lower front moderately long. Antennae reddish brown with a pale edge on the basal joints, unusually long, almost reaching the middle of the elytra. Prothorax not quite twice as wide as long, not very convex and with a basal depression below the dark median fascia, mirror smooth, pale yellow, with a narrow deep piceous fascia composed of a short wide lateral spot on either side of a small roundish spot. Elytra also mirror smooth, pale, with a broad dark sutural vitta uniting at apex with a very narrow marginal vitta, a broad median vitta, epipleura dark. Body beneath covered by thick fine pale pubescence, the prosternum, abdomen, coxae, and underside of anterior femora pale, breast and legs otherwise dark, tibiae and first tarsal joints unusually long. Length 5.7 mm., width 3 mm.

Type: Male, USNM 61825, from Cosincho region, Beni, Bolivia, G. L. Harrington.

Remarks: There is only a single specimen of this unusual little species. The transverse elytral spotting and long legs are distinctive. It is not very closely related to any other species.

Disonycha multivittata, new species

Figure 32

About 8 mm. in length, oblong oval, rather flat, with wide explanate margins, faintly shining, finely alutaceous and punctate; pale yellow brown; antennae with the base of the first five or six joints pale, remainder entirely dark; elytra with many narrow pale vittae, including a sutural, the usual median one broken up into three, and the submarginal vitta broken up into two, none of these reaching the apex; head, legs, and body beneath entirely pale.

Head with interocular space about half width of head, entirely pale, smooth over occiput, the usual fovea or cluster of punctures on each side near the eye, tubercles marked by a median depressed spot over the narrow, slightly produced carina, lower front short. Antennae short and moderately stout, the first two joints pale, joints 3 to 7 pale in basal half, remainder entirely dark or with only extreme base pale. Prothorax not quite twice as broad as long, with arcuate sides and wide explanate margin, depressed over scutellum and on either side near base; very indistinctly punctate, finely alutaceous, not very shiny. Scutellum pale. Elytra finely alutaceous, not very shiny, pale yellowish brown with vittae a little deeper brown, a narrow sutural vitta, three very narrow median vittae, the submarginal-lateral vitta broken up into two narrow ones, none of these reaching the apex. Body beneath and legs entirely pale yellow brown. Length 7.5 to 8.3 mm., width 3.9 to 4.5 mm.

Type: Male, and six paratypes, MCZ 29041, and one paratype, USNM 61826, from Santa Catarina (3) and Rio de Janeiro (5), Brazil.

Remarks: The general appearance of the elytral vittae is of many pale vittae but possibly there are specimens that show only a very narrow sutural and median vitta, and these other vittae are merely a subcutaneous darkening such as often is to be seen in the case of punctures.

Disonycha plagifera, new species

Figure 43

From 5 to 6.5 mm. in length, elongate oblong, finely alutaceous and feebly shining, elytra finely punctate; head with a short dark oblong spot on occiput; prothorax barely twice as wide as long and with a pair of dark spots anteriorly and a washed-out brown area from these down to the base, on each side usually two confluent spots; elytra with a dark sutural and a narrow submarginal vitta not joined at apex, and a moderately wide median vitta; body beneath pale with the femora pale with a dark line, tibiae dark at apex, tarsi dark.

Head pale, with an oblong dark occipital spot and dark mouthparts, a cluster of punctures on either side of front near eye, tubercles distinctly marked, carina broad and rounded, lower front moderately long. Antennae rather stout and short, with the three basal joints edged with pale, rest dark. Prothorax barely twice as broad as long, moderately convex and little depressed over the scutellum, finely alutaceous and moderately shiny, impunctate, two spots anteriorly with a brownish area from them to the base, in pale specimens this resolves into two spots and a median line, usually two confluent spots on each side. Elytra elongate, the sutural vitta not joined with the narrow submarginal vitta, median vitta not very wide, surface alutaceous and finely punctate; epipleura pale with a washed-out brown edge. Body beneath pale, covered with fine pubescence, femora pale, sometimes with a brownish streak, tibiae dark at apex, tarsi dark. Length 5 to 6.7 mm., width 2.5 to 3.4 mm.

Type: Male, USNM 61827, and one paratype, female, from Sapucai, Paraguay, W. T. Foster.

Other localities: Argentina: Salta, G. L. Harrington, USNM. Paraguay: no locality, Dr. Bohls, MCZ (5 specimens). Brazil: Rio de Janeiro, J. T. Maury, BM; Corumbá, Mato Grosso, MCZ; Caviuna, Paraná, A. Maller, AMNH; Rio Autaz, Roman, Stockholm Naturhistoriska Riksmuseet. Venezuela: Plason, MCZ, Jacoby (2nd collection).

Remarks: This species is distinctive because of the broad median dark area on the pronotum extending from the two anterior spots to the basal margin. Most of the specimens are from southern Brazil, Argentina, and Paraguay, but the female from the Rio Autaz, a tributary of the Amazon River, in the Stockholm Museum, and the one from Venezuela seem to indicate that it may occur east of the Andes, at least, the length of South America. The specimen from Rio Autaz was identified by Weise as *D. caustica* Harold, but this latter species is quite different, having a coarsely punctate head and prothorax, although with similar anterior spots on the prothorax.

***Disonycha explanata*, new species**

Figure 30

About 6.5 mm. in length, oblong oval, elytra finely and rather closely punctate, margin of prothorax and elytra widely explanate;

shining; pale yellow; deep brown antennae, brown apices to femora, brown anterior tibiae, the posterior tibiae brown only at apex; elytra with a narrow brown sutural vitta not reaching the apex, a short, slightly sinuate, median vitta that is wider at the tip, a submarginal vitta not nearly reaching the apex.

Head with interocular space about half the width of the head, smoothly rounded over occiput with a circle of punctures on each side near the eye, frontal tubercles finely marked and carina between antennal sockets narrowly produced, lower front narrow and rather long, mouthparts deeper brown. Antennae long, with the three basal and apical joint paler than the other joints, which are deep brown. Prothorax a little more than twice as wide as long, not very convex, somewhat depressed over scutellum, a wide explanate margin, entirely pale yellow, shining, very indistinctly punctate. Elytra also flattish, with a wide explanate margin, shining pale yellow, with a narrow reddish brown sutural vitta not reaching the apex, a short sinuate median vitta knobbed at its apex and extending only to apical curve, a narrow submarginal vitta not nearly reaching the apex, epipleura pale with a dark inner half below the humeri to the middle. Body beneath pale, the femora pale with dark brown apices, anterior tibiae brown, posterior tibiae with apices brown, tarsi dark. Length 6.6 mm., width 3.4 mm.

Type: Female, MCZ 29040 (Bowditch collection), Rio de Janeiro, Brazil; paratype, female, USNM 61828, "St. Catharina, Brazil."

Remarks: This species is distinctive because of its wide explanate margin and unusually short elytral vittae, none of which reach the apex. Unfortunately there is no male specimen.

Disonycha nigrofasciata (Jacoby)

Figure 51

Nephrica nigrofasciata Jacoby, Proc. Zool. Soc. London, p. 197, 1902.

About 8 mm. in length, broadly oblong oval, elytra rather coarsely punctate, shiny; head entirely dark, antennae dark with the four distal joints pale; prothorax pale; elytra with wide sutural, median, and not so wide marginal vittae, the last joined at the apex with the sutural vitta; body beneath with breast and abdomen dark, femora and tibiae dark at apex, tarsi dark.

Head with interocular space half width of head, eyes no larger or more deeply emarginate than in any other species of *Disonycha*, head shining black with a deep reddish brown spot below antennal sockets, a cluster of coarse punctures on each side near eye extending down towards frontal tubercles, tubercles well marked, carina narrowly produced, lower front moderately long. Antennae long, the three basal joints pale edged, the distal four joints entirely pale, rest dark. Prothorax nearly twice as wide as long, with rounded sides, moderately convex, only slightly depressed over scutellum, entirely pale, very finely alutaceous and very finely punctate, a few coarse punctures anteriorly on side below eye. Elytra broad and moderately convex, shining, rather coarsely punctate, the dark sutural and median vittae wide, the narrow marginal one broadly joined at apex with sutural vitta. Epipleura dark. Breast and abdomen dark, femora and tibiae dark at apex, the anterior tibiae with dark streak entire length beneath, tarsi dark. Length 8.4 mm., width 4.4 mm.

Type: In BM, from Espírito Santo, Brazil.

Remarks: A single specimen in MCZ (Bowditch collection) labeled *Nephrica nigrofasciata* Jacoby may be a cotype, as it is from the type locality and answers to the description. The eyes in this beetle are no more emarginate than in other species of *Disonycha* nor is there any more thickening of the middle antennal joints, so I can see no reason for not including it in *Disonycha*. This is one of a group of closely related vittate species from the Amazon basin that resemble a group of smaller species, of which *D. barberi* Blake, described from Brownsville, Texas, is representative, in their broad oblong-oval shape, short prothorax with wide apical angles, and in general coloration, especially of the legs. The beetles of this smaller group are so much alike that without seeing the differences in the aedeagi it is difficult to tell them apart.

Disonycha imitans (Jacoby)

Figure 46

Nephrica imitans Jacoby, Proc. Zool. Soc. London, p. 196, 1902.

From 7 to 8.5 mm. in length, broadly oblong oval, shining; head (usually), prothorax, and body beneath pale; antennae long and except for paler basal joints dark; elytra with wide sutural and median vittae, the submarginal one narrow and not reaching the apex.

Head with interocular space less than half the width of head, occiput smooth, a large fovea on each side near eye, frontal tubercles not well marked, carina short and narrowly produced, lower front rather short, eyes not any larger or more emarginate than usual in species of *Disonycha*, head entirely pale in all but one specimen, and that one with an occipital dark spot. Antennae long and slender, three basal joints with pale edging, rest dark. Prothorax about twice as wide as long, rather flat, with well developed apical angles, nearly straight sides, a slight depression over scutellum, entirely pale, impunctate. Elytra broad, moderately convex, shining, very faintly punctate, a wide deep reddish brown sutural and median vitta and a narrow submarginal one not reaching the apex. Epipleura partly dark. Body beneath pale, femora pale with narrow dark stripe, hind femora dark at apex, tibiae and tarsi dark. Length 7 to 8.6 mm., width 3.8 to 4.5 mm.

Type: In BM, from Perú.

Other localities: Perú: Cumbare, four specimens, Reyes, one specimen, all in MCZ (Bowditch collection); Río Huallaga, Río Morona, Río Santiago, and Iquitos, five specimens, all collected by H. Bassler, in AMNH.

Remarks: As in the case of *D. nigrofasciata* (Jacoby) this species clearly belongs in the genus *Disonycha* by reason of having eyes only slightly emarginate and not truly reniform, in this respect not being any different from others of the genus. It differs from *D. nigrofasciata* in having a paler head and not bicolored antennae.

***Disonycha paula*, new species**

Figure 48

Between 8 and 8.5 mm. in length, broadly oblong oval, shining although faintly alutaceous; pale yellowish brown; head and pronotum unspotted; the elytra with wide dark sutural, marginal, and median vittae not united at apex; body beneath pale, femora pale with a dark streak, tibiae and tarsi dark.

Head with interocular space about half width of head, occiput smooth, impunctate except for a single large fovea near eye, frontal tubercles faintly marked, carina narrow and a little produced, lower front short, mouthparts a deeper brown. Antennae dark except for the three paler basal joints, unusually long and slender, extending to the middle of the elytra and even beyond. Prothorax fully twice as broad as long, with moderately wide margin, not very convex, a slight hump on either side, depressed along the base, pale and unspotted, shiny, faintly alutaceous. Scutellum pale at base. Elytra broad, not very convex, shining, very finely and indistinctly punctate and faintly alutaceous, pale yellow brown with sutural, median, and lateral-marginal dark vittae not united at apex. Epipleura dark. Body beneath pale, shining under the pale pubescence, femora pale with a dark streak, hind femora dark at apex, tibiae and tarsi dark. Length 8 to 8.5 mm., width 4.5 mm.

Type: Female, in BM, from "St. Paulo"; paratype, female, USNM 61829, without locality label.

Remarks: Only two specimens, both females, are at hand, but these seem quite distinct from the rest of the *nigrofasciata* group. They have in common with the others the large size, short, wide prothorax, broad elytra, and the coloration of the legs, but differ from them in the unusually long antennae. Except for this and the pale head, the beetles resemble *Disonycha nigrofasciata* (Jacoby).

Disonycha juruensis, new species

FIGURE 45

About 7 mm. long, broadly oblong oval, not very convex, with moderately wide explanate margins, shining, yellowish brown with reddish brown spot on the occiput, an irregular reddish brown fascia across pronotum, and wide reddish brown sutural, submarginal, and median elytral vittae not joined at the apex; body beneath pale, femora with a brown streak, tibiae and tarsi reddish brown.

Head with interocular space a little less than half width of head, occiput smooth with a reddish brown oblong spot, a fovea or cluster of punctures on each side near eye, tubercles distinct, carina narrow and a little produced, labrum dark, eyes not any larger or more emarginate than in rest of species of *Disonycha*. Antennae dark, with the three basal joints pale edged, long. Prothorax fully twice as broad as long with wide anterior angles, rather flat and depressed along base, with a slight callosity on the side, shining, a broad and irregular reddish brown fascia nearly reaching the margin, faintly 5-spotted. Scutellum dark. Elytra broad, rather flat with a wide explanate margin, shining, the pale yellow vittae not so wide as the reddish brown, the latter not quite joining or reaching apex or base, sutural edges pale, sutural and median vittae wide, the submarginal narrower. Epipleura pale. Body beneath pale, the femora with a dark streak and hind femora with dark apex, tibiae and tarsi dark. Length 7 mm., width 3.9 mm.

TYPE: Male, in BM, from Rio Jurua, Amazon region, Brazil, November 13, 14, 1874; paratype, female, USNM 61830, from Rio Purus, Amazon region, Brazil, October 1874.

REMARKS: This is another of the large species with broad elytra, closely related to *D. imitans* (Jacoby) from Perú. It is unusual in having reddish brown markings. The aedeagus resembles somewhat that of *D. imitans*, but in this species the eyes are smaller.

Disonycha amplipennis, new species

FIGURE 50

About 8 mm. in length, broadly oblong oval, shining; pale yellow; head with a dark occipital spot; prothorax short and broad, with faint reddish brown spotting; elytra broad and moderately convex, with wide dark sutural and median vittae, the submarginal one narrow and not reaching the apex; a dark streak on anterior femora and darkened apex to posterior femora, otherwise tibiae and tarsi dark, body beneath pale.

Head with interocular space less than half the width of head, eyes no more emarginate than in other species, occiput smooth, a cluster of coarse punctures on each side near eye, frontal tubercles indistinctly marked, carina narrow and a little produced, area below antennal sockets excavated, pale with a dark occipital spot and dark mandibles. Antennae long and slender, dark with the basal joints paler. Prothorax more than twice as broad as long, with wide anterior angles and straight sides, a slight hump on each side and a short basal depression over scutellum, faintly alutaceous and very finely punctate, pale with indistinct brownish spots. Elytra more convex than prothorax, broad and long, with wide dark sutural and median vittae and a narrow submarginal vitta not reaching the apex, surface shining, impunctate. Epipleura partly dark. Body beneath pale, the femora of anterior legs with a dark streak, the apex of posterior dark. Length 7.9 mm., width 4 mm.

Type: Female, MCZ 29047 (F. A. Eddy collection), bearing label "Amazon—Mar. 2, 1891."

Remarks: Only one specimen, and that a female, is known. Another of the *nigrofasciata* group, it appears to be confined to the Amazon River basin, and is distinctive in its large size, broad elytra, and short prothorax. The markings are somewhat similar to *D. juruensis* but darker.

Disonycha conjuncta (Germar)

Figure 52

Haltica conjuncta Germar, Insectorum species novae aut minus cognitae, p. 610 1824.

Disonycha conjuncta Dejean, Catalogue de la collection de Coléoptères . . . , ed. 3, p. 414, 1837.

Disonycha tristis Jacoby, Proc. Zool. Soc. London, p. 440, 1879.

Between 6.5 and 7.5 mm. in length, broadly oblong oval, alutaceous, faintly shining; head entirely dark and coarsely punctate, prothorax with 5 dark spots, often confluent and forming an irregular fascia across pronotum; elytra with broad dark sutural vitta uniting with a narrow marginal one at apex, a broad median vitta; body beneath and legs dark except the border of the prosternum and a narrow area between front coxae, the abdomen of the male with a deep rounded depression near the apex.

Head entirely dark and coarsely punctate, a shallow depression above tubercles, tubercles only smooth and well marked, space between antennal sockets narrowly carinate and extending to above labrum. Antennae moderately long and stout, dark except for the pale edging of the three basal joints. Prothorax twice as wide as long, moderately convex and at base a little depressed above the scutellum and on the sides, surface alutaceous and finely punctate, pale with five dark spots often confluent in part at least and often forming an irregular fascia across pronotum. Elytra alutaceous and with very fine punctures, faintly shining, a broad dark sutural vitta uniting at apex with a narrow marginal vitta, and a broad median vitta, sometimes the median vitta coalescing with the sutural in places, leaving only an interrupted pale line joined at the apex with a similarly thin pale submarginal line (these dark specimens appearing nearly black on the elytra), epipleura dark. Body beneath and legs entirely dark except for the border of the prosternum and a narrow area between the front coxae, alutaceous, only faintly shining under the short fine pubescence, abdomen of the male unusual in having a broad rounded excavation near the apex with a tiny knob in the middle of the apical side. Length 6.5 to 7.4 mm., width 3.4 to 3.8 mm.

Type and paratypes: In Zoologisches Museum, Humboldt-Universität, Berlin; type locality given by Germar as Buenos Aires, Argentina.

Other localities: Argentina: Veronica, Buenos Aires; La Plata, Spegazzina; Tucumán. Brazil: Corupá (Hansa Humboldt), Santa Catarina, A. Maller; Pôrto Alegre, Pareci Novo, Serro Azul, Itapirango, Padre Pio Buck; Rio Grande do Sul. Uruguay: Montevideo. Paraguay: no other locality for Jacoby (2nd collection) specimen in MCZ (Bowditch collection); Puerto Pinasco, "Podtiaguin."

Remarks: Dr. K. Delkeskamp of the Zoologiches Museum, Humboldt-Universität sent me what he considered the type of Germar's *Haltica conjuncta* together with two paratypes. The specimen with the type label bears on the label "*conjuncta* Germ." and the locality "Bras." It is a female with a spotted, not banded pronotum. The two paratypes have no locality labels. One of them, also a female, has a wide dark fascia across the pronotum. The other, a male, with the usual round excavation near the tip of the abdomen, has a spotted pronotum. Otherwise the three specimens are similarly colored. Whether these are really Germar's specimens is not certain to me. His original description gave the habitat as Buenos Aires. In the U. S. National Museum are specimens from Buenos Aires similar to these, and also examples from Paraguay of another species, with more coarsely and densely punctate elytra, that correspond fairly well to Germar's description.

Jacoby described *D. tristis* from Brazil, and I have examined two cotypes in the Bowditch collection at the Museum of Comparative Zoology. These are the same species as Germar's. Presumably other specimens of the type series are in the British Museum (Jacoby did not designate type specimens). The coarsely punctate dark head and the excavation on the abdomen of the male are the distinguishing characters of the species. A number of specimens of this species are in the Bowditch collection identified by Jacoby as *D. conjuncta* (Germar). The ones that he described as *D. tristis* have darker elytra, the pale vittae being a little narrower. I cannot find any essential difference otherwise. The aedeagi are the same.

Padre Pio Buck writes, "Many of the *Disonycha conjuncta* (Germar) I collected on *Pennisetum purpureum* Schumacher (here commonly named 'Elephant grass'), but it is also found on other Graminaceae."

Disonycha prolixa Harold

FIGURE 75

Disonycha prolixa Harold, Coleopterologische Hefte, vol. 14, p. 105, 1875.

From 5.5 to 6.5 mm. in length, oblong oval, shining, mirror smooth; pale yellow; broad black spot on occiput, dark mouthparts; wide median and two large lateral spots on prothorax; on elytra a wide sutural vitta uniting at apex with a narrower marginal one, median vitta wide; body beneath pale, the legs, except coxae, black.

Head smooth except for a circle of punctures about fovea near eye, extending to the rear of eye, interocular space about half width of head, frontal tubercles not marked, a narrow carina between antennal sockets extending to labrum, head pale with a darkening about eyes and a broad occipital spot, the mouthparts dark. Antennae dark with the three basal joints pale edged. Prothorax a little more than twice as broad as long, surface somewhat convex, without distinct depression along base, surface mirror smooth, pale with a broad dark irregularly shaped median spot and two large lateral spots. Elytra mirror smooth, pale, with a broad dark sutural and marginal vitta united at apex and a wide median vitta. Epipleura dark. Body beneath pale, shining, lightly pubescent, coxae pale, rest of legs dark and shining. Length 5.5 to 6.5 mm., width 2.8 to 3.3 mm.

TYPE: Collected at Córdoba, Argentina, possibly at the Natural History Museum, Stettin, Germany.

OTHER LOCALITIES: Argentina: La Viña, Salta, Monrós; Campo Gallo, Santiago del Estero, Monrós; San Pablo, Famailla, Tucumán, Monrós; Frias, Santiago del Estero, H. L. Parker; La Rioja Patquia, K. J. Hayward; Salta, H. L. Parker. Paraguay: Asunción, E. G. Kent; Sapucai, W. T. Foster; San Salvador, Dr. Bohls. Bolivia: Cochabamba, Germain; Rurrenabaque and Río Beni, W. M. Mann; Trinidad, Kusche. Brazil: São Paulo, A. A. Barbiellini; Campinas, H. L. Parker; Serro Azul, Padre Pio Buck.

REMARKS: In the Museum of Comparative Zoology is a box of specimens collected by Davis in Argentina and sent to C. A. Dohrn, who in turn sent them to von Harold, who described many of them in volume 14 of the Coleopterologische Heft. In this Davis collection are three specimens not labeled types but labeled by Hagen as *D. prolixa* Harold. They correspond very well with Harold's description. The markings of the prothorax might also be construed as a "corona reversa" but the pale undersurface does not agree with Germar's old description of *D. copulata*. Moreover, this is a shiny and not alutaceous beetle.

Dr. K. Delkeskamp of the Zoological Museum of Humboldt University, Berlin, writes that the Harold material received from C. A. Dohrn is probably in the Natural History Museum at Stettin if it is in existence. At the present time material at that museum is not accessible.

Disonycha copulata (Germar)?

FIGURE 74

Haltica copulata Germar, Insectorum species novae aut minus cognitae, pp. 610–11, 1824.
Disonycha copulata Harold, Coleopterologische Hefte, vol. 14, p. 106, 1875.

Between 5.5 and 6.5 mm. in length, broadly oblong oval, alutaceous, moderately shiny, finely punctate; pale yellow; head with a dark occipital spot, darkened tubercles and mouthparts; prothorax with two wide lateral and an elongate median spot; elytra with broad sutural vitta uniting with marginal vitta, the marginal vitta narrow and often not extending about humerus, median vitta wide; body beneath pale, usually with darkened sides to breast and abdomen, legs except coxae usually entirely dark, tibiae sometimes with pale streak.

Head pale with large dark occipital spot often running down front to darkened tubercles, labrum dark, a row of punctures from the large puncture near eye down to tubercles, carina broad and little produced, interocular space about half the width of the head. Antennae dark with the three basal joints pale edged. Prothorax about twice as broad as long, not very convex and somewhat depressed along the base, somewhat shiny although alutaceous, finely punctate, pale with a broad irregular lateral spot on each side curving forwards towards the center into a point, an elongate diamond-shaped spot in middle. Elytra broad and not very convex, moderately shiny although alutaceous, finely and more distinctly punctate than prothorax, a dark sutural vitta uniting with a narrow submarginal vitta, the latter sometimes not covering margin towards base and fading away about humerus; median vitta broad. Epipleura dark. Body beneath pale with dark sides, sometimes middle of breast dark, legs entirely dark except the pale coxae and sometimes tibiae with a light streak; lightly pubescent; hind femora with fine pubescence. Length 5.5 to 6.5 mm., width 2.9 to 3.4 mm.

Type: Not located (not in Berlin). The species was described from a specimen from Buenos Aires.

Other localities: Argentina: Felipe Solá, Buenos Aires, Monrós; Güemes, Salta, Martínez; Zelaya, Buenos Aires, Hepper; Buenos Aires, J. Bosq; Ceres, C. J. Drake; Pampas, Germain; Pico, H. L. Parker; Urundel, Salta, Monrós; Tucumán, P. Girard, C. Bruch; Tablillas, Salta, G. L. Harrington. Paraguay: Asunción, E. G. Kent; without locality, Dr. Bohls; Sapucai, W. T. Foster. Uruguay: Montevideo. Chile: Germain. Brazil: Cauna, Santa Catarina, Rio Natal; the last two collected by A. Maller, in AMNH; Serro Azul, Padre Pio Buck; one old specimen in MCZ (Bowditch collection) from Brazil with a Chevrolat name.

Remarks: I have been unable to find the whereabouts of the type of this species and it may be lost, although the type of *D. conjuncta* (Germar), described at the same time, is in Berlin. Harold, writing in 1875, stated that *D. copulata* was unknown to him. Thus, I am uncertain whether the insect described above is really *D. copulata*, but of several closely related species from Argentina this best corresponds with Germar's description. He described the thoracic markings as a spot on the disk composed of three confluent ones making a crown in reverse ("corona reversa"). The thoracic markings of this and *D. prolixa* Harold might be interpreted as a "corona reversa," but the undersurface of the latter is not dark as described by Germar.

Disonycha plaumanni Costa Lima

Figure 73

Disonycha plaumanni Costa Lima, Rev. Brasil Ent., vol. 1, p. 9, January 1954.

Between 6 and 7 mm. in length, broadly oblong oval, somewhat shiny although faintly alutaceous, finely punctate; pale yellow; a dark occipital spot, dark tubercles and mouthparts; prothorax with three dark spots, the median one elongate; elytra with wide dark sutural vitta uniting with narrow lateral-marginal vitta and a broad median vitta, the pale vittae very narrow; body beneath dark except for pale prosternum, space between middle coxae, and a few pale spots on sides of abdomen.

Head with interocular space about half width of head, pale with a large dark occipital spot running down the front, darkened tubercles and dark mouthparts, a series of punctures from the fovea near eye to tubercles, area between antennal sockets broad and rounded and not much produced. Antennae with three basal joints pale edged, rest dark. Prothorax barely twice as wide as long, smoothly rounded, without any depression, somewhat shining although faintly alutaceous, finely punctate, pale with three dark spots, the lateral ones wider than long, the median one elongate. Elytra broad, faintly shining, alutaceous and a little more distinctly punctate than prothorax, a common dark sutural vitta rather broad and uniting at apex with a narrow marginal vitta, a very broad median vitta. Body beneath not very shiny but densely covered with fine pubescence, dark except for prosternum and space between middle coxae and spots about edge of abdomen, legs entirely dark. Length 6 to 6.8 mm., width 3.4 to 3.8 mm.

Type: In Institute of Ecology and Agricultural Research, Rio de Janeiro, collected at Nova Teutonia, Santa Catarina, Brazil, by Fritz Plaumann, September 1934.

Other localities: Paraguay: Sapucai, San Bernardino, K. Fiebrig. Brazil: Cauna and Rio Natal, Santa Catarina, A. Maller, AMNH. One specimen, in MCZ (Bowditch collection) labeled "C. Amer.," which is probably not correct.

Remarks: This is closely related to *D. copulata* Germar, having much the same markings, except that the spots on the prothorax are not so large, the dark elytral vittae are as a rule wider, and the body beneath is darker; also the prothorax is less depressed, with wider anterior angles, the punctation is denser and more distinct on the elytra, and the shape of the aedeagus is slightly different.

This species had already been described and assigned a name in my manuscript; the identity of my material with Costa Lima's species is based on a photograph of a drawing that he has sent me.

Disonycha septemmaculata, new species

Figure 69

From 5.5 to 6 mm. in length, oblong oval, mirror smooth; pale yellow; head orange with a dark occipital spot and dark labrum; prothorax short and broad with seven small dark spots; elytra with broad sutural, median and narrow marginal black vittae, the sutural and marginal uniting at apex; body beneath pale, femora and tibiae mostly dark with pale streaks, tarsi dark; antennae dark with paler basal and apical joints.

Head with interocular space half width of head, smooth, with a fovea or circle of punctures on each side near eye, tubercles not distinctly marked, antennal sockets closely placed, with a narrow carina not much produced but extending down lower front, occiput orange, with a median brown spot, lower front narrow and pale, labrum dark.

Antennae with the three basal joints pale edged, remainder except brownish apical joint deep piceous. Prothorax more than twice as broad as long, with wide anterior angles and nearly straight sides, disc rather flat and depressed at base, surface mirror smooth, pale yellow with seven small deep brown spots. Elytra with a broad dark common sutural vitta uniting at apex with a lateral marginal vitta, a very wide median vitta; surface mirror smooth, epipleura dark. Body beneath entirely pale, lightly pubescent, coxae pale, femora shiny and dark above with pale under surface, tibiae dark, the hind ones with a pale streak, tarsi dark. Length 5.3 to 6.4 mm., width 2.6 to 3 mm.

Type: Male, and four paratypes, USNM 61831, taken at Huache and Rurrenabaque, Río Beni, Bolivia, W. M. Mann, September, Mulford Biological Expedition 1921–22; one paratype in MCZ.

Other localities: Paraguay: Sapucai, W. T. Foster, 6 specimens. Brazil: near Campinas, São Paulo, P. A. Berry, 1939, 1 specimen; Caviuna, Paraná, A. Maller, January 1946, AMNH (1). Argentina: Tablillas, Salta, G. L. Harrington, CAS (2); Urundel, Salta, Monrós, 1 specimen; Tablillas, Salta, Dr. Oran, 2 specimens; Alto Paraná, Misiones.

Remarks: The short broad prothorax with its seven small dark spots is sufficient to identify this species. Some of the Brazilian specimens have femora that are dark only towards the apex and in all, the tibiae have paler streaks, but the aedeagus is like those from Bolivia.

Disonycha argentinensis Jacoby

Figure 72

Disonycha argentinensis Jacoby, Entomologist, vol. 34, p. 147, 1901.

Between 5 and 6 mm. in length, elongate oblong, moderately shining, head and pronotum densely and coarsely punctate, elytra usually more finely punctate; head entirely dark; prothorax pale; elytra with a broad dark sutural vitta joining with the lateral-marginal one at apex (in the Brazil specimens the median dark vitta completely united with the lateral-marginal, but in the Argentine specimens these not joined or only partly joined); breast dark, legs bicolored.

Head entirely dark and shiny, coarsely and rugosely punctate, with tubercles smooth, carina somewhat produced, interocular space more than half width of head. Antennae of moderate length, dark with the three basal joints pale edged and the apical joint often paler brown. Prothorax barely twice as wide as long with rounded sides, not very convex, depressed over the scutellum, entirely pale, coarsely and densely punctate and also alutaceous. Elytra usually more finely punctate, the punctation denser and coarser below the scutellum but in the Bolivian specimen the elytra coarsely punctate throughout, the width of the dark vittae varying, in Brazilian and Bolivian specimens the median vitta joining with the lateral marginal vitta, leaving only a very narrow pale vitta curving towards to margin at apex, in the Argentinian specimens the median vitta only partially joining with the lateral or entirely free, but usually wider at the apex and slightly club-shaped. Epipleura dark. Body beneath with prosternum and abdomen pale but the breast usually dark (in one specimen pale on the side); femora pale with dark apices, tibiae pale in the middle, tarsi dark. Length 5 to 6.2 mm., width 2.3 to 2.8 mm.

Type: Not designated, probably in BM, described from four specimens from "Argentine R." One specimen in MCZ (Bowditch collection, 2nd Jacoby collection), from the province of Buenos Aires, C. Bruch, bears Jacoby's label "*argentinensis*" and a type label but was collected in 1903.

Other localities: Argentina: La Plata, P. G. Russell, M. Kisluik; Famailla, San Pablo, Tucumán, F. Monrós; Tucumán, G. L. Harrington; Buenos Aires, G. L. Harrington, C. Bruch; San Fernardo, Don Torcuato, Buenos Aires, Monrós. Chile: Germain. Uruguay: Montevideo. Brazil: Campinas, A. Hempel; S. Leopoldo, Padre Pio Buck. Bolivia: Reyes, W. M. Mann, Mulford Biological Expedition, 1921–22. One specimen taken at Boston in a shipment of peppers from Argentina, anothei at New York in sunflower seed.

Remarks: This is an unusually distinctive little species because of the rugose head and prothorax and the tendency of the median elytral vitta to unite with the marginal, leaving only a very narrow pale vitta. The shape of the aedeagus is unusual, too. The appearance of the beetle is much like that of the North American *Disonycha maritima* Mannerheim because of the coloration and a similar coarse punctation. The female beetle from Reyes, Bolivia, has the same elytral color pattern as the male from Campinas, Brazil.

Disonycha maritima Mannerheim

Figure 70

Disonycha maritima Mannerheim, Bull. Soc. Imp. Moscou, vol. 16, p. 311, 1843.—Crotch, Proc. Acad. Nat. Sci. Philadelphia, vol. 25, p. 64, 1873.—Horn, Trans. Amer. Ent. Soc., vol. 16, p. 206, 1889.—Blake, Proc. U. S. Nat. Mus., vol. 82, art. 28, pp. 51, 52, 1933.

From 4 to 5 mm. in length, broadly oblong oval, somewhat shining, densely punctate; pale with dark labrum and occipital spot extending down front; dark sutural, median, and marginal vittae covering most of the elytra; undersurface dark except prosternum and last ventral segments.

Head with interocular space a little more than half width of head, frontal carina narrow and slightly produced, occiput and front as far as tubercles usually densely and coarsely punctate, sometimes with a smooth median area, pale with black occipital spot extending down front, a darkened labrum. Antennae dark with paler basal joint, third, fourth and fifth joints subequal, the fourth slightly the longest. Prothorax approximately twice as wide as long, somewhat convex, narrowed anteriorly with arcuate sides, alutaceous, densely and moderately coarsely punctate, except sometimes a smooth median linear area; entirely pale. Scutellum dark. Elytra broadly oblong oval, convex, humeri not marked and with little trace of intrahumeral sulcus, moderately coarsely and densely punctate and somewhat shining, pale with wide sutural, median, and marginal vittae, the sutural and marginal vittae uniting at apex. Body beneath sparsely and indistinctly pubescent, shining black except prosternum and last ventral segment, legs black with a light streak on outside of tibiae. Length 4 to 5 mm., width 2.3 to 3.3 mm.

Type: Whereabouts unknown; described from a specimen collected by Eschscholtz and Blaschke in California, near the shore.

Other localities: United States: California and Nevada. One specimen "ex Duvivier," labeled "S. America," probably incorrectly labeled.

Remarks: The South America locality is probably incorrect, but it is quite possible that the species may turn up in México, as it has been collected in southern California. *D. argentinensis* Jacoby, although a more slender beetle, is very similar in coloration and sculpture.

Disonycha interlineata Berg

Figure 49

Disonycha interlineata Berg, Ent. Zeitung, Stettin, vol. 42, p. 65, 1881.

Between 6 and 7 mm. in length, oblong oval, moderately shining, somewhat alutaceous, pale yellow, usually with a broad dark spot at back of occiput and two tiny spots anteriorly on the pronotum, the elytra with a narrow sutural vitta, a median vitta having within it a pale inner line, and a washed out submarginal vitta; body beneath with the middle of the breast and abdomen and sides of the prosternum usually darker.

Head with interocular space more than half width of head, pale, usually with a broad dark spot over back of occiput, the mouthparts a little deeper in coloring, a circle of coarse punctures on either side near eye, the frontal tubercles separated by a deep groove usually and below a broadly rounded carina. Antennae varying from pale yellowish to deep reddish brown with the 4 or 5 basal joints paler. Prothorax twice as broad as long, narrowed anteriorly, moderately convex with little trace of basal depression, faintly alutaceous, pale yellow with two widely separated small dark spots anteriorly. Elytra faintly alutaceous and finely punctate, pale yellow with a narrow dark sutural vitta and a median vitta having within it a pale line not reaching base or apex, along the side a pale, washed out vitta, this being somewhat costate; epipleura pale. Body beneath covered with fine, pale pubescence, pale with the middle of the breast and abdomen darkened usually, also a spot on either side of the prosternum, legs often entirely pale. Length 6 to 6.7 mm.; width 2.8 to 3.2 mm.

Type: Not designated; described from several specimens from Salinas Chicas, Fuerte, and Río Colorado, Argentina, collected by Adolf Döring and P. Lorentz.

Other localities: Argentina: Buenos Aires, G. L. Harrington, Chaco santo-fesino, W. H. Schladitz, August, September, October, 1911. Uruguay: Montevideo. Brazil: Santa Catarina.

Remarks: One specimen from Chaco, and one from Santa Catarina are a little larger and paler than the others, with the ventral surface entirely pale. The splitting of the median elytral vitta is peculiar to this species although one other species is known to have this characteristic to a lesser degree.

Disonycha scissovittata, new species

Figure 47

About 5 mm. in length, oblong oval, feebly shining, alutaceous and finely punctate; pale yellow; antennae except the basal joints dark; a faint reddish brown spotting in the middle of the pronotum; elytra with a narrow dark sutural vitta and a submarginal vitta, neither reaching the apex, and a wider median vitta with a pale center line (in one specimen the entire length, in the others the pale interline only towards the apex); body beneath and legs pale.

Head with interocular space approximately half the width of the head, entirely pale except for reddish brown mouthparts, smooth except for fovea near eye, the tubercles distinctly marked, carina moderately broad, lower front long and narrow. Antennae short and stout, the three basal joints pale. Prothorax twice as wide as long, with curved sides, moderately convex, with little trace of basal depression, alutaceous and very finely punctate, pale yellow with a deeper reddish brown spotting in middle, consisting of two spots anteriorly and a long median mark, these all confluent. Scutellum pale. Elytra smoothly ovate, faintly shining, alutaceous and finely and moderately densely punctate, the sutural vitta narrow, not reaching the apex, the sutural edges pale, the median dark vitta in two specimens divided in apical part, the third specimen having a nearly entire pale vitta within the dark one, the submarginal vitta deep reddish brown, not reaching the apex. Epipleura pale. Body beneath and legs entirely pale. Length 5.3 to 5.4 mm.; width 2.9 mm.

TYPE: Male, in BM, from Santarém, on the Amazon, Brazil; two paratypes, both females, one, in BM, taken on the Amazon by Bates, the other, USNM 61832, without any locality label.

REMARKS: Only three specimens of this species are known, but these are quite distinct in their markings and in the shape of the aedeagus. The pale streak in the median elytral vitta usually does not extend as far as in *D. interlineata* Berg and the pronotal spots are not widely separate as in that species. It is also a somewhat smaller, more slender beetle. The aedeagus resembles somewhat that of *D. pittieri* from Venezuela, but the Brazilian species has a quite differently shaped, longer and narrower head, with only a single fovea instead of a cluster of punctures on each side.

Disonycha suturalis Bryant

FIGURE 67

Disonycha suturalis Bryant, Ann. Mag. Nat. Hist., ser. 11, vol. 11, pp. 652–3, 1944.

About 6 mm. in length, oblong oval, somewhat shiny although very faintly alutaceous, prothorax finely and elytra more distinctly and densely punctate; pale yellow; head with mouthparts and tubercles dark; elytra with narrow sutural vitta, humeri darkened and a spot in middle near the apex; breast, tibiae and tarsi, and apex of hind femora dark, explanate margins wider than usual.

Head pale except for tubercles and mouthparts, alutaceous and with coarse punctures scattered across vertex, a cluster of punctures on each side near eye, tubercles distinct, frontal carina broad, lower front rather short, interocular space half width of head. Antennae dark piceous with the three basal joints pale edged and the terminal joint paler reddish brown, joints not veiy long. Prothorax fully twice as wide as long, with curved sides and wide explanate margin, depressed over the scutellum, alutaceous, finely punctate, entirely pale. Scutellum dark. Elytra also with wide explanate margin, pale yellow with narrow sutural vitta and a dark streak down humeri and an irregular spot at middle of the apical angle, sometimes also a spot halfway down on the side of the elytra, surface alutaceous and densely and more coarsely punctate than the pronotum. Epipleura pale. Body beneath with breast dark, tibiae and tarsi, apex of femora, and apical half of hind femora dark. Length 6.1 mm., width 3 mm.

TYPE AND PARATYPES: In BM (10 specimens), collected by G. E. Bryant at Estancia la Noria, Río San Javier, Santa Fé, Argentina, December 20, 1911.

REMARKS: This species has a less coarsely punctate pronotum and more densely punctate elytra than *D. caustica* Harold (*D. nigrosuturalis* Bryant). None of Bryant's ten specimens shows any fully developed lateral vitta, and I have not found any other specimens in any collection. It is quite possible, however, that, as in the form of *D. caustica* described as *D. nigrosuturalis*, there are fully vittate specimens. The wide explanate margin on both prothorax and elytra is striking.

Disonycha caustica Harold

Figure 68

Disonycha caustica Harold, Coleopterologische Hefte, vol. 14, p. 106, 1875.
Disonycha nigrosuturalis Bryant, Ann. Mag. Nat. Hist., ser. 11, vol. 11, p. 701, 1944.

From 5.5 to 6.5 mm. in length, oblong oval, faintly shining, alutaceous; yellow; a dark occipital spot; pronotum with two round spots on each side of an elongate median one; elytra with a sutural vitta joining at apex with a narrow submarginal vitta, latter sometimes vanishing before the middle, and a wide median vitta, often interrupted with only traces on the humerus and below it and at apex; the legs with apices of femora and tibiae dark, the body beneath pale with the breast sometimes dark.

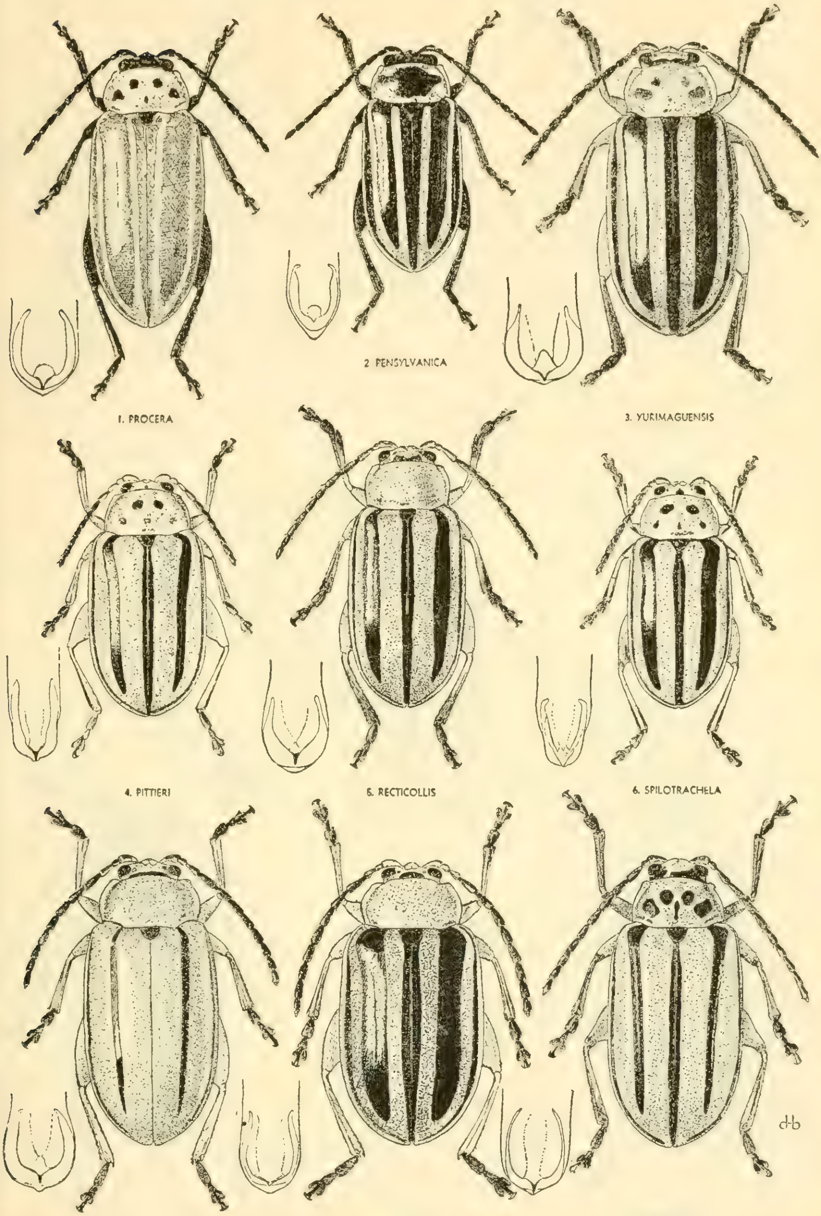
Head coarsely but not densely punctate, pale with a broad dark occipital spot running down into a point, tubercles well marked, often brownish, interantennal space broad, rounded into a flattish carina, excavate below antennal sockets, mouthparts brownish. Antennae dark, with the three or four basal joints paler, sometimes the distal joints brownish. Prothorax about twice as broad as long, narrowed towards apical angles, moderately convex and with a faint depression along base over the scutellum, surface alutaceous and rather densely and coarsely punctate, pale yellow with two spots in anterior part sometimes joined with a tiny elongate median spot. Elytra less alutaceous and faintly shining and a little more finely but densely punctate, pale yellow, with a dark sutural vitta joining at apex with a narrow submarginal one that frequently vanishes or becomes washed out along the side above the middle, a broad median vitta also often interrupted or with traces on the humerus, below it, and at apex, epipleura pale, sometimes with brownish edge. Body beneath pale, sometimes with the breast and sides of abdomen brownish, legs pale with apices of femora and tibiae darker and tarsi deep brown or piceous. Length 5.5 to 6.5 mm., width 2.6 to 3.4 mm.

Type: Female, in MCZ (Bowditch collection), also a paratype and eight other paratypes in the general collection there, all from Córdoba, Argentina, collected by Davis.

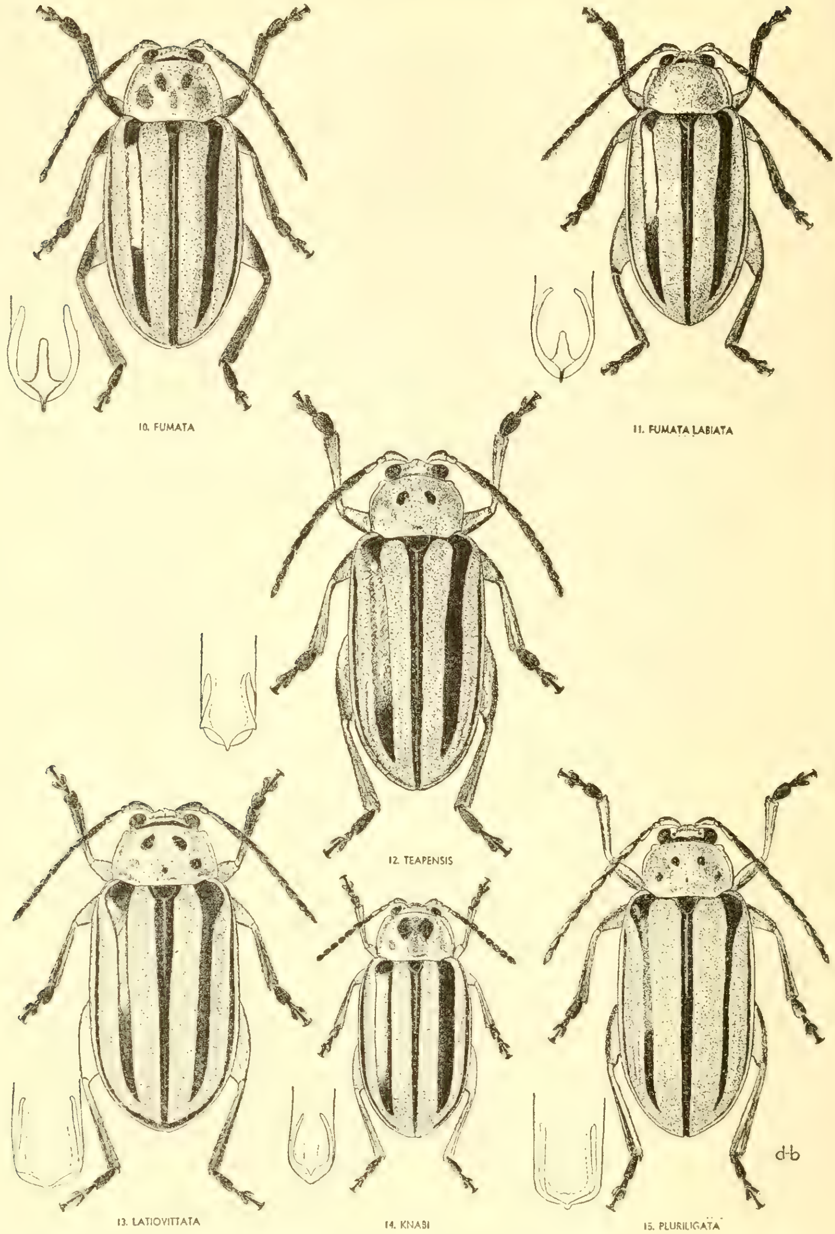
Other localities: Bolivia: Machareti, G. L. Harrington. Paraguay: Sapucai, W. T. Foster. Argentina: Desaguadero, Mendoza, F. Monrós; Rosario de la Frontera, El Naranjo, Monrós; Pico, La Pampa,

H. L. Parker; Güemes, Salta, Martínez; Río San Javier, Santa Fé, Bryant (type locality of *D. nigrosuturalis* Bryant); Maza, "F. C. S.," Aravena, Buenos Aires.

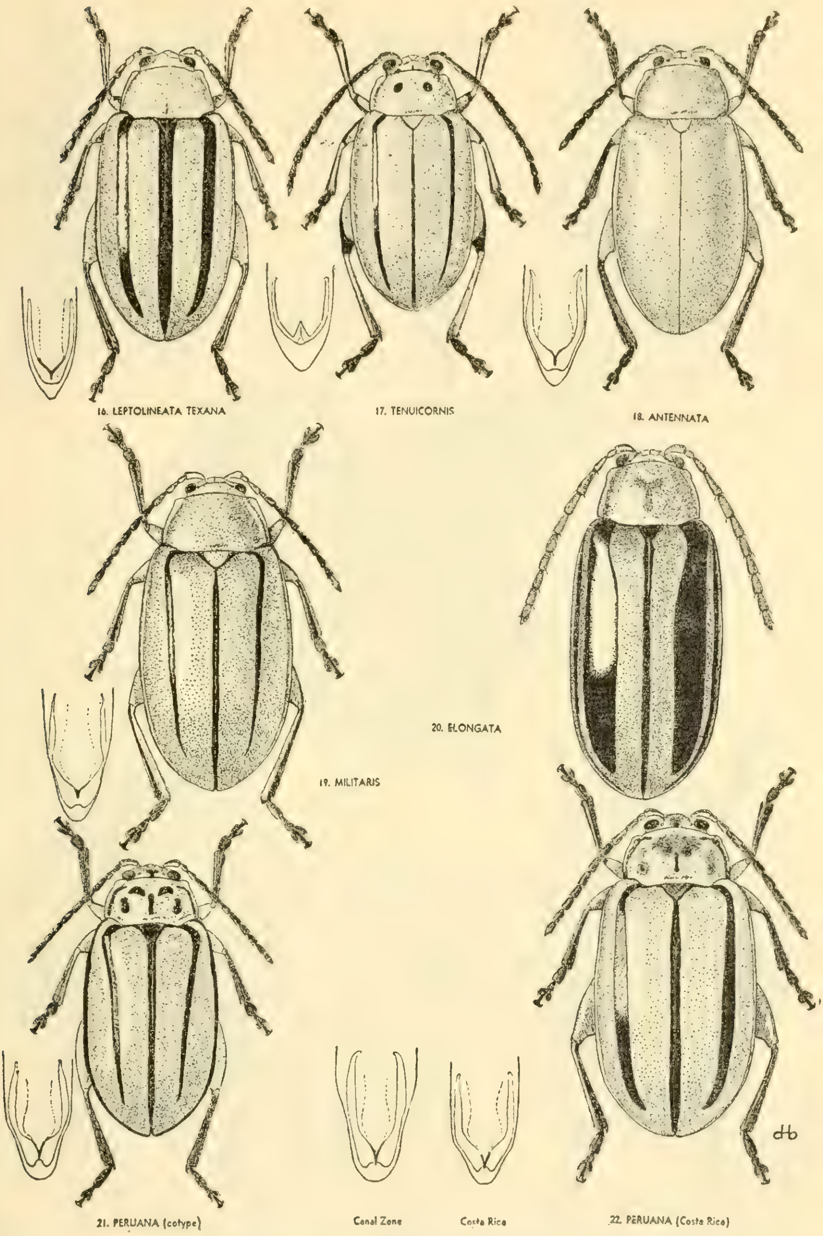
REMARKS: In the Museum of Comparative Zoology is a drawer of specimens with the note "16 types of Harold material collected by Davis, sent by Hagen to Dohrn, sent by Dohrn to von Harold who published in the Coleopterologische Hefte, 1875, pp. 95–106." In this are 8 specimens labeled *D. caustica* Harold. In the Bowditch collection are two others, evidently of the same series, the first labeled type, from Córdoba, Davis (2nd Jacoby collection), the second with the same label; also one from Bolivia (2nd Jacoby collection), and another from Paraguay, Dr. Bohls. Two of those in the Davis drawer have interrupted elytral vittae such as Bryant described in *D. nigrosuturalis*, in which the median elytral vittae are interrupted with only traces. I have dissected both forms and found the aedeagi alike.



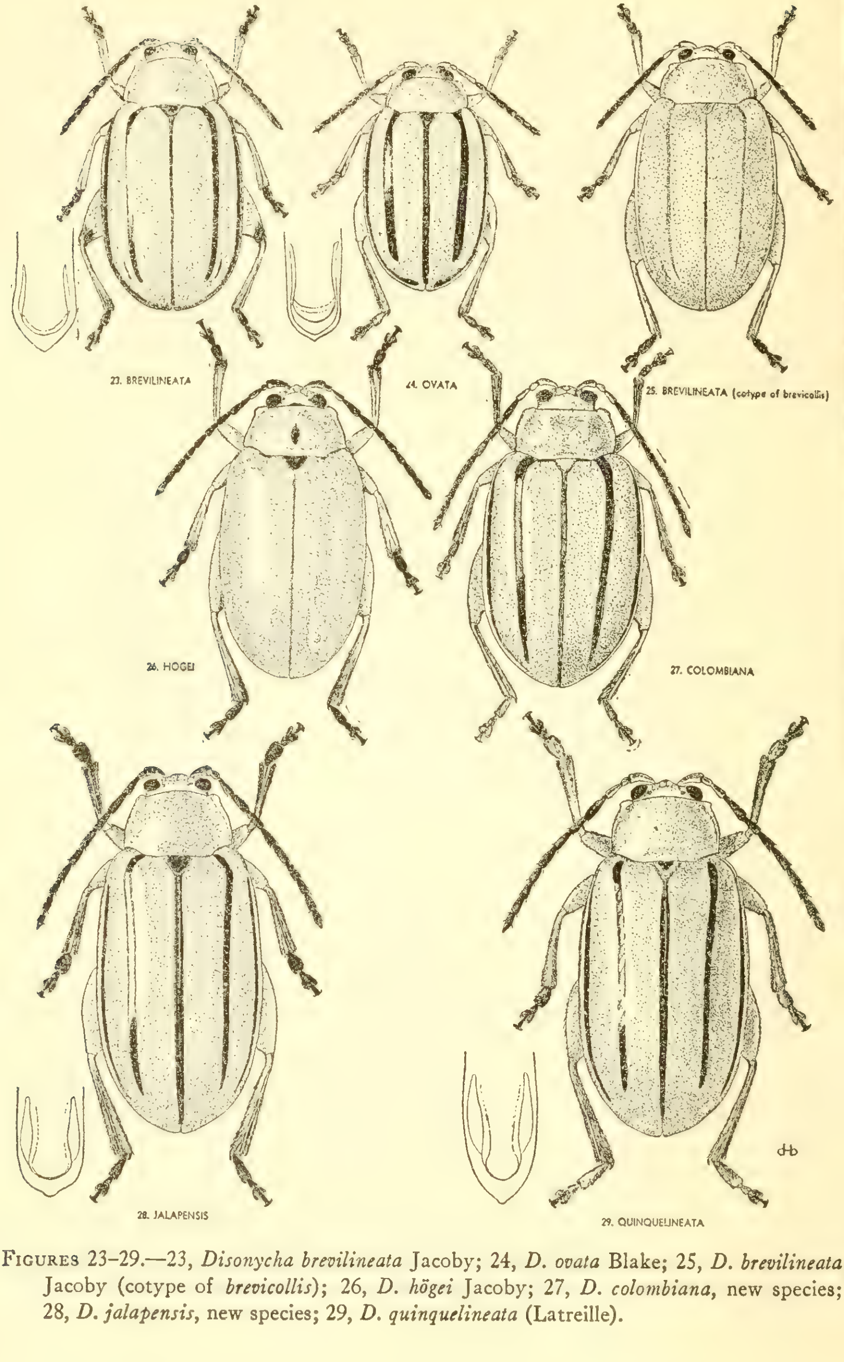
FIGURES 1–9.—1, *Disonycha procera* Casey; 2, *D. pensylvanica* (Illiger); 3, *D. yurimaguensis*, new species; 4, *D. pittieri*, new species; 5, *D. recticollis* Jacoby; 6, *D. spilotrachela* Blake; 7, *D. immaculata*, new species; 8, *D. varia*, new species; 9, *D. bicarinata* Boheman.



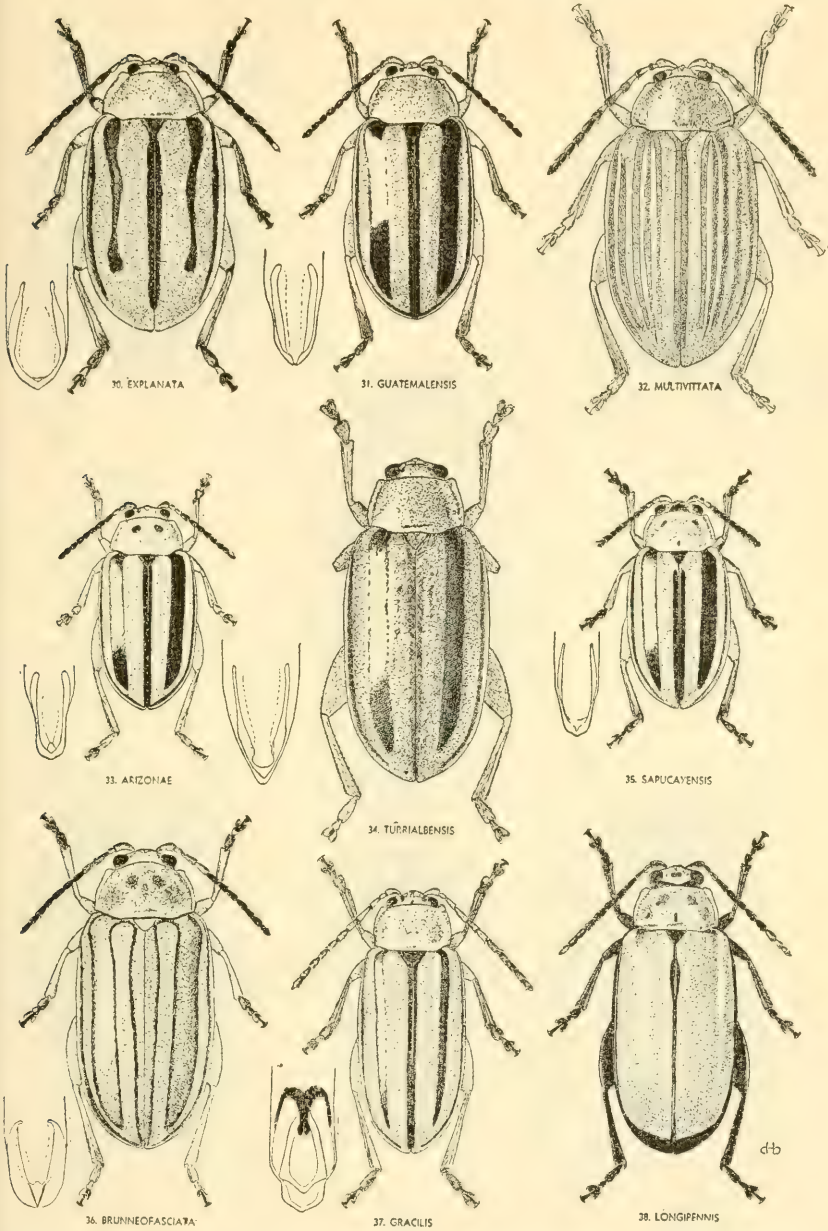
FIGURES 10–15.—10, *Disonycha fumata* (LeConte); 11, *D. f. labiata* Jacoby; 12, *D. teapensis* Blake; 13, *D. latiovittata* Hatch; 14, *D. knabi*, new species; 15, *D. pluriligata* (LeConte).



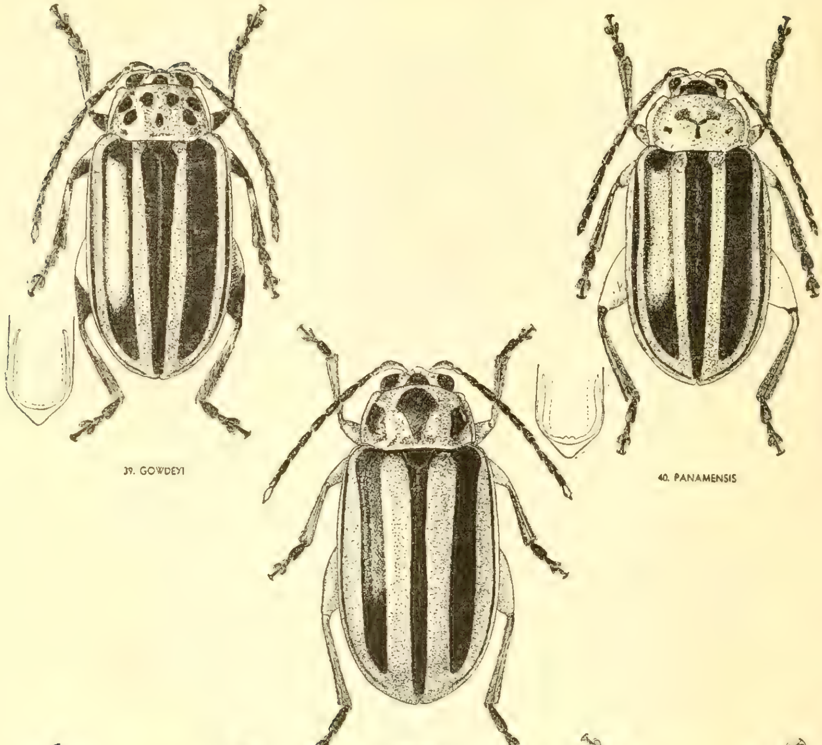
FIGURES 16–22.—16, *D. leptolineata texana* Schaeffer; 17, *D. tenuicornis* Horn; 18, *D. antennata* Jacoby; 19, *D. militaris* Jacoby; 20, *D. elongata* Jacoby; 21 and 22, *D. peruana* Jacoby.



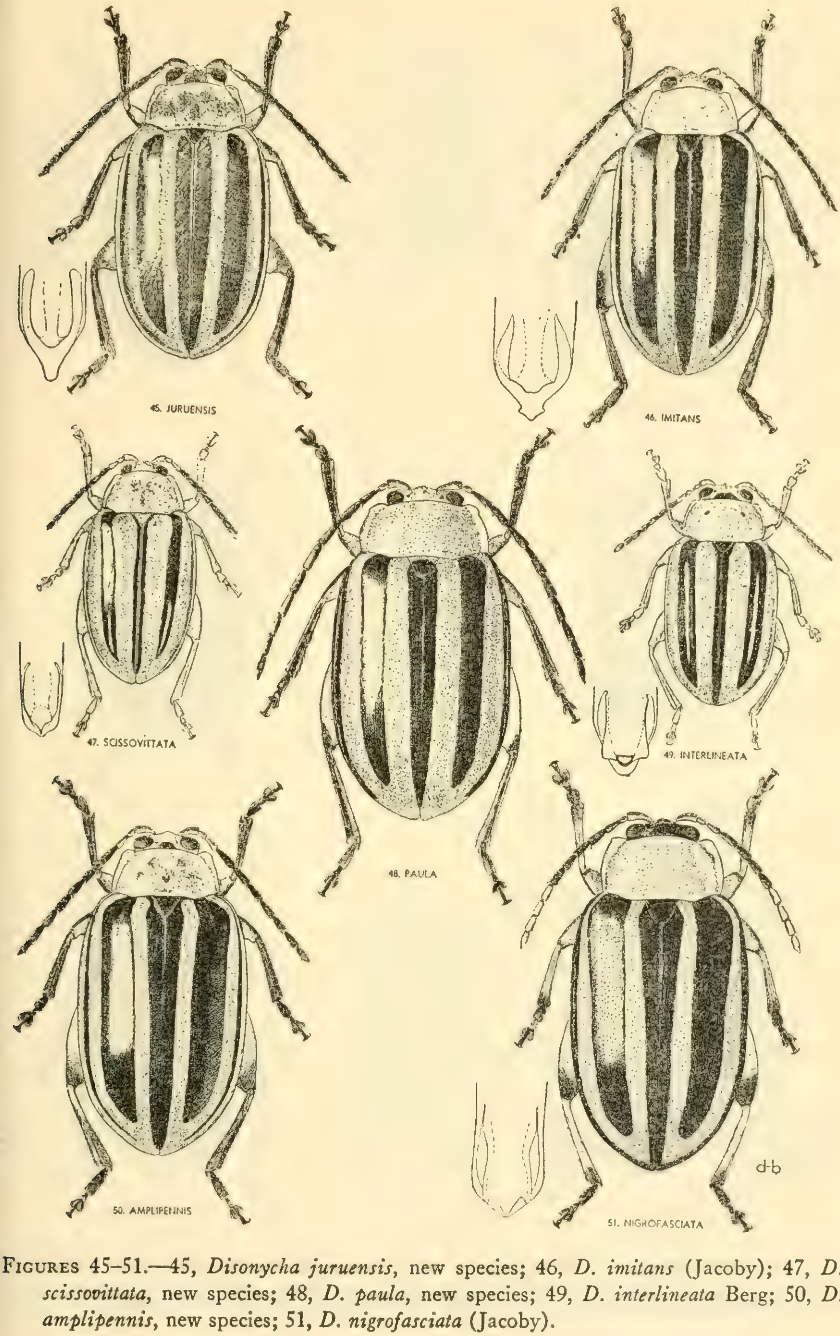
FIGURES 23–29.—23, *Disonycha brevilineata* Jacoby; 24, *D. ovata* Blake; 25, *D. brevilineata* Jacoby (cotype of *brevicollis*); 26, *D. högei* Jacoby; 27, *D. colombiana*, new species; 28, *D. jalapensis*, new species; 29, *D. quinquelineata* (Latreille).



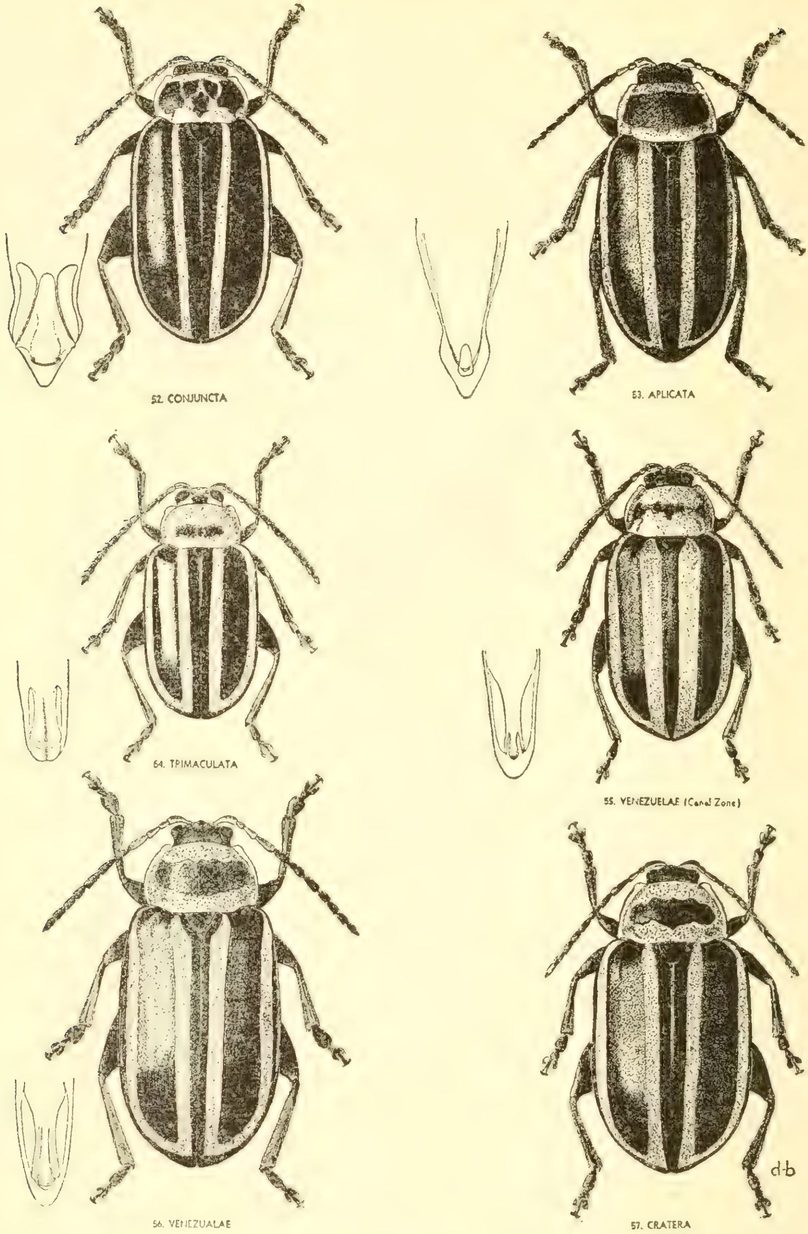
FIGURES 30–38.—30, *D. explanata*, new species; 31, *D. guatemalensis* Jacoby; 32, *D. multivittata*, new species; 33, *D. arizonae* Casey; 34, *D. turrialbensis*, new species; 35, *D. sapucayensis*, new species; 36, *D. brunneofasciata* Jacoby; 37, *D. gracilis*, new species; 38, *D. longipennis*, new species.



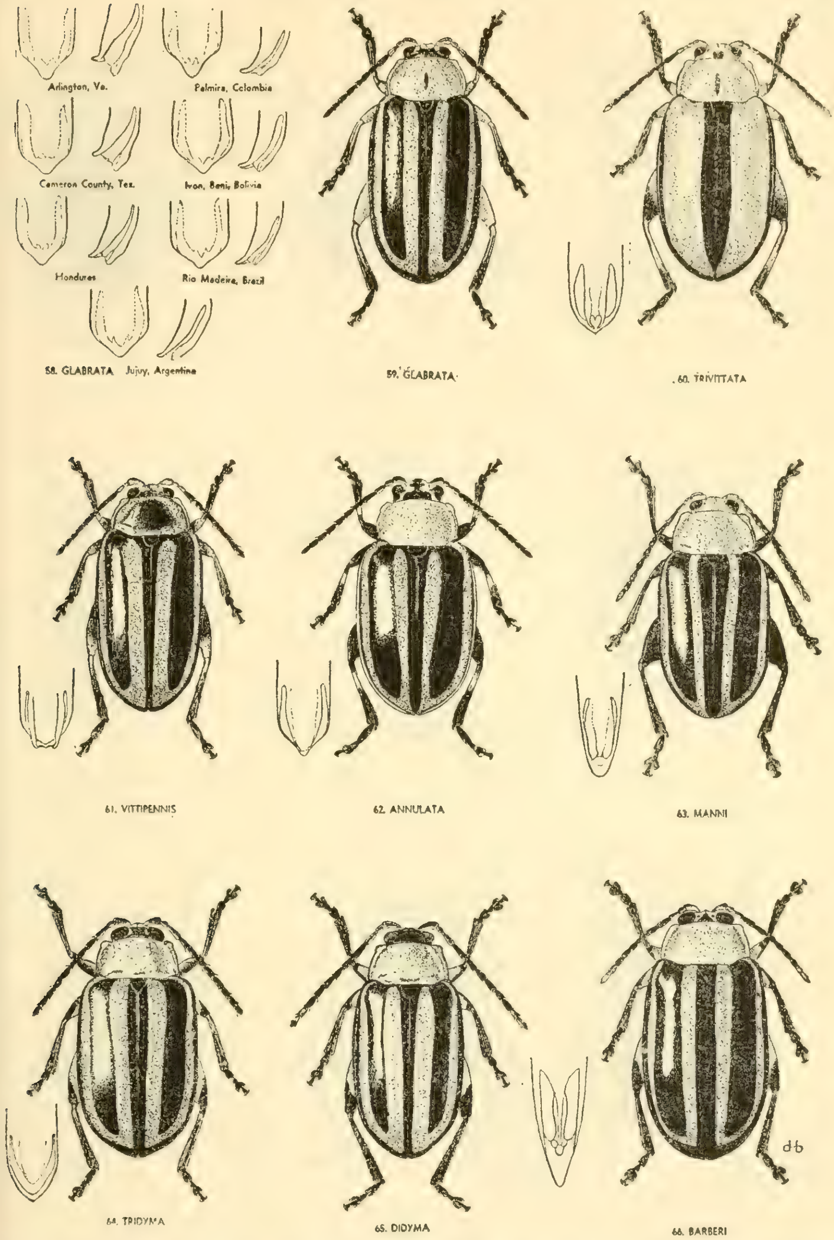
FIGURES 39-44.—39, *D. gowdeyi* Bryant; 40, *D. panamensis* Jacoby; 41, *D. megaspilota*, new species; 42, *D. figurata* Jacoby; 43, *D. plagifera*, new species; 44, *D. crassicornis*, new species.



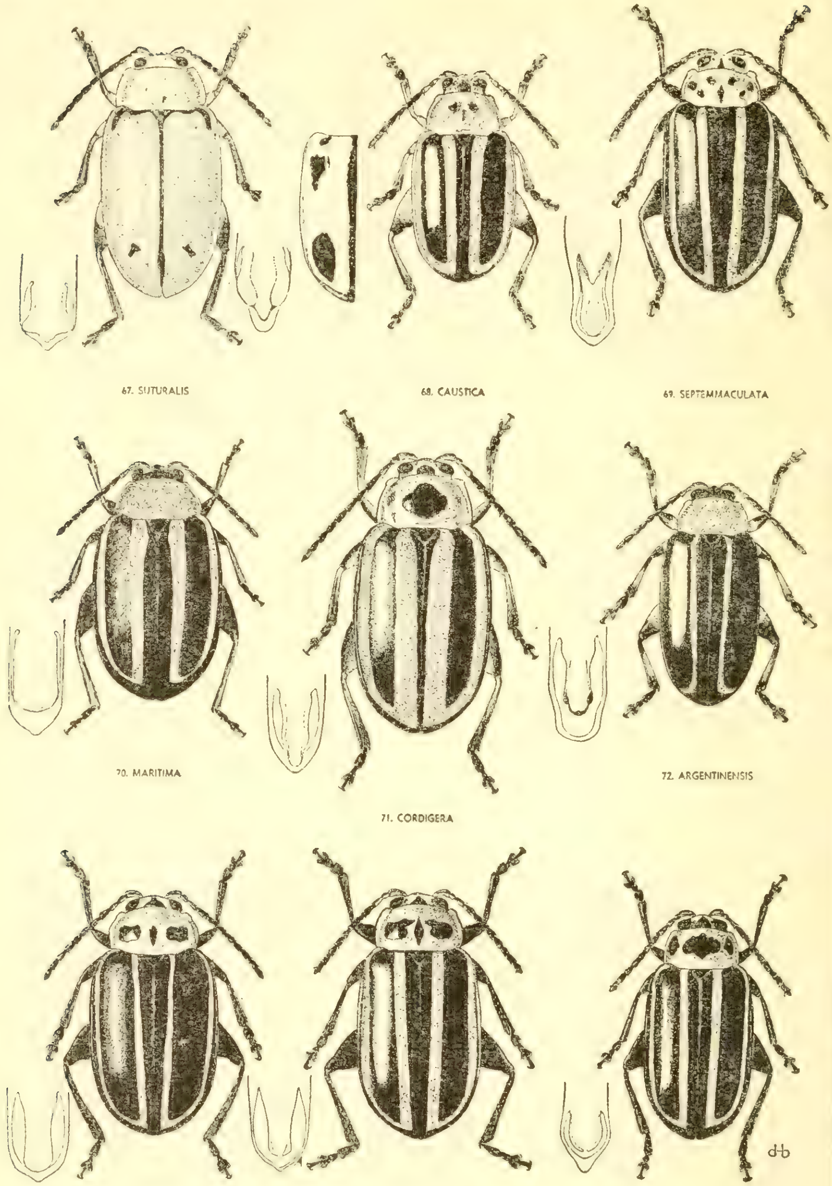
FIGURES 45–51.—45, *Disonycha juruensis*, new species; 46, *D. imitans* (Jacoby); 47, *D. scissovittata*, new species; 48, *D. paula*, new species; 49, *D. interlineata* Berg; 50, *D. amplipennis*, new species; 51, *D. nigrofasciata* (Jacoby).



FIGURES 52-57.—52, *Disonycha conjuncta* (Germar); 53, *D. aplicata*, new species; 54, *D. trimaculata*, new species; 55 and 56, *D. venezuelae* Jacoby; 57, *D. cratera*, new species.



FIGURES 58–66.—58 and 59, *Disonycha glabrata* (Fabricius); 60, *D. trivittata*, new species; 61, *D. vittipennis* Boheman; 62, *D. annulata*, new species; 63, *D. manni*, new species; 64, *D. tridyma*, new species; 65, *D. didyma*, new species; 66, *D. barberi* Blake.



FIGURES 67–75.—67, *Disonycha suturalis* Bryant; 68, *D. caustica* Harold; 69, *D. septemma culata*, new species; 70, *D. maritima* Mannerheim; 71, *D. cordigera*, new species; 72 *D. argentinensis* Jacoby; 73, *D. plaumanni* Costa Lima; 74, *D. copulata* (Germar) 75, *D. prolixa* Harold.

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A REVISION OF THE NEARCTIC SPECIES OF THE BEETLE GENUS MELIGETHES (NITIDULIDAE)

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The representation in North America of the genus *Meligethes* Stephens was first discovered by LeConte, who, in 1857, described three species—*rufimanus*, *moerens*, and *seminulum*. In 1859 he added to this list *saevus* and *ruficornis*. Gemminger and Harold in their catalog published in 1868 retained at five the total of Nearctic species, though the trivial name *mutatus* Harold was introduced in place of *ruficornis* LeConte by reason of the preoccupation of the latter (Heer, 1841). Horn, in 1879, when revising the Nitidulidae of the United States, added a further species, *M. pinguis*, but the recognition of the identity of *rufimanus* LeConte and *moerens* LeConte served to maintain the previous total, in which no further change was noted at the publication of the Leng catalog in 1920, or in 1943 when Parsons again revised the Nitidulidae of North America. A sixth species, *M. simplipes* Easton, was described in 1947.

The present paper introduces two further species, *M. canadensis*, new species, and *M. atratus* Olivier, already well known in the Old World. *M. seminulum* LeConte is shown to be identical with the Palaearctic *M. nigrescens* Stephens, while *M. aeneus* Fabricius is deleted from the list, it being asserted that its representatives in North America are conspecific with *M. rufimanus* LeConte and distinct from the Palaearctic species.

In compiling this revision I am fully conscious of the debt I owe to my many friends across the Atlantic without whose untiring help in sending material its inception would have been impossible. So many have rendered invaluable assistance in this and other ways

that it becomes impracticable to list them. Outstanding among them, however, are Mr. Hugh B. Leech, through whose courtesy I have been enabled to study all the material belonging to this genus in the collections of the California Academy of Sciences (CAS); Mr. H. Dietrich, who kindly sent on loan 206 examples from the collection of Cornell University; Mr. Edward A. Chapin, through whose cooperation I received for revision 259 specimens belonging to the U. S. National Museum (USNM), Mr. E. A. Dickason of Oregon State College; Prof. R. E. Larson; Mr. L. R. Gillogly; and Mr. J. W. Green. To these gentlemen, as to the many others whose names are not here recorded, grateful acknowledgement is made of the important part which they have played in bringing about the completion of this paper.

***Meligethes canadensis*, new species**

FIGURE 76,*a–f*

MALE: Length, 2.2 mm.; width, 1.3 mm. Oval, somewhat elongate, moderately convex, shining black, with second segment of antennae and segments 1–4 of all tarsi brown; short fine inconspicuous pubescence.

Head strongly transverse, triangular, slightly convex. Clypeus with anterior margin straight. Punctures equal in size to the eye facets and separated by one-half to one diameter, the surface between finely microscopically reticulate. Antennae black, except the second segment pale brown, and the third brownish black, the club of medium size, about twice as long and 2¼ times as wide as the first antennal segment.

Pronotum nearly twice as wide as long (1.1 : 0.6 mm.), with sides almost straight in the middle, strongly rounded inwards in front, less so towards the base. Front margin almost straight, except at its extremities where the front angles are slightly prominent, little more than half as long as the hind margin. Hind margin extremely feebly sinuate on each side of the scutellum, hind angles obtuse, bluntly pointed. Upper surface moderately strongly convex, feebly explanate towards the hind angles; sides narrowly bordered. Punctures slightly coarser than those of the head, and on the disc equally close, towards the base separated by 1 to 1½ diameters, surface between finely microscopically reticulate.

Elytra a little more than twice as long as the pronotum (1.4 : 0.6 mm.), scarcely longer than broad, at base as wide as base of pronotum, gently rounded at the sides and somewhat narrowed posteriorly, the apex of each being gradually rounded off, and having an extremely minute tooth at the sutural angle. Moderately strongly convex, sides very narrowly bordered. Punctures on disc as course as those of the pronotum but separated by two diameters, gradually much finer and more diffuse towards the apex, each bearing a fine recumbent hair reaching the puncture behind. Surface between with distinct, fine, chiefly transverse, microscopical reticulation.

Scutellum finely diffusely punctured, strongly reticulate.

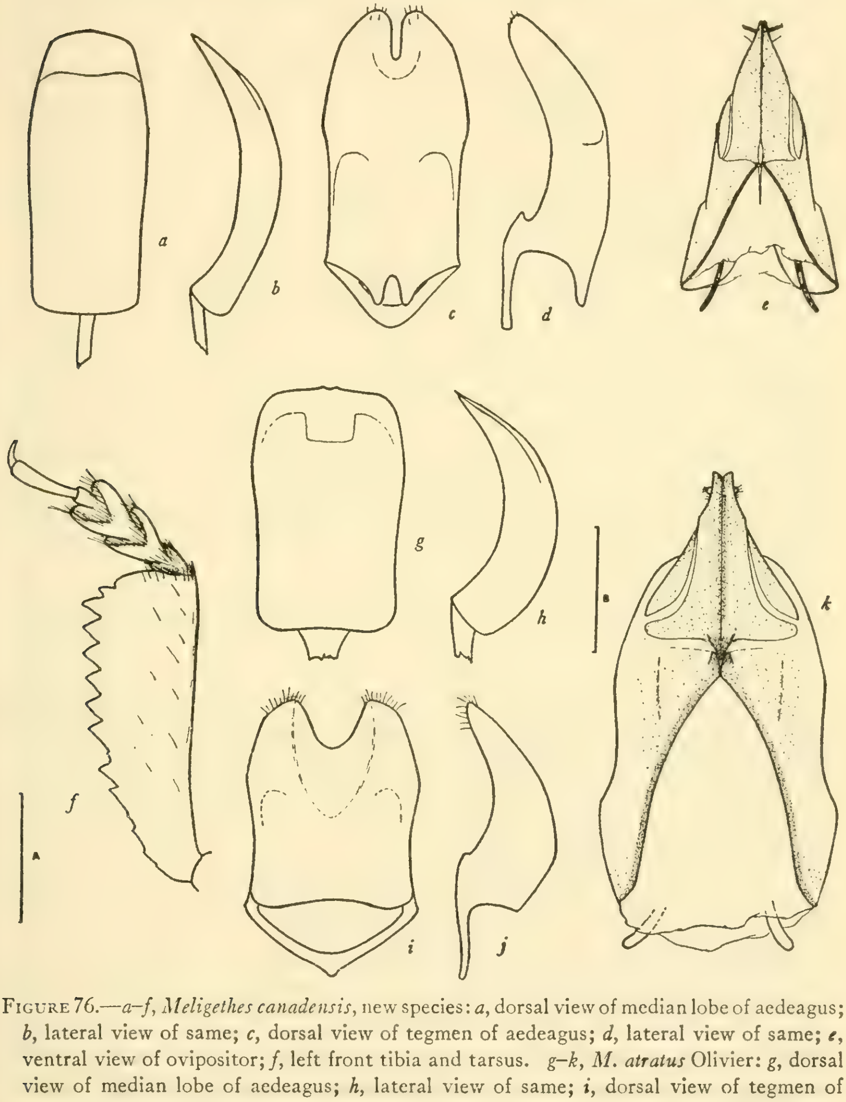

FIGURE 76.—*a–f*, *Meligethes canadensis*, new species: *a*, dorsal view of median lobe of aedeagus; *b*, lateral view of same; *c*, dorsal view of tegmen of aedeagus; *d*, lateral view of same; *e*, ventral view of ovipositor; *f*, left front tibia and tarsus. *g–k*, *M. atratus* Olivier: *g*, dorsal view of median lobe of aedeagus; *h*, lateral view of same; *i*, dorsal view of tegmen of aedeagus; *j*, lateral view of same; *k*, ventral view of ovipositor. Scale A (*a–d*, *f*), 0.2 mm.; scale B (*e*, *g–k*), 0.25 mm.

Pygidium moderately coarsely and rugosely punctured, pubescence somewhat erect.

Ventral surface black. Prosternum coarsely and closely punctured, broadened posteriorly with apex rounded. Metasternum with punctures less coarse, about equal to eye facets, separated by 1½ diameters, surface between almost smooth; triangularly flattened in posterior two-thirds, and with a small longitudinal central area unpunctured. Abdomen with first sternite punctured as metasternum, the second to the fifth more finely and closely punctured, the areas between reticulate. The caudal marginal line of the hind coxal cavity follows closely the hind edge of the latter almost to its outer end where it curves abruptly backwards. The last sternite without secondary sexual characters.

Legs unicolorous black except segments 1–4 of all tarsi brown. Anterior tibiae (fig. 76,*f*) slightly broadened towards the apex, with outer edge finely, not quite evenly, serrate from the basal third, very similar except in color to those of *M. seminulum* LeConte. Intermediate and hind tibiae scarcely broader, the former widest at the middle, the latter at the apical third, the outer edge rounded and obliquely truncate at the apex and furnished with a row of fine close-set setae. Inner edge of all tibiae straight. Tarsi narrow, the anterior nearly twice as broad as the others; last segment a little shorter than the first four together, claws simple.

Genitalia as in figure 76,*a–d*. Median lobe parallel-sided, simply rounded at the apex, tegmen slightly narrowed to its rounded apex, with narrow linear excision.

Female: Externally similar to the male except front tibiae narrower, more parallel-sided, front tarsi only 1½ times as broad as the others, and metasternum not flattened.

Genitalia as in figure 76,*e*. Ovipositor with apex acute, and with a sclerotized spicule running backwards from the central point in the ventral membrane as in *M. seminulum*. Styli somewhat elongate.

Type: ♂, CAS, and paratype, USNM 61625, Duparquet, Quebec, Canada, June 18, 1938, G. Stace Smith.

Paratypes: Canada: Quebec Province: 3, including 2 ♀♀, with same data as type, and 15 taken by the same collector in the same district at various dates in June (except one on August 2) between 1934 and 1943, one of these on *Solidago*, one on *Fragaria*, two on *Epilobium*, others in lake-drift and on stones and plants beside the lake. Alberta: Edmonton, 4, June 1910 and July 1919, F. S. Carr. British Columbia: Stanley, 1, July 22, 1931, K. Graham; Beaton River, 15 miles northwest of, 1, by sweeping, June 8, 1950, P. Bubtsoff. Yukon: Dawson, 5, in USNM, June 1924, H. C. Fall.

Alaska: Mount McKinley National Park, 72, in USNM, June 1931,

F. W. Morand; College, 2, in USNM, June, J. C. Chamberlain; Anchorage, 1, in USNM, May, N. Hoffman.

United States: California: Alta Meadow, Sequoia National Park, 9,000 ft., ♂, July 19, 1907, J. C. Bradley. Colorado: Argentine Road, 4 ♀♀, in USNM, Wickham. Utah: ♀, "Cornell U. Lot 909 Sub Schaeffer coll."; Park City, ♂, in USNM, Hubbard and Schwartz.

Little variation is manifest in the material available except in the teeth on the outer edge of the anterior tibiae. These vary appreciably in number, size, and degree of sharpness, while an irregularity in distribution and size of individual teeth appears to be a constant feature. Some of the specimens are slightly duller than others depending on the degree of reticulation, which at times is almost absent. In some the sides of the pronotum are more rounded than in the type, while, in the examples from the United States, pallor of legs and antennae, apparently due to immaturity, is a prominent feature.

Though undoubtedly closely related to and superficially resembling *M. seminulum* LeConte, the new species is readily distinguished by its dark legs, the microscopical reticulation of its upper surface, the absence of any male secondary sexual character on the last ventral segment of the abdomen, and by its entirely different aedeagus. The ovipositor, too, by its longer styli and absence of apical pigmentation, constitutes a sure means of distinction. Its much smaller teeth on the anterior tibiae and its reticulate upper surface at once distinguish it from *M. saevus* LeConte; and its simple claws separate it from *M pinguis* Horn. In addition to its other characters, its color should prevent confusion with the other Nearctic species. Among European species, apart from M. *nigrescens* Stephens (= *picipes* Sturm)—regarding which the reader is referred to the subsequent section dealing with *M. seminulum* LeConte—it most nearly approaches *M. brachialis* Erichson, but the smooth surface, wider and more robust tibiae, and divergent course of the caudal marginal line of the hind coxal cavity of the European species serve readily to distinguish it.

The paratypes to which name tabs were attached had been determined as either *M. saevus* LeConte or *M. seminulum* LeConte.

Meligethes atratus Olivier

Figure 76,*g–k*

This species is added to the Nearctic list on the evidence of a single specimen in the British Museum collection bearing the data: "Metlakatla, Brit. Columbia. J. H. Keen 1915—355." This specimen agrees externally in all respects with Palaearctic examples, and on dissection it proved to be a female whose ovipositor is identical with that found in European specimens.

M. atratus Olivier is well distinguished from the other Nearctic species by its large size (length 3–4 mm., width 1.6–2.1 mm.) and by the following combination of its principal external characters: the black color of its upper surface except for the reddish translucency of the explanate side margins of the pronotum, its yellowish legs and antennae, the fine close punctures of its upper surface which on the elytra are elongate and finely cross-rugose, the nonreticulate surface between the punctures, and the evenly finely crenulate outer edge of its front tibiae. Added to these features are the characteristic forms of aedeagus and ovipositor that are shown in figure 76,*g–k*.

Meligethes rufimanus LeConte

FIGURE 77,*a–e*

In 1857 LeConte described the species *Meligethes rufimanus* and *M. moerens* from examples taken in California and Oregon, respectively. Two years later he published the description of a third species, *M. ruficornis*, taken at Platte River, Kansas. The first two came subsequently to be accepted as identical, while the name *ruficornis* was found to be a homonym, Heer having used the same epithet in 1841. Consequently, in 1868, Harold changed this latter name to *mutatus*.

In 1871 Reitter, from a specimen taken by Kirsch in California, described briefly his variety *californicus* of *M. aeneus* Fabricius; clearly, he did not regard this American beetle as exactly identical with Palaearctic examples, though little evidence is apparent from his descriptions as to the grounds on which he based the distinction.

At a subsequent date Reitter sent a specimen of *M. californicus* to Horn, in America, who compared it with examples of *rufimanus* and found the two "perfectly identical," a fact that he recorded in 1879. Because of this identity, both *M. rufimanus* LeConte and *M. moerens* LeConte came to be regarded as synonymous with *M. californicus* Reitter; later, all three were sunk as synonyms of *M. aeneus* Fabricius, and the latter name became included in the Nearctic list.

M. mutatus Harold, however, in spite of Horn's doubts as to its distinctness from *rufimanus* LeConte, maintained its specific identity, and was so treated by Parsons (1943), although he too found its distinction from *aeneus* Fabricius obscure and difficult of interpretation. Both these authors, moreover, stressed the variability of both species. Horn appeared doubtful as to the logic of avoiding further specific subdivision of *mutatus*, while at the same time retaining its distinctness from *rufimanus* on equally feeble characters, and Parsons considered that the variations of *aeneus* were sufficient to include *mutatus* within their range.

My own now considerable experience with both Nearctic and Palaearctic material has led me to the conclusion that North American *Meligethes* which may have been variously determined as *rufimanus*, *moerens*, *ruficornis*, *mutatus*, or *californicus*, as well as many of those regarded as *aeneus* or *brassicae*, constitute but one single, although variable, species very closely related to but distinct from the Palaearctic *M. aeneus* Fabricius. Other specimens among Nearctic mate-

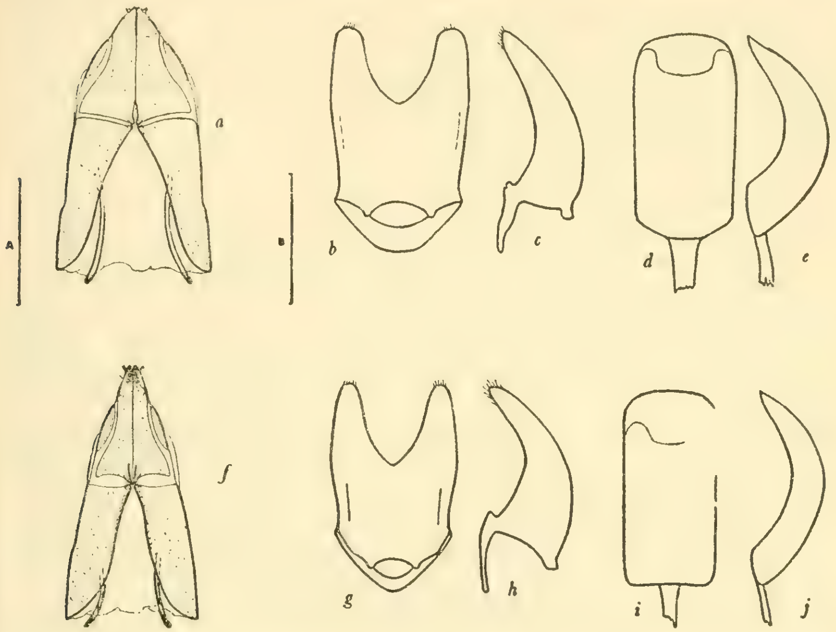

FIGURE 77.—*a–e*, *Meligethes rufimanus* LeConte: *a*, ventral view of ovipositor; *b*, dorsal view of tegmen of aedeagus; *c*, lateral view of same; *d*, dorsal view of median lobe of aedeagus; *e*, lateral view of same. *f–j*, *M. aeneus* Fabricius: *f*, ventral view of ovipositor; *g*, dorsal view of tegmen of aedeagus; *h*, lateral view of same; *i*, dorsal view of median lobe of aedeagus; *j*, lateral view of same. Scale A (*a*, *f*), 0.25 mm.; scale B (*b–e*, *g–j*), 0.2 mm.

rial that had been determined as belonging to this latter species have proved on critical examination to be unrecognized examples of *M. simplipes* Easton, and I have yet to see a specimen from America that I would regard as a true *M. aeneus* Fabricius. Thus I find myself in disagreement with such workers as Chittenden (1925) and Dr. Stuart W. Frost (quoted by Peng-Fi and Larson,[1] 1949), who regard it as a species introduced into North America.

[1] The paper referred to, "*Meligethes aeneus* as a Factor in Muskmelon Breeding Program in Pennsylvania," was based on the determination by Mr. Henry Dietrich as *M. aeneus* Fabricius of specimens derived from the heavy infestation of the plants in 1948. During 1951 Prof. R. E. Larson very kindly sent me 188 beetles freshly collected off the same crop of *Cucumis melo* Linnaeus, and these, without exception, proved to be *M. nigrescens* Stephens (= *seminulum* LeConte).

The type specimens of *M. rufimanus* LeConte, *M. moerens* LeConte, and *M. ruficornis* LeConte are in the LeConte collection housed in the Museum of Comparative Zoology and it has not been my good fortune to have the opportunity of examining them. The present whereabouts of the type specimen of *M. californicus* Reitter is a matter of doubt, for I am informed that it is not in the Hungarian National Museum in Budapest as presumed by Parsons. However, a cotype of *M. rufimanus* LeConte is in the British Museum (Natural History), and examination of this specimen has served but to strengthen my conviction of its identity with *mutatus*.

Among these various trivial names, priority attaches to the epithet *rufimanus*, and under this name the characters distinguishing the species from the Palaearctic *M. aeneus* may now be considered.

Character	M. rufimanus *LeConte*	M. aeneus *Fabricius*
Upper surface	Slightly less shining, with metallic reflection almost entirely limited to elytra.	More shining, with metallic reflection from entire upper surface.
Head and pronotum	Black, rarely showing slight greenish reflection.	Concolorous with elytra though usually slightly darker, very seldom pure black.
Eyes	Larger, anterior extremities separated by about 2 diameters.	Slightly smaller, separated in front by about 2¼–2½ diameters.
Antennal club	Distinctly broader and more circular, about three-fourths as wide as long; approximating that of *M. viridescens* Fabricius.	Distinctly narrower and elongate, about two-thirds as wide as long.
Pronotal punctures	Very slightly coarser, and closer, being separated by 1–1½ diameters.	Slightly finer, separated by 1½–2 diameters.
Middle and hind tibiae	Usually somewhat broader with outer edge more evenly rounded.	Usually less broadened and outer edge less evenly rounded.
Ovipositor	As in figure 77,*a*, with apex blunter, the coxites distinctly broader in proportion to their length. Apex concolorous or only slightly darker.	As in figure 77,*f*, with apex much more acute, the coxites narrower. The extreme apex distinctly piceous.
Aedeagus	As in figure 77,*b–e*, with both lateral and median lobes more broadened towards the apex.	As in figure 77,*g–j*, with median lobe almost parallel-sided, scarcely broadened near the apex; the tegmen feebly broadened.

The characters of greatest value are the form of the ovipositor, the shape and size of the antennal club, and the color of the pronotum. The elytra and undersurface exhibit no differences of note, while the variance in shape of the aedeagi, though deemed worth recording, is in practice so slight as to be of little value as a distinguishing character. It will be observed that no reference has been made to the extent and degree of explanation of the sides of the pronotum, a character which has been given prominent place by previous authors but which, in the writer's opinion, is too variable and difficult of interpretation to be of use in diagnosis.

The variability of both species must again be stressed, and it must be conceded that an occasional example of either will externally so resemble the other that certain determination, unless by means of the ovipositor in the female, will be impossible.

The question of color variation was considered in some detail by Ext (1920, pp. 35–36), who, by basing his conclusions on the combination of black head and pronotum with metallic green elytra, regarded *M. rufimanus* LeConte, *M. moerens* LeConte, *M. californicus* Reitter, and *M. viridipennis* Motschulsky as synonymous with the aberration *dauricus* Motschulsky of *M. aeneus* Fabricius, a form common in eastern Siberia. Ext did not consider *M. mutatus* Harold at all; since it was regarded as a distinct species it did not come within the scope of the subject matter of his paper.

The interesting situation now emerges where we have in Europe and western Asia a species (*M. aeneus* Fabricius) distinct from, yet extremely closely related to, another species (*M. rufimanus* LeConte) inhabiting North America, with between them in eastern Siberia a form (*M. dauricus* Motschulsky) allegedly an aberration of the former, yet showing coloring typical of the latter.

Happily, in the general collection of the British Museum there exist a single specimen (♀) labeled "*Dauricus* Motsch. nov. spec., Dauria," and two (♀♀) inscribed "*viridipennis* Mot. nov. spec., Dauria," with which may be included one other (♂) bearing the data "*motschoulskyi* Murray [2] n. sp. (*viridiaeneus* Motsch.[2]), E. Siberia." These I have been privileged to dissect and remount, thereby proving them identical with one another. Their great similarity to *M. rufimanus* LeConte is striking. Nevertheless I do not believe that they should be regarded as identical with this species, for though agreeing exactly in color they appear from other characters (including in particular the form of the ovipositor and the shape of the antennal club) to lie in an intermediate position between it and *M. aeneus* Fabricius.

[2] No description published.

The inevitable conclusion must be that all three forms—*M. aeneus* Fabricius, *M. dauricus* Motschulsky, and *M. rufimanus* LeConte—constitute divergent branches from a common ancestral stock. At the two extremes a barely sufficient differentiation has been reached to entitle us to regard them as distinct species. *M. dauricus* Motschulsky, in the intermediate position, should be considered as a subspecies of *M. rufimanus* LeConte, to which it lies closer both in its morphological characters and in its geographical distribution.

The synonymy of *M. rufimanus* LeConte thus becomes:

M. rufimanus LeConte, 1857
M. moerens LeConte, 1857
M. ruficornis LeConte, 1859, nec Heer, 1841
M. mutatus Harold, 1868
M. californicus Reitter, 1871
M. aeneus of American authors (ex parte), nec Fabricius, 1775
subspecies *dauricus* Motschulsky, 1849
subspecies *viridipennis* Motschulsky, 1866

The synonymy of *M. aeneus* Fabricius should be amended by the deletion of *dauricus* Motschulsky, *rufimanus* LeConte, *moerens* LeConte, *viridipennis* Motschulsky, and *californicus* Reitter.

In considering the distribution of this species, we note that LeConte's *rufimanus* was found in California, *moerens* in Oregon, and *ruficornis* in Kansas. Reitter's *californicus* derived from California. Horn recorded *rufimanus* from California and Oregon, and he considered *mutatus* to range from New York to Colorado. Parsons reiterated this distribution for *mutatus* but stressed its abundance in the mountainous region from Montana to Arizona and New Mexico. He reported *aeneus* from British Columbia (based no doubt on Criddle's 1922 record), and from Montana to California, Arizona, New Mexico, Tennessee, Indiana, Pennsylvania, and Maine. Blatchley (1910) included both *aeneus* and *mutatus* in his "Coleoptera of Indiana," while Blackwelder (1945) includes México within the range of "*M. aenea* F."

Examples of *M. rufimanus* LeConte in my collection and those whose identity I have personally confirmed are derived from the localities that follow.

Canada: British Columbia: Lorna, Little White Mountain, Oliver. Saskatchewan: Pennant. Manitoba: Aweme.

United States: Washington: Spokane. Oregon: Mitchell. California: Very numerous localities throughout the State. Idaho: Lewiston, Coeur d'Alene. Nevada: Austin. Utah: Salt Lake City, Zion Canyon, Little Cottonwood Canyon, Wasatch Mountains, Monroe, Richfield, Bountiful, Alta, Lehi, Park City, Coalville. Arizona: Globe, Mount Lemmon, Oracle, Huachuca Mountains, Flagstaff, Chiricahua Mountains. Montana: Assinniboine, Helena, Yellowstone. Wyoming: Delano Ranch in Platte County. Colorado: Antonito, Gunnison, Lincoln County, Mount Lookout, Leavenworth Valley, Buena Vista, Denver, Garland, Mesa, Veta Pass, De Beque, Colorado Springs, Idaho Springs. New Mexico: Santa Fe, Las Vegas, Hot Springs, Magdalena. Nebraska: Pine Ridge, Plum Creek, West Point. Kansas: Douglas County, Lawrence.

Many of the records of American authors quoted above are based on misdeterminations, notably of *M. simplipes* Easton, and are therefore open to doubt. My own experience suggests that *rufimanus* does not occur at all in the Eastern States, where *seminulum* LeConte and *simplipes* Easton are the sole representatives of the genus, but that its distribution covers a wide area throughout the Western and Midwestern States, extending into Canada in the north, and probably into México in the south.

Meligethes simplipes Easton

Since describing this species from Ohio in 1947 a greater experience has shown it to be a not uncommon species widely distributed throughout many of the adjacent States. In collections *M. simplipes* Easton has generally been determined as *M. brassicae* Scopoli, an established synonym of *M. aeneus* Fabricius, and sometimes as *M. mutatus* Harold. In these guises there is no doubt that it has been responsible in large part for the confusion that has existed regarding the relationship of *M. mutatus* Harold and *M. aeneus* Fabricius, a subject that has been discussed in some detail above. Thus, in the collections of the British Museum, standing above the name *M. brassicae* Scopoli are six specimens from the W. S. Blatchley collection taken in Marion County, Indiana, one bearing the date June 1, 1928, and another labeled "*Meligethes brassicae* Scop. W. S. Blatchley det." These beetles, as also two of like derivation in the collection of New York State College of Agriculture, I find not only to be amply distinct from both *M. aeneus* Fabricius (= *brassicae* Scopoli) and *rufimanus* LeConte, but to agree exactly with *M. simplipes* Easton, and it is clear that Blatchley's record of "*M. aeneus*" in his "Coleoptera of Indiana" must be regarded as referring to this species.

The characters by which *M. simplipes* Easton may be distinguished from *M. rufimanus* LeConte (= *mutatus* Harold) were considered at the time of its original description (Easton, 1947). While the distinction between typical specimens of the two species is at once obvious, a small percentage of specimens exhibits a sufficient variation as to render diagnosis difficult, especially as regards size and proximity of punctuation. In the majority of these specimens, however, an accurate conclusion can be reached by a consideration of the greater degree of convexity and more shining surface of *simplipes*. Even so, a very small residuum persists in which final determination is virtually impossible, for here we are dealing with two species whose form of aedeagus and ovipositor differ so little as to be useless in differentiation. That such is the case should not be invoked as evidence of identity of the two species, for in Europe also a parallel exists, in which, however, one small additional character serves always as the final criterion. I refer to *M. aeneus* Fabricius and *M. viridescens* Fabricius, in which the chief differential characters, as in the case under consideration, depend on the size and proximity of the punctures of the elytra and the color of the legs. More closely finely punctured examples of the latter species are often indistinguishable from more diffusely punctured examples of the former, except by one small feature—the inconspicuous yet constant angulation on the lower edge of the intermediate femur in *M. viridescens*.

The distribution of *M. simplipes* as deduced from material personally determined covers the following localities.

Canada: Ontario: Michipicoten, Batchawana Bay.

United States: New York: Greene County, Catskill Mountains, West Point, Trenton. New Jersey: Phillipsburg. Pennsylvania: Easton, Allegheny. Maryland: Plummers Island, Hempstead. West Virginia: Fairmont, Mannington, Fort Pendleton. Ohio: Adams County, Highland County, Camden, New Concord. Tennessee: Great Smoky Mountains National Park, Flat Top Mountain, Chestoa, Unaka National Forest.

Except for the following records, determination of the above examples offered no difficulty: one example collected at Plummers Island, Maryland, on June 6, 1909, by W. L. McAtee; one example collected at Phillipsburg, New Jersey, on July 7, 1918, by J. W. Green; and three examples from the Schaeffer collection, now owned by Cornell University (New York State College of Agriculture), of which one bears a label "N. J." The first two would appear to be genuine examples of *M. simplipes* Easton. The last three examples give rise to greater difficulty, and I should have been inclined to call them *M. rufimanus* LeConte had not their place of origin been so much at variance with all my other experience. These three specimens apart (and it must be remembered that one of them bears only the hardly sufficient data "N. J."), we find a complete absence of overlap in the areas of distribution of *simplipes* Easton and *rufimanus* LeConte, a factor which may legitimately be taken into consideration in the diagnosis of any particularly difficult example.

M. simplipes is to be taken from April to August, abundantly in the flowers of *Rubus canadensis* Linnaeus, and less frequently on *Syringa*.

Meligethes nigrescens Stephens

FIGURE 78,*a–e*

Examination of a considerable number of individuals of the beetle known in North America as *Meligethes seminulum* LeConte has shown a remarkable agreement in external characters with *M. nigrescens* Stephens (= *picipes* Sturm) (see Easton, 1951), a species very common throughout Europe and the British Isles and whose range includes Madeira and the Canary Islands, North Africa, Cyprus, the Caucasus, Siberia, and Arabia. Both show close to the apex of the last ventral segment the identical transverse smooth shining area with slightly raised ends that characterizes the male sex; moreover, dissection shows an identical aedeagus whose very distinct tegmen (fig. 78,*a–d*), is of a form quite unusual in the genus and, in the female, identical ovipositors characterized by the presence of a spicular sclerite arising from the midpoint and passing in a basal direction in the ventral membrane connecting the valvifers of the two sides (fig. 78,*e*).

That *M. seminulum* LeConte and *M. nigrescens* Stephens are identical is the obvious and only possible conclusion to be drawn from the above facts. Here we are dealing with one common Holarctic species, the identity of whose representatives in the Old and New Worlds has hitherto escaped recognition, a fact in part explained by Reitter's lack of opportunity to examine *M. seminulum* LeConte (Reitter, 1873, p. 71).

The synonymy of the species now becomes:

M. nigrescens Stephens, 1830
M. xanthoceros Stephens, 1830
M. picipes Sturm, 1845
M. funebris Förster, 1849
M. seminulum LeConte, 1857
M. saulcyi Reitter, 1872
M. pallipes Rey, 1889, nec Boheman, 1851
M. subsimilis Rey, 1889
M. circularis Sahlberg, 1903

As pointed out by Parsons, the distribution of this species is apparently discontinuous; abundant and widespread in Oregon, where it was first recorded by LeConte in 1857, common in the Northeastern States, and met with in several of the Canadian provinces, it has yet to be reported from a vast area covering the central United States. Horn knew of it only from Oregon and from the north shore of Lake

Superior. Parsons was able to include in its range Massachusetts and Pennsylvania in the eastern United States and Manitoba, Alberta, and Yukon Provinces in Canada, though some of these latter records may be based on misdetermined examples of *M. canadensis*.

My own collection contains material from States in the extreme west and in the east, as well as from Canada. In Oregon, *M. nigrescens* Stephens is widespread and especially abundant, occurring on a wide range of plants. Here it attacks, particularly, crops of *Trifolium pratense* Linnaeus grown for seed in the Corvallis district, the larval stage being passed in the flowers of this plant (the common Dutch clover) and of hairy vetch. Mr. E. A. Dickason of Oregon State College kindly sent me more than 2,000 examples from this source in July 1950.

Other specimens whose identity I have personally confirmed are from New York, New Jersey, Pennsylvania, Maryland, Ohio, and Washington. Mr. C. A. Frost tells me it is common in Massachusetts. In Erie County, Pennsylvania, this species constitutes a not inconsiderable pest on crops of muskmelon, *Cucumis melo* Linnaeus (see footnote, p. 91). Mr. R. J. Fitch sent me over 150 examples collected off dandelion and goldenrod at Vancouver, British Columbia, during May and August 1950. The British Museum possesses a single example from Metlakatla, British Columbia (J. H. Keen, 1915), while three specimens in the collection of the California Academy of Sciences were taken in turnip flowers at Dewdney in the same province.

Specimens in the collection of the U. S. National Museum are from the following localities: New Jersey (Radburn), Maryland (Priest Bridge, Arcadia, Aberdeen, Hempstead), and Oregon (Corvallis, Rickreall, Oswego, Scio, Dover).

Meligethes saevus LeConte

FIGURE 78,*f–j*

This very distinct species appears to have no close relative among either the American or the European fauna, being at once separated from such species as *nigrescens* Stephens, *canadensis*, new species, and *brachialis* Erichson—to which in other characters it bears a superficial resemblance—by the large broad teeth along the outer edge of its front tibiae. These at first sight suggest an affinity with *M. buduensis* Ganglbauer, but such possibility is at once ruled out by a consideration of its other morphological details. *M. maurus* Sturm is superficially simulated in size and general form, though the group to which this species belongs has a typical aedeagal form entirely different from that of the Nearctic species.

In *saevus* LeConte the aedeagus (fig. 78,*g–j*) is somewhat elongate, its median lobe nearly parallel-sided and abruptly narrowed and bluntly pointed at the extreme apex, and its paramere of the usual bilobed form having a narrow parallel-sided central excision with simple lobes rounded and narrowed on the outer side. The ovipositor (fig. 78,*f*) is elongate narrow and sharply pointed, and exhibits the ventral spicule noted under *M. nigrescens* Stephens and *M. canadensis.*

The recorded distribution of *M. saevus* covers a wide area including several of the Central States of the United States, to which the Canadian province of Manitoba may now be added on the strength of a single example in the collection of the California Academy of Sciences taken by N. Criddle at Aweme on June 11, 1923. Specimens

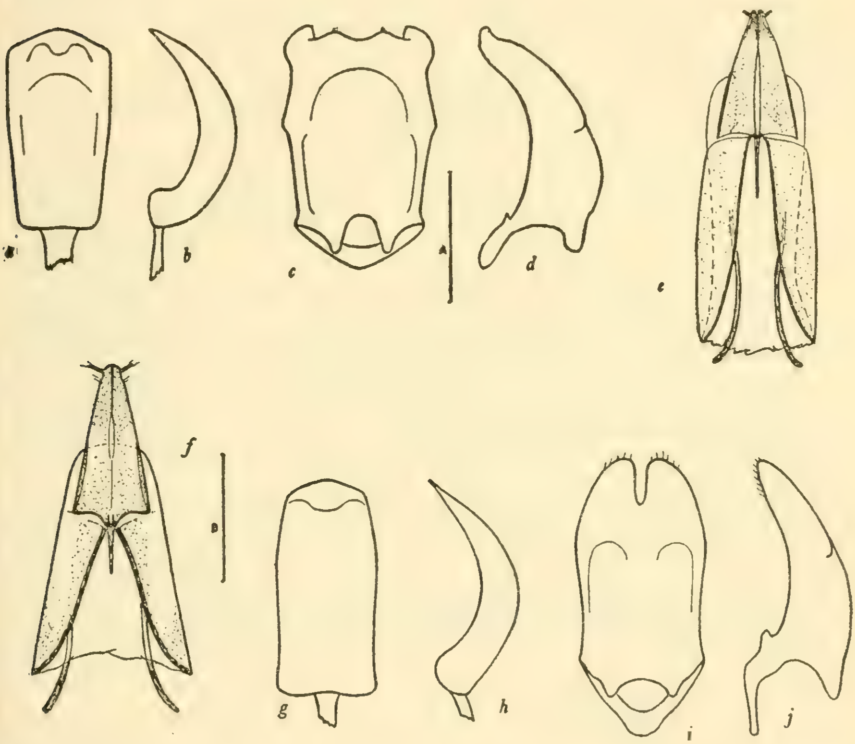

FIGURE 78.—*a–e, Meligethes nigrescens* Stephens: *a*, dorsal view of median lobe of aedeagus; *b*, lateral view of same; *c*, dorsal view of tegmen of aedeagus; *d*, lateral view of same; *e*, ventral view of ovipositor. *f–j, M. saevus* LeConte: *f*, ventral view of ovipositor; *g*, dorsal view of median lobe of aedeagus; *h*, lateral view of same; *i*, dorsal view of tegmen of aedeagus; *j*, lateral view of same. Scale A (*a–d*), 0.2 mm.; scale B (*e–j*), 0.25 mm.

in the U. S. National Museum are from the following localities: Kansas (Topeka), Iowa (Lake Okoboji), North Dakota (Devils Lake).

Meligethes pinguis Horn

No additional example of this species has been recorded beyond the unique type from southern Newfoundland in the LeConte collection. It was considered by Horn to be allied to the Palaearctic *M.* (*Acanthogethes*) *brevis* Sturm, though Parsons found it "well within the range of variation" of his own series of *M.* (*A.*) *fuscus* Olivier.

Key to the Nearctic species of Meligethes

1. Tarsal claws toothed at base; anterior margin of clypeus somewhat deeply emarginate . . . . **pinguis** Horn
   Tarsal claws simple; anterior margin of clypeus truncate or only feebly emarginate 2
2. Elytra metallic greenish or bluish green 3
   Upper surface entirely black or nearly so, not metallic. 4
3. Form less convex; punctures of elytra as large as eye-facets, separated by 1 to 1½ diameters; color darker, including legs, and less shining. **rufimanus** LeConte
   Form distinctly more convex; punctures of elytra slightly larger than eye-facets, separated by 2½ diameters; color lighter, including legs, more shining . . . . **simplipes** Easton
4. Length 3–4 mm.; explanate side margin of pronotum exhibiting a reddish translucency; surface of elytra finely transrugose; outer edge of front tibiae evenly, finely crenulate; legs pale reddish yellow . . . . . **atratus** Olivier
   Length 1.5–2.8 mm.; pronotum unicolorous; elytra not transrugose; outer edge of front tibiae with small irregular denticulations, or strongly serrate . . 5
5. Anterior tibiae strongly serrate; upper surface between the punctures smooth; legs black; size larger, length, 2–2.8 mm. . . . . **saevus** LeConte
   Anterior tibiae finely, slightly irregularly denticulate; size smaller, length, 1.5–2.3 mm. 6
6. Upper surface between the punctures smooth; legs pale pitchy yellow; male with a polished transverse depression at the apex of the last ventral segment. **nigrescens** Stephens
   Upper surface between the punctures finely microscopically reticulate; legs black when mature; last ventral segment of abdomen without male secondary sexual characters . . . . **canadensis,** new species

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FOUR NEW VENEZUELAN REDUVIID BUGS

By J. Maldonado Capriles[1]

The four species described in this paper were collected by the author in different places in Territorio Amazonas, Venezuela, during an expedition sponsored by the University of Puerto Rico.

The author is greatly indebted to Dr. Petr Wygodzinsky, of the Instituto de Medicina Regional at Tucumán, Argentina, for his invaluable suggestions, and to Dr. Carl J. Drake for the loan of a paratype of *Sirthenea peruviana* Drake and Harris.

Diarthrotarsus marahuacensis, new species

Figure 79,*a-c*

Female: Over-all length 12.2 mm. Head grayish stramineous, lighter from between the antenna up to and including the interocular depression. Eyes brownish. First antennal segment stramineous, with reddish basal, median, and apical bands, the last darker; second yellowish, with black apical band; third with basal third stramineous, apical two-thirds reddish; fourth missing. Thorax dorsally and scutellum stramineous. Clavus and corium stramineous with a reddish tinge, veins and many small irregular markings lighter, apical angles brownish. Membrane finely corrugate, light brown, veins concolorous. Rostrum with first and second segments stramineous with narrow reddish band near apices; third segment brownish. Anterior femur, posteriorly, from base, with four alternating light and dark brown bands, each about one-fourth the length of the femur; anteriorly the two dark bands coalesce irregularly, forming an incomplete lighter

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band in between. Anterior tibia with four narrow reddish bands, three on basal two-thirds, the last one apical. Tarsi stramineous. Median and hind femora with three conspicuous bands on apical two-thirds, the outer two wide and brown and the median narrow, incomplete, and reddish. Midtibia and hind tibia with four reddish bands; the last narrower. Midtarsi and hind tarsi reddish. Thorax laterally brownish; prosternum and metasternum stramineous, mesosternum reddish. Abdomen ventrally light brown and with many irregular dark brown and blackish spots laterally on first five segments; last two segments brown. Connexivium dorsally and ventrally with anterior halves dark brown and posterior halves reddish brown.

Head as in figure 79,*a*,*b*. Finely granulated, with inconspicuous pilosity; slightly shorter than thorax and less than twice the width of the head across the eyes. Width of eyes dorsally less than half interocular space. Deep interocular depression. Ocelli closer to eyes than to each other. Spines behind antenniferous tubercles relatively short, from above equal to width of eye. No tubercle present behind ocelli. Antenna inconspicuously pilose; length of segments 73:50:52:—; first segment thicker than second and third. Rostrum relatively thick; segments 32:20:14. Pronotum finely granulated; carinae granulated and more conspicuous on anterior lobe and extending to anterior part of posterior lobe. Collar with lateral angles not prominent, rounded. Spines on humeral angles broad, shorter than spines on bases of antenna, granulated. Posterior margin of pronotum slightly concave; sublateral angles roundly angulate. Scutellum carinate, ending in a horizontal process. Fore femur covered dorsally with coarse tubercles, irregularly distributed; ventrally smooth, with but a few very small tubercles; anterior margin with many setigerous spines in an even row. Hind femur and midfemur slightly incrassate at apex, with a few, scattered, very small tubercles. Upper margins of abdomen straight, margin of connexivium without elevations. Genitalia from the side as in figure 79,*c*. Posterior margin of seventh sternite convex near middle. Posterior lobe of eighth tergite not prominent.

This species is closer to *Diarthrotarsus malaisei* Wygodzinsky and *annulosus* (Stål) than to the other two known species of the genus. It can be separated from the first by the coloration, the shape of the posterior lobes of the eighth tergite, and the shape of the posterior margin of the pronotum. It can be separated from *annulosus* by the coloration, the absence of tubercles behind the ocelli, the smoother femora, and the shape of the genitalia.

Holotype: Female, USNM 61730, collected on the northern slopes of Mount Marahuaca, Territorio Amazonas, Venezuela, May 1–25, 1950.

***Sirthenea venezolana*, new species**

FIGURE 79,*d-f*

MALE: Over-all length 11.1 mm. Head, thorax, scutellum, and abdomen black. Ocelli shiny, yellowish. Hemelytra with corium blackish brown with a central large, suboval, stramineous spot; membrane blackish brown, veins black. First, second, and third antennal segments fuscous; fourth stramineous. Rostrum blackish brown, with a very narrow yellowish area at joint of second and third segments. Anterior coxa yellowish, translucent, with black base; trochanter blackish; femur on the inside yellowish, on the outside with three equidistant, longitudinal, wide blackish stripes; tibia dark brown, lighter on the inside; tarsi dark brown. Midcoxa and hind coxa yellowish; trochanters with blackish apices; femur with base and a very small area at apex yellowish, remaining portion blackish; tibia with basal half lighter than apical half which is brownish; tarsi dark brown. Connexivium, dorsally and ventrally, with first segment black, from second to sixth, half and half yellowish and black.

Head as in figure 79,*d,f*. Smooth; covered with long pilosity, except above behind eyes and below in front of eyes. Head shorter than thorax. Eyes concave behind, from sides reaching upper and lower margins of head; width of eyes above subequal to interocular space. Preocular region three times as long as postocular; less than one-half total length of head. Distinct postocular transverse impression. Interocellar space broader than diameter of an ocellus. Antenna inserted closer to eyes than to base of rostrum; not reaching to half of body. First segment thickened, slightly curved, narrower at base; second segment thinner; third and fourth slender; all covered with hairs. Proportions of segments 21:43:36:40. Segments of rostrum relatively slender; proportions of segments 18:37:25.

Pronotum as in figure 79,*f*. Anterior lobe 2½ times as long as posterior; smooth except near anterior margin; with long hairs. Posterior lobe smooth; with deep longitudinal depressions near lateral margins; rounded sinuate in middle. Scutellum large, triangular, with Y-shaped elevation at tip. Wings with sparse long decumbent hairs on corium. Legs covered with long decumbent spinelike hairs and with longer erect bristles among them. Anterior coxa two-thirds as long as femur; trochanter large, triangular; femur swollen, widest before middle, with very long vertical hairs on ventral margin; tibia short, wider at apex, with a spatulate calcar. Midlegs and hind legs with large coxae, prominent trochanters, and slender femora and tibiae, tarsi with two long claws. Forelegs and midlegs subequal in length, short; hind legs long, with tibia and tarsi together as long as forelegs. Upper margins of abdomen straight, below carinate along median line. Body hairy.

Process of apex of genitalia not hidden by claspers when in repose. Claspers as in figure 79,*e*, with upper hind margin roundly produced, not forming a spine; laterally compressed and curved.

Female: More robust than male. With smaller eyes and ocelli. Interocular space nearly twice diameter of an eye from above. Pre ocular region twice as long as postocular. Ocelli less prominent, closer to eyes than to each other, interocellar distance over three times diameter of an ocellus. Antenna and beak stouter than in male. Antennal formula 10:20:20:8. Pronotum broader than male; anterior margin deeply sinuate. Anterior lobe nearly three times as long as posterior; from humeral angles very slightly shorter than broad. Coloration, pilosity, and markings as in the male.

This species is close to *Sirthenea vittata* Distant and *S. peruviana* Drake and Harris. It can be separated from both by the much smaller size, antennal formula, proportion of preocular margin to total head length, coloration of legs, and shape and size of the claspers.

Holotype: Male, USNM 61732, collected in the small settlement of Samariapo, 45 km. south of Puerto Ayacucho, capital of Territorio Amazonas, Venezuela, June 12, 1950; allotype, female, same collecting data, in collection of Carl J. Drake; paratype, male, in author's collection.

Salyavata wygodzinskyi, new species

Figure 80,*a-e*

Male: Over-all length 15.6 mm. Head fuscous with a rectangular black area including ocelli on vertex. Eyes black with crystal shiny facets. Ocelli shiny. Antennal first segment black with yellowish base and apex; second with narrow yellowish basal ring, dark to half of segment, yellowish to apex and a narrow black apical ring; third and fourth blackish brown. Blackish brown markings of pronotum as in figure 80,*a*; central spine of posterior lobe of pronotum fuscous with blackish apex. Scutellum black; apical erect spine brownish with black tip; postscutellum including apical spine black. Rostrum brown. Anterior coxa blackish; trochanter yellowish; femur with reddish yellow anteapical and apical bands. Two yellowish broad bands on all tibiae. Midfemur and hind femur with two preapical, and one very narrow apical? yellowish bands. Front and hind tarsi brownish. Abdominal segments with broad irregular brownish areas near median line and spiracles. Connexivium with bases of spines blackish; portions between spines yellowish brown.

Head from side and above as in figure 80,*b*,*c*; long pilose. Distance between eyes much less than length of eye; ventrally slightly more than diameter of the rostrum as in figure 80,*d*. Antenniferous tubercle small, slightly longer than wide at base, without lateral spines.

Antennal segments 35:193:58:24; first segment thicker, slightly shorter than length of head, covered with sparse long hairs of nearly the same length as diameter of segment; second segment thinner than first, covered with long pale hairs which become shorter as they approach apex; third segment thinner than second, pilosity similar to third; fourth of same diameter as third, covered with pale hairs. Rostrum broad, segments 26:20:14. Pronotum slightly wider than long; anterior lobe elevated, one-third of pronotum; sculptured. Posterior lobe with posterolateral spines long; central spine almost vertical, wavy. Scutellum broader than long; lateral margins elevated near base, with an almost vertical long spine at apex. Postscutellum small, with a long, slightly decumbent terminal spine. Wings surpassing end of abdomen; venation and markings as in figure 80,*a*. Femora slightly incrassate near apices, with sparse vertical pilosity. Tibiae, from about the middle to the apex, with shorter, gradually more abundant and more forwardly inclined hairs. Apical spongy fossae well developed in fore tibia, rounded, shorter than diameter of apical portion of same tibia; smaller in midtibia and hind tibia. Prosternum with anterolateral processes as in figure 80,*e*. Fore tarsi 2-segmented; hind tarsi 3-segmented. Abdomen ventrally with a carina up to the fifth segment; sternites transversely corrugated. Second connexivial segment with anterior and posterior processes; others with posterior, long, upward and backwardly directed spines only.

Posterior process of hypopygium long, elongate, tapering, not lanceolate; upcurved and closely attached to body.

This species is closer to *Salyavata nigrofasciata* Costa Lima, from which it can be separated by the anterolateral process of the prosternum, absence of a transverse dark band in pronotum, very different color pattern of the hemelytra, and the first antennal segment being less than one-fifth the length of the second.

Holotype: Male, USNM 61731, collected on the northern slopes of Mount Marahuaca, Pacaraima Range, Territorio Amazonas, Venezuela, May 1–25, 1950.

Ctenotrachelus pallidopodus, new species

Figure 80,*f-h*

Male: Over-all length 10.2 mm. Body infuscated, legs pale. Head with lighter areas behind antennal sockets and eyes. Antenna and beak stramineous. Anterior lobe of pronotum infuscated; posterior lobe with stramineous areas on ridges. Scutellum black. Hemelytra with scattered irregular stramineous spots, more abundant on membrane; inner discal cell with irregular yellowish longitudinal fascia on outer half; outer discal cell with narrow yellowish fascia adjacent to

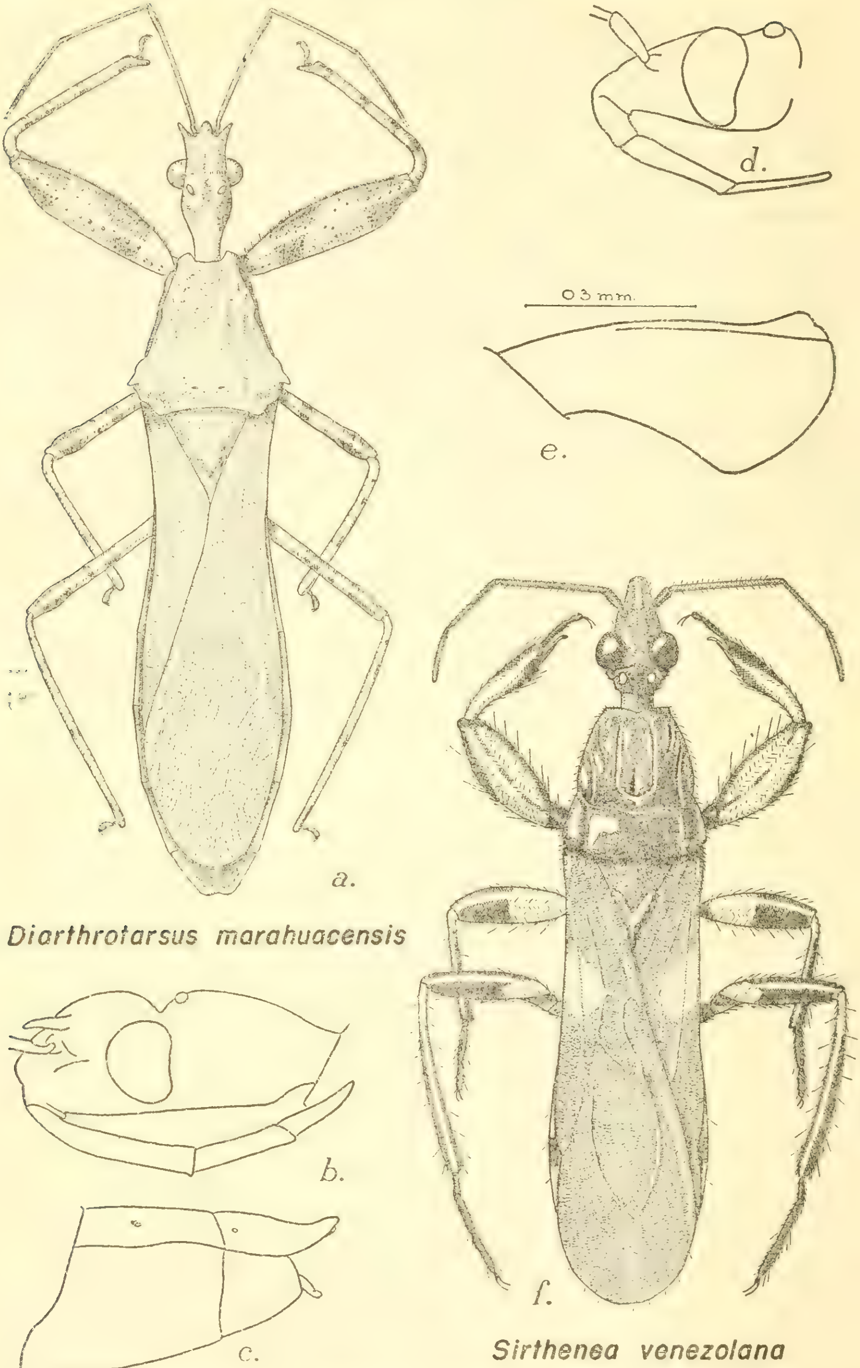

FIGURE 79.—*a–c*, *Diarthrotarsus marahuacensis*, new species: *a*, dorsal view; *b*, lateral view of head; *c*, lateral view of end of abdomen. *d–f*, *Sirthenea venezolana*, new species: *d*, lateral view of head; *e*, lateroexternal view of clasper; *f*, dorsal aspect of male.

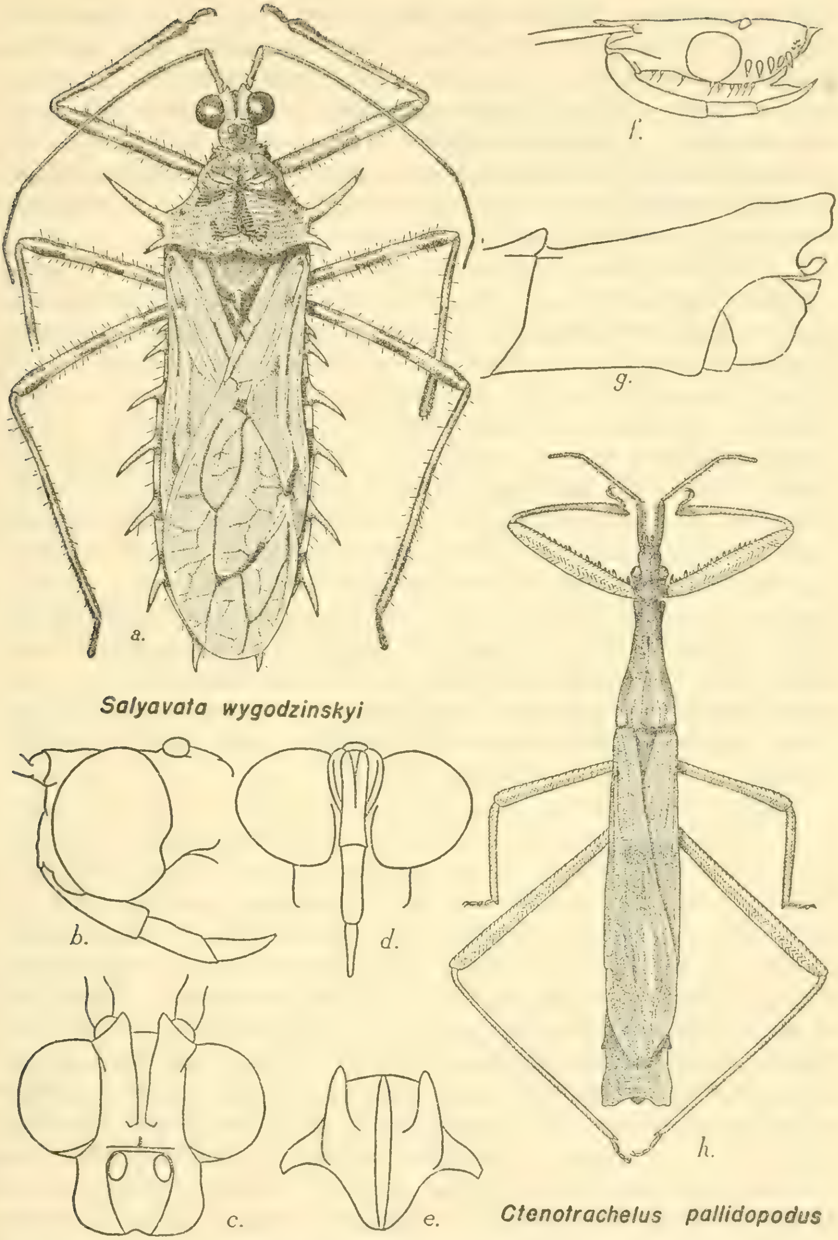

FIGURE 80.—*a–e*, *Salyavata wygodzinskyi*, new species: *a*, dorsal view; *b*, lateral view of head, *c*, dorsal view of head; *d*, ventral view of head; *e*, prosternum. *f–h*, *Ctenotrachelus pallidopodus*, new species: *f*, lateral view of head; *g*, lateral view of tip of abdomen; *h*, dorsal aspect of male.

inner discal cell. Anterior coxa, trochanter, and base of femur with black maculations, remaining parts yellowish; middle and hind legs yellowish. Prosternum with two broad rows of golden short appressed hairs, making it appear lighter. Mesosternum lighter on anterior half. Metasternum lighter than general body color. An irregular reddish brown broad stripe along the abdomen about midway from the median line to the upper margin. Connexivial segments fuscous; slightly lighter on anterior halves.

Dorsal parts, except membrane, sparingly covered with very small bulbous setigerous spines. Head from tip of jugae to anterior margin of pronotum nearly one-half length of pronotum. Preocular margin to apex of antenniferous tubercles equal to postocular margin. Jugae slightly converging at tip; reaching to one-fourth of first antennal segment. Antennal tubercles outwardly without spinules. Ocelli closer to the eyes than to each other. Before eyes, as in figure 80,*f*, armed below with two 1-setigerous spinules; behind eyes laterally with five large setigerous spinules and four or five smaller spinules grouped above last two. Genae anteriorly acute. Basal antennal segment with long hairs below and on inner sides only; one-fifth shorter than head from apex of antenniferous tubercle to collum; 2½ times as long as preocular margin. Second segment one-half times longer than first, with decumbent and straight hairs, slightly longer than diameter of segment. Third segment one-fourth length of first, pilose; fourth segment twice as long as third, pilose. Beak relatively slender; proportions of segments 36:16:13.

Pronotum with lateral margins unarmed, nearly twice as long as wide; anterior lobe slightly more than 1½ times as long as posterior lobe; posterior lobe with a low longitudinal ridge on either side of middle, contiguous in front; shorter ridges near posterior angles of the pronotum. Apex of scutellum with a small black tubercle, rounded at tip. Membrane with apical inner margin sinuate; apex nearly acute, reaching to one-third of sixth abdominal segment. Discal cell of corium three times as long as wide, except posteriorly bounded by fuscous veins. Anterior trochanter with three or four black spines. Incrassate fore femora inconspicuously pilose with globose setigerous spines, armed below with a row of spines of uneven length, diminishing in size toward apex. Fore tibia, midlegs, and hind legs with rows of same kind of setigerous spines. Anterior margin of propleura and rim of acetabulum with spines. Inferior margin of pronotum with a row of more prominent rounded setigerous spines. Venter longitudinally ridged to end of third visible segment and carinate to end of sixth. Apical angles of connexivial segments acutely prominent; margins with setigerous spines.

Genitalia from side as in figure 80,*g*, claspers triangular. Apical angles of seventh tergite as in figure 80,*g*,*h*.

This species is closely related to *Ctenotrachelus infuscatus* Barber, from which it can be separated by the coloration of the pentagonal cell and surrounding veins, number of spines behind eye, presence and number of spines below, in front of, and back of the eyes, less produced posterior angles of the terga, lateral aspect of the genitalia, absence of a small spine on outer edge of antenniferous tubercle, and the much less produced gena.

HOLOTYPE: Male USNM 61802, collected on the northern slopes of Mount Marahuaca, Pacaraima Range, Territorio Amazonas, Venezuela, May 1–25, 1950.

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SOME POLYCLAD FLATWORMS FROM THE WEST INDIES AND FLORIDA

By Libbie H. Hyman

The polyclads collected on the *Fish Hawk* Expedition to Puerto Rico in 1898–99 and by the Smithsonian-Hartford Expedition to the West Indies in 1937 have been turned over to me for identification by the U. S. National Museum. There are further available four vials of polyclads taken by W. G. Hewatt in 1946 at Puerto Rico. These three collections furnish the basis for the present article and probably give a fair but far from exhaustive picture of the polyclad fauna of the West Indies. As technical terms and taxonomic categories are carefully defined in an extensive article of mine recently published (Hyman, 1953), it appears unnecessary to repeat these definitions here. Definitions will be limited to families and genera not represented in that article.

Order Polycladida

Suborder Acotylea

Section Craspedommata

Family Discocelidae Laidlaw, 1903

Definition: Craspedommata without definite tentacles and with or without definite tentacular eye clusters; pharynx ruffled, medially located; copulatory apparatus close behind the pharynx; prostatic vesicle, when present, interpolated; typically with numerous small prostatic apparatuses in the wall of the male antrum and the penis papilla (when present); female apparatus with a Lang's vesicle.

Genus *Adenoplana* Stummer-Traunfels, 1933

DEFINITION: Discocelidae with or without tentacular eye clusters; mouth behind the pharynx; gonopores separate; male gonopore with or without small accessory pore; with interpolated prostatic vesicle situated above the male antrum; penis papilla wanting; wall of male antrum with numerous prostatic apparatuses.

TYPE SPECIES: *Polycelis obovata* Schmarda, 1859.

Adenoplana antillarum, new species

FIGURE 81,*a*–*c*

MATERIAL: One specimen from the Smithsonian-Hartford Expedition.

FORM: Small, thick, opaque, slender (fig. 81,*a*); 8 mm. long by 2 mm. wide (preserved); without any indication of tentacles.

EYES: Limited to the anterior end (fig. 81,*a*); marginal eyes relatively large, forming a band along the anterior margin, scarcely extending to the level of the brain; tentacular clusters wanting; what may

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EXPLANATION OF FIGURES

1, marginal eyes
2, cerebral eyes
3, tentacular eyes
4, frontal eyes
5, pharynx
6, uteri full of eggs
7, female gonopore
8, male gonopore
9, cement glands
10, male antrum
11, prostatoids
12, prostatic vesicle
13, prostatic glands
14, common sperm duct
15, female antrum
16, cement pouch
17, vagina
18, Lang's vesicle
19, mouth
20, tentacles
21, spermiducal bulbs
22, seminal vesicle
23, prostatic duct
24, penis papilla
25, entrance of oviduct into vagina
26, ejaculatory duct
27, brain
28, parasites?
29, muscle masses
30, prostatic expansion
31, cement duct
32, sphincter
33, prostatic mass
34, spermiducal vesicles
35, cirrus sac
36, brown network
37, orange spots
38, grayish black markings
39, orange border
40, marginal glands
41, epidermis
42, bundles of rhabdites
43, main intestine
44, sucker
45, intestinal network
46, penis stylet
47, penis sheath
48, uterine vesicle
49, accessory vesicles
50, entrance of sperm duct

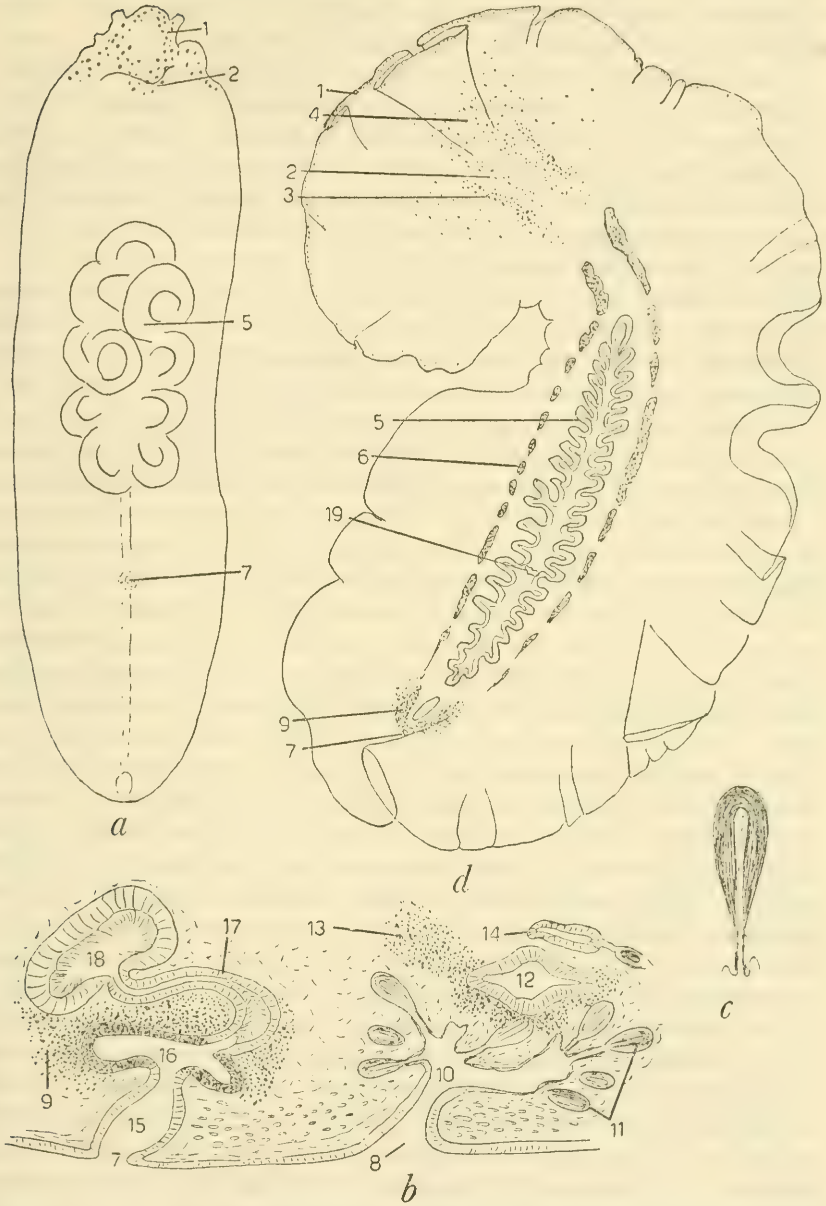

FIGURE 81.—*a–c*, *Adenoplana antillarum: a*, dorsal view; *b*, sagittal view of copulatory apparatus; *c*, a prostatoid. *d*, *Indistylochus hewatti*, dorsal view. (For explanation see facing page.)

be considered cerebral groups extend from brain region anterolaterally to meet the marginal band; due to a deep fold in the brain region, there may be some uncertainty about the cerebral eyes.

Color: Indeterminable; specimen was dark brown like most preserved polyclads; this color often bears no relation to the color in life.

Digestive tract: Pharynx central, elongated, with heavy folds (fig. 81,*a*); the position of the mouth could not be ascertained due to the opacity of the specimen and was not found on sections. In the other known species of this genus, the mouth lies just behind the pharynx, an unusual position in polyclads.

Copulatory apparatus: The male apparatus lies immediately behind the pharynx but could not be seen in the whole specimen; the female gonopore was seen and is indicated in figure 81,*a*. The copulatory apparatuses are shown in sagittal view in figure 81,*b*. Due to the condition of the specimen, not all details could be determined. The male apparatus is typical of the genus; the male gonopore leads into a male antrum, tubular at first, then expanding into a chamber with irregular walls. These walls contain a number of small prostatic apparatuses, or prostatoids as I have elsewhere called them. There are probably about 25 of these altogether but only a few occur in the median sagittal plane; most of them are in the lateral walls and do not show in figure 81,*b*. As both Stummer-Traunfels (1933) and Marcus (1950) have figured parasagittal sections of the male apparatus, it appears unnecessary to present such a view here. The prostatoids of *A. antillarum* differ somewhat from those figured for the two other known species of the genus. In the other species the muscular wall is thin and the glandular interior relatively large. In *A. antillarum* (fig. 81,*c*), the prostatoids are of bulbous shape with a thick muscular wall and slender glandular interior. They narrow to a tubular terminal part that appears sclerotized with dense nuclei and that opens on a little projection of the antrum wall. A definite penis papilla is wanting but the dorsal antrum wall presents a rather large eminence. The antrum wall lacks the web of muscle fibers seen in the two other species of the genus; muscle fibers, evidently transverse, were seen only below the main part of the antrum. Above the antrum lies a prostatic vesicle of angular shape and unusual appearance. It is lined by a tall epithelium but lacks the muscular investment usual to prostatic vesicles. It is accompanied, especially ventrally, by masses of eosinophilous granulations, presumably representing prostatic glands. The entrance of the prostatic vesicle into the male antrum could not be found nor was the entrance of the sperm duct into the vesicle trace-able. There appears to be a common sperm duct with rather thick walls; this could be seen above the prostatic vesicle but could not be traced definitely into it although there is little doubt that it must enter the dorsal wall of the vesicle. There are no indications of a seminal vesicle in any of the three known species of this genus, but one of the other species has spermiducal bulbs. There was no indication of these in *antillarum*. A small accessory male gonopore close to the main gonopore occurs in the two other species of *Adenoplana* but is wanting in *antillarum*, at least in the available specimen.

The female apparatus differs markedly from that of the other species of the genus. The female gonopore lies well behind the male pore (fig. 81,*b*) and leads into a broadly tubular antrum that enters the middle of an expanded, dorsoventrally flattened cement pouch. This pouch is surrounded by a cloud of cement glands whose granular secretion fills its epithelial lining. From the anterodorsal region of the cement pouch, the vagina proceeds dorsally as a tube that soon turns posteriorly, lying above the cement pouch, and enters the middle of the ventral surface of the sacciform Lang's vesicle. This vesicle consists of a tall ciliated epithelial wall. The beginning of the vagina is slightly expanded and also ciliated. The entire female apparatus is wanting in muscularity. The entrance of the oviduct into the vagina could not be found.

Differential diagnosis: *Adenoplana antillarum* differs from the other two known species of the genus—*A. obovata* (Schmarda), 1859, redescribed by Stummer-Traunfels, 1933, and *A. evelinae* Marcus, 1950—in body shape, eye arrangement, details of the female apparatus, and lack of an accessory male pore. Both these species are of broadly oval form with definite tentacular and cerebral eye clusters and an extended marginal band of eyes, and in both the female apparatus lacks a cement pouch and has a crescentic Lang's vesicle. They further are provided with a very small male pore alongside the principal one.

Distribution: Collected by W. L. Schmitt on the Smithsonian-Hartford Expedition (specimen No. 23) at Charlotte Amalie, St. Thomas, Virgin Islands, Apr. 4, 1937, on shore of harbor.

Holotype: Anterior part as whole mount, posterior part as sagittal sections (2 slides), deposited in the U. S. National Museum, No. 24630.

Remarks: Although the male apparatus of the specimen agrees well with that of the other species of the genus, the specimen differs so much from them in body shape, eye arrangement, and details of the female apparatus that it will be desirable to remove it to a new genus if similar species are found.

Family Stylochidae Stimpson, 1856

Genus *Stylochus* Ehrenberg, 1831

Stylochus megalops (Schmarda), 1859

Figure 82,*a*,*b*

Dicelis megalops Schmarda, 1859, p. 15, pl. 2, fig. 30.
Stylochus heteroglenus, Schmarda, 1859, p. 34, pl. 7, fig. 77.
Stylochus megalops, Stummer-Traunfels, 1933, p. 3488, figs. 1–4; p. 3556, figs. 126–128.

Material: One specimen from the *Fish Hawk* Puerto Rico Expedition.

Form: Almost circular, 20 mm. long by 17 mm. wide but evidently much contracted; the Schmarda specimens were broadly oval, measuring 14 by 9 and 12 by 9 mm.; margins much ruffled and folded, probably the result of contraction; with a pair of nuchal tentacles, contracted as usual to a bulbous shape (fig. 82,*a*).

Eyes: There are numerous eyes in each tentacle, also some around their bases; the cerebral eyes are rather scanty, consisting of loose groups between the tentacles; frontal eyes are lacking; the marginal band is fairly wide and extends back less than half the body length (fig. 82,*a*). On account of the many folds and general opacity of the specimen, the eyes were not distinguished with entire satisfaction.

Color: The specimen shows the usual dark brown color common to preserved polyclads. According to the original colored figures of Schmarda, the species is light brown with dots and reticulations. However, these figures appear to have been made from preserved material, not from life.

Digestive tract: The pharynx is central with a few broad, much ruffled lateral folds. On account of the darkened condition of the specimen no other details of the digestive tract could be ascertained. The mouth is beneath the posterior part of the pharynx (fig. 82,*a*).

Copulatory apparatus: Lies close behind the pharynx, therefore far from the posterior margin (fig. 82,*a*). In the whole specimen the outline of the prostatic vesicle could be seen in this position; farther on, the uteri extended anteriorly to either side of the pharynx (fig. 82,*a*). Sagittal sections were made of the postpharyngeal region. They revealed an unfortunate fold between the male and female apparatuses that somewhat distorted the relations of these parts, but the specimen proved in fair histological condition. The male apparatus was found to have been cut nearly sagittally but, owing to the fold just mentioned, the female apparatus was cut crosswise. The details of both structures agree well enough with the two figures furnished by Stummer-Traunfels (1933), but they differ in small details.

FIGURE 82.—*Stylochus megalops: a,* dorsal view; *b,* sagittal view of copulatory apparatuses. (For explanation see page 116.)

The male antrum is much longer than in the Schmarda specimens reinvestigated by Stummer-Traunfels but this may be the result of the distortion in that region. The penis papilla is a good-sized conical eminence within which the prostatic duct parts from the ejaculatory duct. The former leads into the elongated, horizontally oriented prostatic vesicle (fig. 82,*b*) that has a muscular wall of moderate thickness and an equally thick lining which was disintegrated into strands. Prostatic glands were not in evidence. Ventral to the prostatic vesicle the ejaculatory duct runs a slightly sinuous course, gradually widening into a bulbous seminal vesicle with well-developed muscular walls of circular fibers. Into either side of this seminal vesicle open short spermiducal bulbs that form the terminations of the sperm ducts. With the seminal vesicle proper they form the tripartite type of seminal vesicle common to many species of *Stylochus*.

The female gonopore lies considerably behind the male one. As typical of the genus, it leads into a vertically ascending tubular vagina that terminates with the reception of the two oviducts. As the vagina was cut crosswise in the series of sections, its exact form could not be determined. Stummer-Traunfels' figures indicate a pronounced forward curve of the vagina that did not seem to be present in my specimen. The vagina has a fair muscular investment; cement glands were not in evidence.

Distribution: The Schmarda specimens came from Jamaica. The present specimen was taken on the *Fish Hawk* Expedition at Playa de Ponce Reef, Puerto Rico, Feb. 1, 1899. It is probable that the species is fairly common in the West Indian region.

Specimen: Anterior half as whole mount, posterior half as sagittal serial sections (four slides) deposited in the U. S. National Museum.

Remarks: This species belongs to the long list (26) of *Stylochus* species (see Hyman, 1953) in which the marginal eyes are limited to the anterior part of the body margin. It is further characterized by a tripartite seminal vesicle of which the lateral limbs, formed of the spermiducal bulbs, are unusually short.

Stylochus oculiferus (Girard), 1853

Imogine oculifera Girard, 1853, p. 367.
Stylochus oculiferus, Diesing, 1861, p. 570.
Stylochus floridanus Pearse, 1938, p. 71, fig. 24.
Stylochus oculiferus, Hyman, 1940, p. 464, figs. 27, 28a.

Remarks: A fine large specimen of this species was collected by H. Dodge at Dick's Point, New Providence Island, in the Bahamas. Preserved, it had retained the typical coloration of light brown dotted with small rose-red spots. The specimen has been deposited in the American Museum of Natural History. As will appear in this paper, there are known at present six polyclad species common to Florida and the West Indies. *Stylochus oculiferus* was previously recorded only from the coasts of Florida and North Carolina.

Indistylochus, new genus

DEFINITION: Stylochidae of elongated oval form without tentacles; with tentacular and cerebrofrontal eyes; male apparatus with very small prostatic vesticle located ventral to the very large and elongated seminal vesticle; vagina extremely long, slanting forward above the male apparatus, then recurving parallel to itself, terminating at the oviduct entrance; Lang's vesticle wanting.

TYPE SPECIES: *Indistylochus hewatti*, new species.

Indistylochus hewatti, new species

FIGURES 81,*d*; 83,*a*

MATERIAL: Two specimens sent by Hewatt.

FORM: Elongate oval with rounded ends (fig. 81,*d*); both specimens had set into a curved shape as shown in figure 81,*d*; tentacles absent; margins ruffled; about 20 mm. long by 8 mm. wide.

EYES: There is an elongated group of tentacular eyes on each side; between the tentacular groups the cerebrofrontal eyes extend forward as distinct linear groups that, anterior to the tentacular eyes, join and spread anteriorly but do not reach the marginal eyes; there are also scattered eyes lateral to and behind the tentacular groups. The marginal eyes are very small and located close to the margin; they extend, mostly as a single row, around the anterior margin back to about the level of the most posterior of the cerebrofrontal eyes.

COLOR: Light brown, white middorsally in life; preserved specimens show the usual brown color.

DIGESTIVE TRACT: Pharynx long and narrow with a number of lateral folds, posteriorly located (fig. 81,*d*); the mouth was seen posterior to the middle of the pharynx.

COPULATORY APPARATUS: Situated immediately behind the pharynx, near the posterior margin (fig. 81,*d*). The postpharyngeal part of one specimen was removed and sectioned sagittally. Study of these sections showed that the animal is a stylochid, not a cryptocelid as was supposed from external appearance. A sagittal view of the copulatory apparatuses is shown in figure 83,*a*. The sperm ducts approach the male apparatus from below and enter, apparently separately, the proximal end of the seminal vesicle. The latter is a large sac of elongated oval form. After receiving the sperm ducts into its narrow beginning, it proceeds forwards for a short distance,

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then turns abruptly backwards, at the same time greatly increasing in size. It then proceeds posteriorly as a long oval sac with a thick muscular wall. The interior in the sectioned specimen is filled with sperm. Upon approaching the vicinity of the penis, the seminal vesicle narrows to an ejaculatory duct that curves ventrally and joins the prostatic duct inside the penis papilla. The prostatic vesicle is a very small oval sac lying beneath the narrowed distal part of the seminal vesicle. It has a thick muscular wall and a glandular lining filled with eosinophilous granules. Its duct immediately joins the ejaculatory duct and the common duct so formed proceeds to the tip of the penis papilla. The latter is a well formed conical projection housed in a male antrum that follows its contours. The male antrum shortly opens below by the male gonopore.

The female gonopore is situated shortly behind the male gonopore. It leads into a short tubular female antrum that at once continues as the vagina. The latter is a ciliated tube of extraordinary length that runs forward above the seminal vesicle to a point slightly anterior to the vesicle's anterior end, then it turns abruptly posteriorly and parallels its former course until it reaches a level of about that of the female gonopore, where it terminates on receiving the two oviducts separately. The vagina is ciliated throughout and accompanied along its entire course by an immense mass of cement glands that practically fill all the space between the seminal vesicle and the dorsal body wall, as well as extending far anterior to the curve of the vagina. Lang's vesicle is wanting and there is no other extension of the vagina caudad of the entrance of the oviducts. The uteri extend forward alongside the pharynx nearly to the level of the most posterior eyes (fig. 81,*d*).

Distribution: Collected by W. G. Hewatt on Mar. 13, 1946, at East Point Beach, Boquerón, Puerto Rico, under beds of *Mytilus* between tides.

Holotype: One whole mount deposited in the U. S. National Museum, No. 24620; also one set of sagittal serial sections of the copulatory region in that institution (four slides), No. 24621.

Remarks: This species combines the characters of several genera of the Stylochidae without fitting satisfactorily into any of them. A greatly reduced prostatic vesicle is also seen in *Parastylochus*, *Enterogonia*, and *Cryptophallus;* an excessively long vagina occurs in *Meixneria* and *Idioplana;* the prostatic vesicle lies to the ventral side or at least the anterior side of the seminal vesicle in *Cryptophallus;* but in no other stylochid genus is found a combination of these characters plus an enormous increase in the size of the seminal vesicle. It therefore appeared necessary to create a new genus for the species.

Family Cryptocelidae Laidlaw, 1903

Anandroplana, new genus

Definition: Cryptocelidae of elongate oval form; band of marginal eyes completely encircling the margin; pharynx long, much ruffled; male apparatus close behind the pharynx; lacks seminal vesicle, prostatic vesicle, and penis papilla; male apparatus excessively muscular; Lang's vesicle wanting.

Type species: *Anandroplana muscularis*, new species.

Anandroplana muscularis, new species

Figures 83,*b*; 84,*a*

Material: One specimen from the Smithsonian-Hartford Expedition of 1937 to the West Indies.

Form: Elongate oval with rounded ends (fig. 83,*b*), 17 mm. long by 7 mm. wide; margins somewhat ruffled, indicating some contraction.

Eyes: Distinct cerebral and tentacular clusters are present, each of a considerable number of eyes (fig. 83,*b*); the cerebral eyes form oval groups to either side of the brain, of 20 to 25 relatively large eyes each; the much smaller and more numerous (40 to 60) eyes of the tentacular groups extend forward between and beyond the cerebral clusters. The band of marginal eyes completely encircles the margin; it consists of rather small eyes, as usual in the family, and diminishes in width posteriorly.

Color: Preserved specimen appears dark brown.

Digestive tract: The rather large, elongated, and much ruffled pharynx is rather centrally located (fig. 83,*b*); a distinct circular opening just behind its last fold was taken to be the mouth. A similar position of the mouth occurs in another cryptocelid genus, *Ommatoplana* Laidlaw, 1903a. Because of the dark color no further details of the digestive tract were evident in the specimen.

Copulatory apparatus: The postpharyngeal region was removed and sectioned sagittally. It was found in bad condition, with many cracks and tears but all parts of the copulatory apparatuses seemed to be present. The male apparatus lies close behind the pharynx so that the last folds of the latter are in contact with the antrum wall. A sagittal view of the apparatuses, insofar as they could be ascertained, is given in figure 84,*a*. The male apparatus is unusual in that it lacks seminal vesicle, prostatic vesicle, and penis papilla. It appears to consist wholly of a very large antrum with irregular walls excessively provided with muscles. The muscles seem to occur in lengthwise cords united with each other in a weblike fashion (fig. 84,*a*). They fill practically all the space between the cavity of the antrum and the dorsal and ventral body walls. Most of the fibers of the muscle masses course around the antrum in a circular direction. The antrum presents numerous bulges into the lumen but its exact shape could not be determined because of the many cracks. It opens below by what appeared to be a very large gonopore but the limits of this also remain uncertain. An anterior ventral diverticulum of the antrum is provided with eosinophilous glands, at least along its lower wall, and probably represents a prostate. It

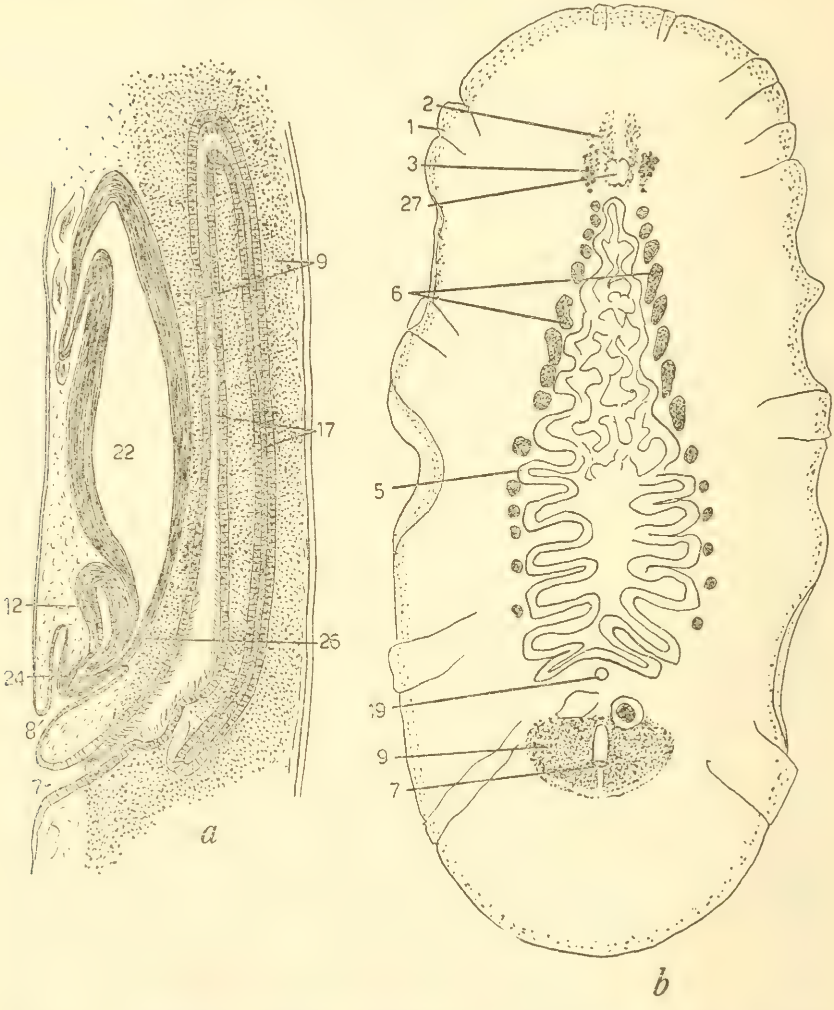

FIGURE 83.—*a, Indistylochus hewatti*, sagittal view of copulatory apparatuses; *b, Anandroplana muscularis*, dorsal view. (For explanation see page 116.)

is conjectured that the sperm ducts enter the anterior end of this prostatic region but they could not be traced in the specimen.

The female apparatus had suffered less damage than the male apparatus but it had one bad crack. The female gonopore lies far behind the male pore (fig. 84,*a*) and leads into a tubular antrum that soon expands into a vaginal chamber receiving some glandular secretion. This chamber is succeeded by a horizontal tube that presumably springs from the roof of the chamber, but a crack here made it impossible to trace the connection. This tube extends posteriorly and terminates in a rounded vesicle that was at first thought to be a Lang's vesicle, but, as it is surrounded by eosinophilous glands and receives abundant secretion, it seems necessary to conclude that it is the proximal part of the vagina. The oviducts could not be traced satisfactorily but they appeared to enter the ventral wall of this sacciform expansion. Between male and female gonopores the body wall musculature is greatly thickened and this musculature continues along the female antrum and first expansion of the vagina. A large mass of cement glands extends from this expansion backwards to and around the proximal chamber of the vagina, and also from the vagina forward up to the male antrum.

Distribution: Collected by W. L. Schmitt off Puntilla Point, Puerto Rico, at 3½ fathoms on a bottom of broken shell, broken coral, and mud on Mar. 29, 1937.

Holotype: Anterior part as whole mount, postpharyngeal region as serial sagittal sections (seven slides) deposited in the U. S. National Museum, No. 24632.

***Anandroplana portoricensis*, new species**

Figures 84,*b*; 85,*a*

Material: One specimen presented by W. G. Hewatt.

Form: Elongate oval, rounded anteriorly, bluntly pointed posteriorly (fig. 84,*b*), 32 mm. long by 15 mm. wide, alive, extended. There is a large tear on one side of the rear half of the specimen but fortunately this did not involve any part of taxonomic importance. To either side of this tear occur several large balls that are probably of parasitic nature, but sections of them did not serve to elucidate their identity. It seems most probable that they are trematode metacercariae but no suckers were found.

Eyes: Tentacular eye groups are wanting. The cerebral eyes form a single triangular cluster (fig. 84,*b*); anterior to this cluster, loose frontal eyes extend on each side towards the marginal eyes without reaching them. The marginal band of eyes completely encircles the margin, diminishing in width posteriorly (fig. 84,*b*). All of the eyes are unusually large and conspicuous for a cryptocelid.

Color: Mottled grayish-brown on a light background in life, and this pattern was retained over most of the specimen; a bit of it is indicated at the posterior end in figure 84,*b*.

Digestive tract: There is an elongated, much ruffled pharynx situated somewhat anteriorly in the body (fig. 84,*b*); no other details of the digestive tract could be ascertained.

Copulatory apparatus: Could not be seen in the worm when whole but was surmised to be located just behind the pharynx to the right of the tear. This region was accordingly removed and sectioned sagittally. It was found to contain the whole of the copulatory apparatus but there was much damage present and, further, through a mishap, some of the most important sections were smeared. However, it was possible to make out practically all of the details of the sexual apparatus and a sagittal view, which is slightly restored, is given in figure 85,*a*. As in the preceding species, the male apparatus lacks penis papilla, prostatic vesicle, and seminal vesicle, but the male gonopore is of the usual size and leads into a normal tubular male antrum. This antrum shortly presents a glandular lining and continues into a sacciform expansion also lined by a glandular epithelium and surrounded by eosinophilous glands. This portion of the male canal undoubtedly represents a prostate, although a definite prostatic vesicle is wanting. Antrum and prostate show little muscularity. From the anterior wall of the prostatic chamber a tube extends anteriorly in a horizontal plane for some distance and then recurves on itself and runs posteriorly parallel to its former course. This tube appears to be a common sperm duct. It is surrounded by an immense muscular mass of circular fibers that extends anteriorly almost to the posterior end of the pharyngeal folds. The proximal end of the common sperm duct, situated shortly anterior to the male antrum, could be traced into the spermiducal vesicles.

The female gonopore lies some distance behind the male pore, but, because of a deep fold between the two gonopores in the present specimen, it appears not far behind the male pore in figure 85,*a*. The female gonopore leads into a short antrum that expands at once into a cement pouch receiving a large number of cement glands both anteriorly and posteriorly. From the cement pouch the vagina, lined by a tall epithelium and with somewhat muscular walls, ascends dorsally and expands into a small chamber, also considerably muscular. From this chamber the vagina continues at right angles posteriorly as a short narrow tube encircled by a mass of circular muscle fibers forming a sphincter. The vagina then widens into a long broad tube with glandular lining encircled by muscle fibers and it finally terminates by receiving separately the two oviducts at its proximal end. A Lang's

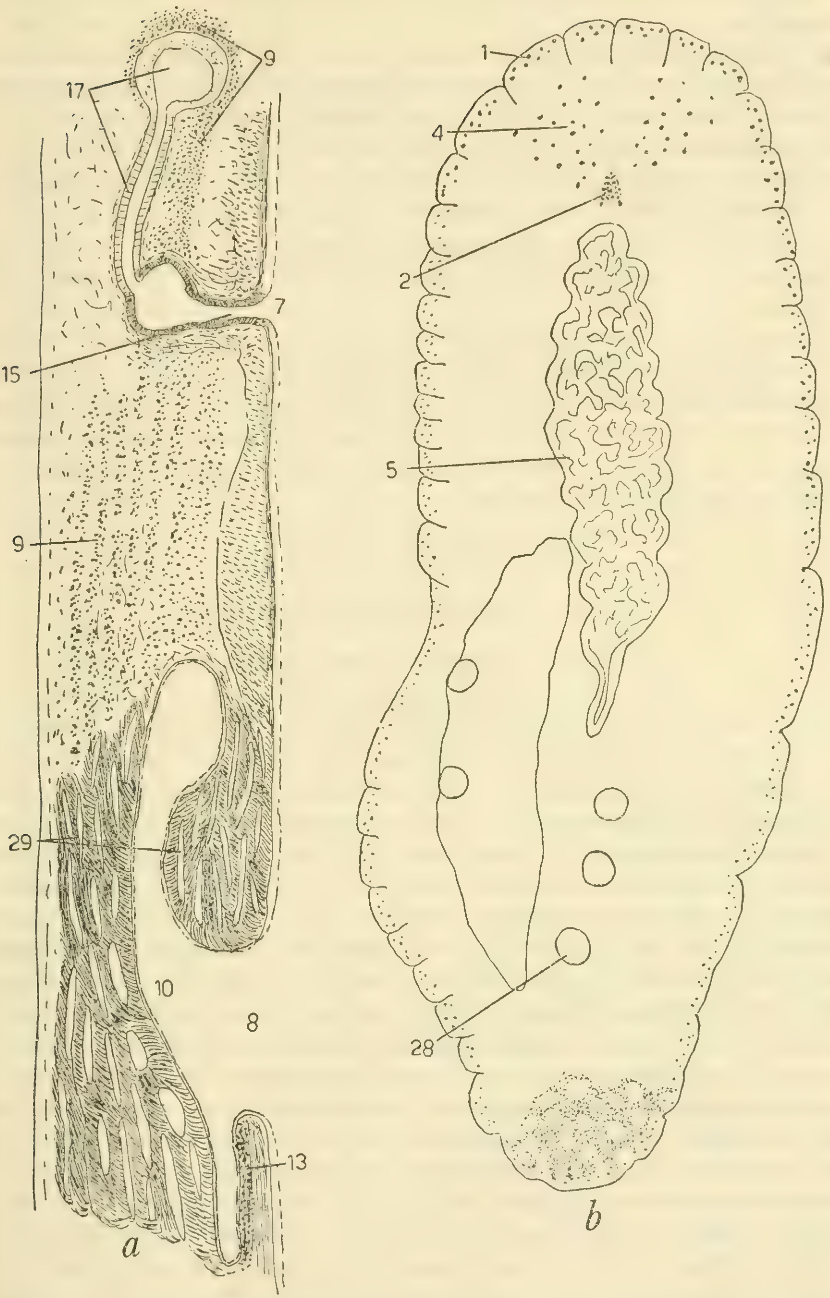

FIGURE 84.—*a*, *Anandroplana muscularis*, sagittal view of copulatory apparatuses; *b*, *A. portoricensis*, dorsal view. (For explanation see page 116.)

vesicle is absent. The course of the uteri was not evident on the whole specimen.

Differential diagnosis: *Anandroplana portoricensis* differs from the preceding species in eye pattern and in that the muscular mass of the male apparatus surrounds the common sperm duct, whereas in *A. muscularis* it surrounds the male antrum.

Distribution: Collected by W. G. Hewatt at Rincón Playa, Puerto Rico, Mar. 7, 1946, under flat rocks in the surf zone.

Holotype: Anterior half as whole mount, copulatory region as sagittal serial sections (eight slides), deposited in the U. S. National Museum, No. 24619.

Remarks: These two species of *Anandroplana* are rather astonishing in their almost total want of the usual parts of the male copulatory apparatus and also in the proximal expansion of the vagina into a glandular chamber. Although they bear some resemblance to the cryptocelid genus *Ilyplanoides* Kato, 1944, one might be justified in creating a new family for them.

Section Schematommata

Family Leptoplanidae Lang, 1884

Genus *Notoplana* Laidlaw, 1903

Notoplana insularis Hyman, 1939

Notoplana insularis Hyman, 1939a, p. 1, figs. 1–3.

Remarks: Five specimens of this species received from the U. S. National Museum were found in the present material. The species is readily recognized, when mounted whole, by the penis stylet and the characteristic eye arrangement with the tentacular clusters incorporated into the cerebral groups to form a linear arrangement on each side. As the species is sufficiently described and illustrated in the original account, it appears unnecessary to repeat this information here. The original specimen was 9 mm. long; the present ones are 5.5, 7, 9, 11, and 14 mm. in length but, as all are somewhat contracted, it seems probable that the species may reach a length of 18–20 mm. when extended alive, although on the whole it is a rather small species of the genus. All of the specimens are of the brown color usual in preserved polyclads; probably in life the species is pale. The specimens were collected as follows: Biscayne Bay, Fla., by F. M. Bayer, Aug. 1, 1951; eastern shore of harbor, Charlotte Amalie, St. Thomas, Virgin Islands, by W. L. Schmitt on the Smithsonian-Hartford Expedition, Apr. 4, 1937; Playa de Ponce Reef, Puerto Rico, on the *Fish Hawk* Expedition, Feb. 1, 1899 (two specimens); and Port of Spain, Trinidad, by W. L. Schmitt, Apr. 18, 1939. The original specimen came from Old Providence Island. Evidently the species is common in the Caribbean and West Indies and also occurs on the southern part of the coast of Florida. There appears to be some variation in the length of the stylet in different parts of this range. The stylet appears shorter in the Trinidad and Old Providence Island specimens than in those from Florida and the West Indies; but this appearance is not correlated with the length of the specimens as the Florida specimen is very small. The West Indies and Trinidad specimens have been returned to the museum as whole mounts.

Notoplana ferruginea (Schmarda), 1859

Polycelis ferruginea Schmarda, 1859, p. 22, fig. 48.
Discocelis binoculata Verrill, 1901, p. 43, pl. 5, figs. 2, 3.
Notoplana bahamensis Bock, 1913, p. 208, text-figs. 41, 42, pl. 6, figs. 2, 3.
Notoplana ferruginea Stummer-Traunfels, 1933, p. 3521, figs. 61–63.
Notoplana caribbeana Hyman, 1939a, p. 2, figs. 4–8.
Notoplana binoculata Hyman, 1939b, p. 8, figs. 13, 14.

REMARKS: I took four specimens of this species alive in the intertidal zone of South Bimini, Bahamas, in August 1952, and four additional specimens were found in the present material as follows: three from the *Fish Hawk* Expedition to Puerto Rico—one collected at Fajaido, Feb. 17, 1899, and two taken at Ensenada, Honda, Culebra, no date—and one collected by W. G. Hewatt at Caya Enrique, Parquero, Puerto Rico, Nov. 22, 1945, under coral rock. The original Schmarda specimen came from Jamaica; Verrill found the species in the Bermudas; the Bock specimens came from Andros Island in the Bahamas; and the specimen taken on the Presidential Cruise of 1938 came from Old Providence Island. Evidently the species is common in the Caribbean-West Indian region. The trivial name is a misnomer, as *N. ferruginea* is milky white when alive but it tends to darken on preservation; two of the *Fish Hawk* specimens were practically black. The species probably shows some geographic variation and at one time (Hyman, 1939b, p. 9) I regarded the Bermudan form, *N. binoculata*, as distinct from the West Indian and Caribbean specimens; but I am now convinced that all of the names given in the synonymy belong to one species. The figures of the eyes given by Bock (1913) and Hyman (1939a) are more characteristic of the species than the eye figure of Stummer-Traunfels (1933, p. 3523). In the latter, the cerebral eyes are more scanty and smaller relative to the tentacular eyes than in the specimens available to me. Whether the Jamaica specimens actually differ in these regards from specimens from the Bahamas and Puerto Rico cannot be decided without more material from Jamaica. The characteristic feature of this species is the heavy musculature ventral to the long tubular male antrum. The specimens sent by the U. S. National Museum have been returned to that institution.

Crassandros, new genus

Definition: Leptoplanidae of oval form without tentacles; with cerebral and tentacular eye clusters; male apparatus with seminal vesicle and interpolated prostatic mass, not formed into a vesicle; ejaculatory duct surrounded by a heavy musculature; penis papilla wanting; female apparatus typical, with Lang's vesicle.

Type species: *Crassandros dominicanus*, new species.

Crassandros dominicanus, new species

Figures 85,*b*,*c*; 86,*a*

Material: One specimen sent by the U. S. National Museum.

Form: Oval with broad ends (fig. 85,*b*) but evidently much contracted; 11 mm. long by 8 mm. wide; without tentacles.

Eyes: Due to the general opacity of the specimen and the presence of heavy folds in the eye region, the eyes were not distinguished with entire satisfaction. What could be seen of them is represented in figure 85,*c*. There is a cluster of tentacular eyes on each side of the anterior part of the brain. The cerebral groups consist of scanty loose eyes behind, in front of, and to the outer side of the tentacular groups.

Color: This is the usual brown found in preserved polyclads and does not indicate the color in life.

Digestive tract: The elongate pharynx could be imperfectly seen in the whole animal in a central location with the mouth beneath the posterior part of the pharynx (fig. 85,*b*).

Copulatory apparatus: Could be seen in the whole animal as three masses behind the pharynx, therefore much posterior in position. These three masses appear to be the prostatic mass, the muscular mass around the ejaculatory duct, and the female apparatus. The copulatory region was removed and sectioned sagittally. It showed breaks and tears and unfortunately had not been cut sagittally as intended. It is reconstructed in figure 86,*a*. The spermiducal vesicles approach the anterior end of the male apparatus from behind and form short spermiducal bulbs that join the retort-shaped seminal vesicle, and thus form a tripartite seminal vesicle that has thick muscular walls of mainly circular fibers. It is in continuity, without any intervening duct, with a rounded mass composed of eosinophilous granulations that appears to represent the prostate but is not formed into a definite prostatic vesicle. There seem to be a few muscle fibers among the granulations but the mass is singularly devoid of musculature. The ejaculatory duct from the seminal vesicle was obvious at first but could not be clearly traced through the prostatic mass. The prostatic mass is followed by an elongated area composed almost wholly of circular muscle fibers through which runs a longitudinal duct that is obviously the ejaculatory duct. This duct finally curves ventrally and opens

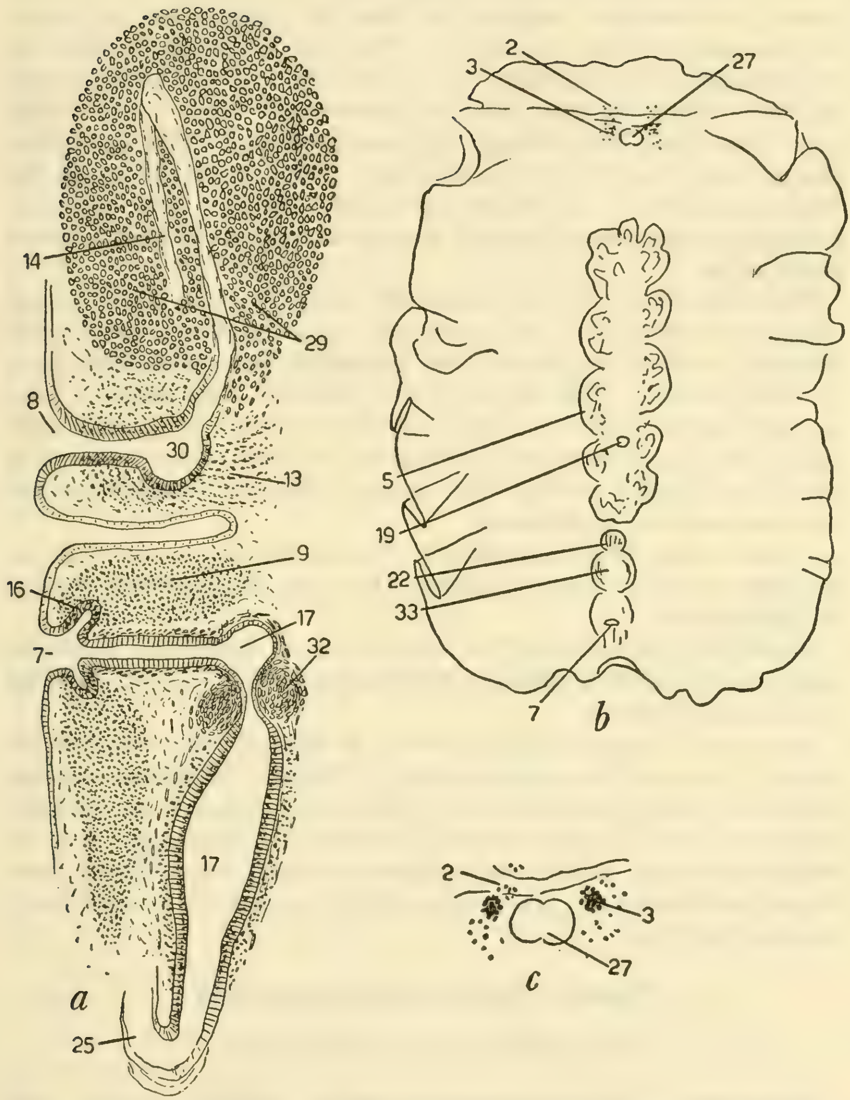

FIGURE 85.—*a*, *Anandroplana portoricensis*, sagittal view of copulatory apparatuses. *b*, *c*, *Crassandros dominicanus:* *b*, dorsal view; *c*, eyes. (For explanation see page 116.)

into the posterodorsal angle of the male antrum. No penis papilla could be discerned, but the fact that the sections were not exactly sagittal made interpretation here difficult. There is a broad but dorsoventrally flattened male antrum that narrows to a tubular portion opening by the male gonopore, so that the entire male antrum is shaped something like a mushroom. That this is antrum is shown by the identity of its epithelial lining with that of the general body epithelium and the marked difference between this lining and the lining of the ejaculatory duct through the muscular mass. This distinction does not show very well in the drawing. The muscular mass fills the whole space between the dorsal antral wall and the ejaculatory duct and also extends around the duct for some distance dorsal and anterior to the latter.

The female pore lies well behind the male pore and has a typical leptoplanid structure. The gonopore leads into a vagina with markedly scalloped walls and a tall epithelial lining surrounded by a fair musculature. The vagina slopes forward, then makes a pronounced backward curve, receives the oviducts into its ventral wall, and continues as a short duct of Lang's vesicle that soon terminates in a small oval Lang's vesicle. The course of the uteri in relation to the pharynx could not be followed.

DISTRIBUTION: Taken by R. G. Fennah for the U. S. National Museum in rock pools at Marigot, Dominica, British West Indies, December 1939.

HOLOTYPE: Anterior half as whole mount, copulatory region as sagittal serial sections (three slides) deposited in the U. S. National Museum, No. 24622.

REMARKS: It appeared impossible to fit this species into any of the existing genera of the Leptoplanidae. Whereas the general appearance of the specimen and the form of the female apparatus are typically leptoplanid, the curious massivity of the male apparatus and the absence of a penis papilla and a formed prostatic vesicle depart from the norm of the family. The relation of this genus to other leptoplanid genera is not clear.

Family PLANOCERIDAE Lang, 1884

Genus *Gnesioceros* Diesing, 1861

DEFINITION: Planoceridae with cuneate pellucid bodies; with tentacles containing eyes; with true seminal vesicle and interpolated prostatic vesicle; distal end of cirrus sac shaped like a conch or cowry shell, armed with parallel toothed bands; vagina with a powerful musculoglandular fold; Lang's vesicle transverse.

TYPE SPECIES: *Planaria sargassicola* Mertens, 1833.

Gnesioceros floridana (Pearse), 1938

Imogine oculifera, Verrill, 1892, p. 475, pl. 40, fig. 1 (not *I. oculifera* Girard, 1853).
Stylochoplana floridana Pearse, 1938, p. 77, fig. 27.
Stylochoplana oculifera Pearse and Walker, 1939, p. 18, fig. 10.
Gnesioceros verrilli Hyman, 1939c, p. 146, figs. 14–16.
Gnesioceros floridana, Hyman, 1940, p. 478.

Remarks: Two specimens of this species, one juvenile and the other mature, were taken by W. L. Schmitt in the Smithsonian-Hartford Expedition on the east shore of the harbor at Charlotte Amalie, St. Thomas, Virgin Islands, Apr. 4, 1937. They have been returned to the museum as a whole mount. This species is easily recognized as a whole mount by the conchlike cirrus end covered with parallel toothed bands. As the general appearance and sexual anatomy of this species have been described and figured by Hyman (1939c) under the name *Gnesioceros verrilli*, repetition appears unnecessary here. This species is common along the Atlantic coast from Massachusetts to Texas. I take this opportunity of placing on record the sending by J. Hedgpeth of a number of specimens of *G. floridana* from Port Aransas, Tex. No doubt the *Gnesioceros sargassicola lata* included in a faunal list (no author, no date) from Grande Isle, off Louisiana, is a misidentification of *G. floridana*.

Genus *Styloplanocera* Bock, 1913

Definition: Planoceridae of long slender form with tentacles; eyes inside the tentacles and around their bases; with seminal vesicle and interpolated prostatic vesicle; cirrus sac elongated containing a narrow sinuous ejaculatory duct lined with spines; Lang's vesicle with a pair of lateral pouches that extend far forward.

Type species: *Stylochus fasciatus* Schmarda, 1859.

Styloplanocera fasciata (Schmarda), 1859

Figure 86,*b*

Stylochus fasciatus Schmarda, 1859, p. 33, pl. 7, fig. 76.
Styloplanocera papillifera Bock, 1913, p. 233, text-figs. 47, 48, pl. 5, fig. 16, pl. 6, figs. 4–7.
Styloplanocera fasciata, Stummer-Traunfels, 1933, p. 3550, figs. 119, 120.

Remarks: As Bock has given an excellent illustrated account of this species and Stummer-Traunfels has verified the description, there is no necessity for spending words upon it. A single specimen was taken by W. G. Hewatt at Rincón Playa, Puerto Rico, Mar. 7, 1946, under flat rocks in surf. This species is easily recognized as a whole mount (fig. 86,*b*). The specimen was 18 mm. long by 7 mm. wide, in life, and light gray with brownish tints. The Schmarda specimen

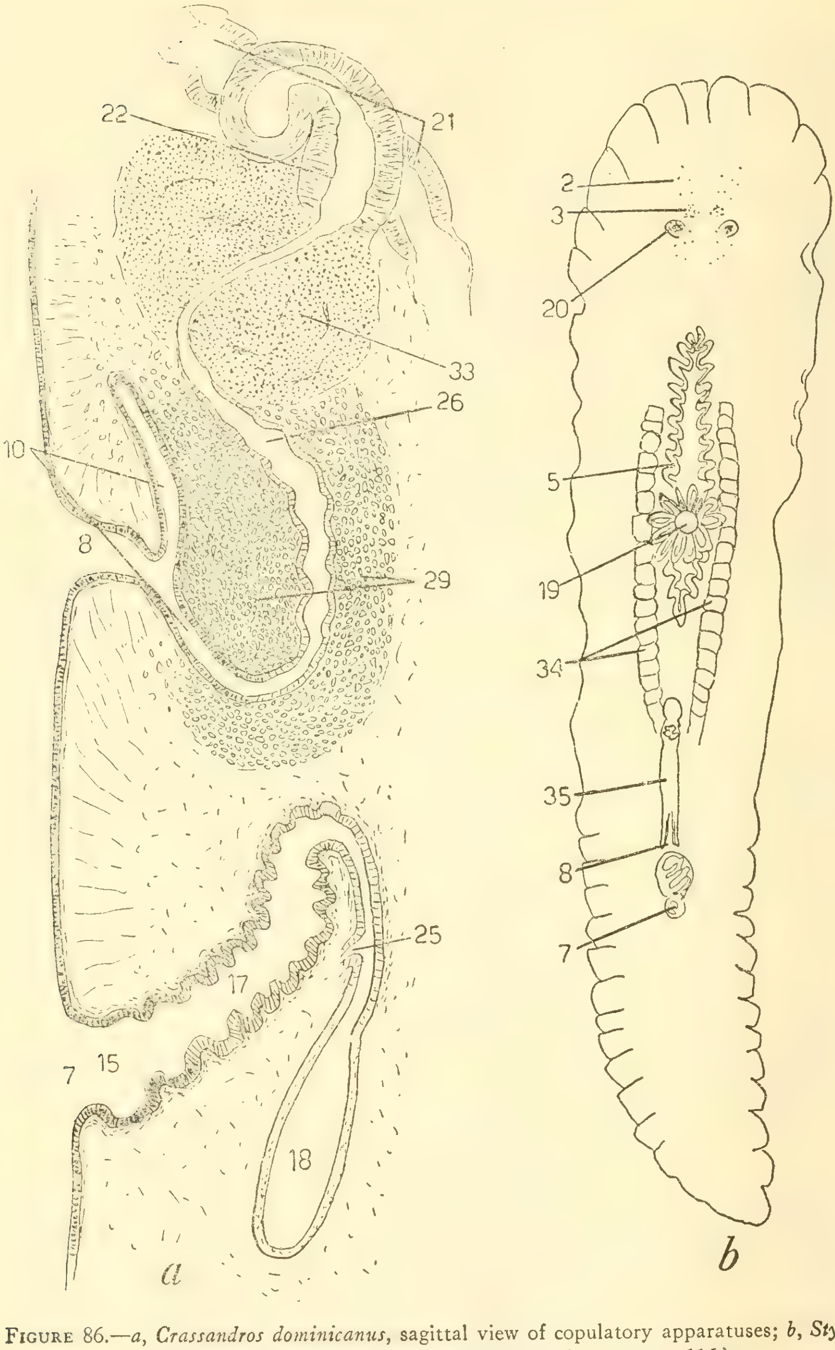

FIGURE 86.—*a*, *Crassandros dominicanus*, sagittal view of copulatory apparatuses; *b*, *Styloplanocera fasciata*, dorsal view. (For explanation see page 116.)

came from Jamaica and the Bock specimens from Barbados, Jamaica, and St. Croix, Virgin Islands. It is thus apparent that the species is common throughout the West Indies.

Suborder Cotylea

Family Pseudoceridae Lang, 1884

Genus *Thysanozoon* Grube, 1840

Thysanozoon nigrum Girard, 1851

Thysanozoon nigrum Girard, 1851, p. 137.
Thysanozoon nigrum, Hyman, 1939b, p. 15, fig. 22; 1940, p. 484.

Remarks: A specimen of this species was collected by Mabel Bishop, wife of the resident naturalist, off the dock in front of the Lerner Marine Laboratory, North Bimini, Bahamas. The animal was caught swimming around a light placed under water. This species was previously recorded from Bermuda and the coast of Florida.

Genus *Pseudoceros* Lang, 1884

Pseudoceros splendidus Stummer-Traunfels, 1933

Pseudoceros superbus Lang, 1884, p. 540, pl. 5, fig. 5.
Pseudoceros splendidus Stummer-Traunfels, 1933, p. 3487.

Remarks: A specimen of this handsome species was taken by W. G. Hewatt under a flat rock in one foot of water on a shore subject to wave action at Rincón Playa, Puerto Rico, Mar. 9, 1946. The specimen is stated by the collector to have been 38 mm. long and 12 mm. wide, hence rather small as the original specimen of Lang was 60 mm. long and 25 mm. wide. The color of the dorsal surface is described in Hewatt's notes as brown with a chocolate brown middorsal area and a bright orange band around the border edged on each side by a chocolate brown line. The anterior margin shows a white line. Although Lang's specimen was of a much darker ground color there is little doubt of the identification.

Pseudoceros splendidus is apparently cosmopolitan. The type locality is the Mediterranean and the species has since been found at Bermuda (Hyman, 1939b) and the Galápagos Islands (Plehn, 1896). The present record is the first for its occurrence in the West Indies. Plehn's identification appears dubious.

Hewatt, like Lang, noted that the species is active, swimming with undulations when disturbed.

Family EURYLEPTIDAE Lang, 1884

Genus *Prostheceraeus* Schmarda, 1859

Prostheceraeus floridanus, new species

FIGURE 87,*a*

MATERIAL: One specimen sent alive by H. Humm of Florida State University.

FORM: When crawling alive, extended, typical of the genus (fig. 87,*a*); narrow anteriorly with rounded margin and conspicuous, slender, pointed tentacles; widening gradually posteriorly, then narrowing slightly again to the rounded posterior end; when at rest, broadly oval. Length, extended, 12 mm., but as the animal is juvenile, presumably a much greater size is attained.

EYES: As usual in the genus, there is a pair of cerebral clusters near the anterior end; eyes occur on the rounded margin between the tentacle bases and numerously along the tentacles.

COLOR: Very distinctive; most of the dorsal surface has a brown network; laterally near the margin there is an irregular row of orange dots interspersed among grayish black markings that extend nearly to the margin; along the margin runs a fine orange line. This color pattern contrasts with the white background. Tentacles black. An attempt is made to represent the color pattern by stippling in figure 87,*a*.

DIGESTIVE SYSTEM: The tubular pharynx occurs in the usual anterior location. The digestive system was plainly seen in the animal when alive but is not evident in the mounted specimen. The main intestine extends back from the pharynx to a point about one-fifth the body length from the posterior end and gives off numerous side branches that anastomose into a small-meshed network extending throughout the body.

REPRODUCTIVE SYSTEM: There are no traces of any part of the reproductive system, hence the specimen is juvenile. However, the color pattern furnishes sufficient recognition.

DIFFERENTIAL DIAGNOSIS: This species is distinguished from other species of the genus by the color pattern.

DISTRIBUTION: Taken Nov. 29, 1952, by dredging some distance out in the Gulf of Mexico off the northwestern coast of Florida.

HOLOTYPE: The specimen, mounted whole, is deposited in the U. S. National Museum, No. 24632. The delicate animal was badly distorted by fixation but the color pattern is well retained.

Genus *Acerotisa* Strand, 1928

Acerotisa multicelis, new species

FIGURES 87,*b*,*c*; 88,*a*

Acerotisa sp. Hyman, 1952, p. 199.

MATERIAL: Six specimens from the Smithsonian-Hartford Expedition (No. 21).

FORM: Broadly oval, with rounded ends (fig. 87,*b*); the largest specimen is 8 mm. long by 6 mm. wide, the smallest, which is nevertheless fully mature, is about 3.5 mm. long by 2.5 mm. wide. The middle of the anterior margin shows two slight protrusions bearing the tentacular eyes.

EYES: More numerous than in any other species of the genus; as usual they vary in number with the size of the animal. The cerebral clusters form two elongated, somewhat wedge-shaped groups that range from 32 to 35 in the smallest of the available specimens to 45 in the largest. The tentacular groups, found on the slight anterior protrusions, range from 42 to 45 in the smaller, up to 50 to 55 in the larger specimens.

COLOR: White covered with minute black dots. The dotting is evident in the preserved specimens and is shown in part of figure 87,*b*. These dots are probably groups of rhabdites.

DIGESTIVE TRACT: Typical of the genus. The short tubular pharynx occurs in the anterior body third, directly behind the brain and cerebral eye clusters. It leads into the main intestine, a broad tube extending posteriorly in the midline and terminating blindly some distance anterior to the posterior margin. The intestine gives off a limited number of lateral branches (the number could not be exactly determined) that anastomose into an extensive network. This network was evident in some of the specimens and is indicated in part of figure 87,*b*. An intestinal network occurs in some other species of *Acerotisa*, namely, *A. meridianus* Ritter-Zahony, 1907; *A. typhlus* Bock, 1913; and *A. arctica* Hyman, 1953.

MARGINAL GLANDS: A distinctive feature of this species is the presence of a row of flask-shaped glands along the entire margin except for the tentacular protrusions, as shown in figure 87,*b*. In sections these glands appear as empty flasks opening through the epidermis. They are located in the mesenchyme internal to the epidermis (fig. 87,*c*).

COPULATORY APPARATUS: A set of sagittal sections was prepared and also a set of transverse sections, but neither was entirely satisfactory due to a lack of good fixation. However, the main features of the copulatory apparatuses have been ascertained and are represented in figure 88,*a*. The male apparatus is crowded beneath the rear part of the pharynx. The male pore leads into an antrum containing the penis, inclosed in a long narrow sheath. The penis stylet is also long with a blunt tip. The penis is bent at an acute angle to the rest of the male apparatus. The small papilla that bears the stylet contains as usual two ducts that unite within it. One duct, the prostatic duct, leads to the oval prostatic vesicle. The other duct pursues a rather narrow course for some distance, then widens into the retort-shaped seminal vesicle with prominent circular muscle fibers forming its walls. The rear part of the seminal vesicle turns forward and receives at once the voluminous spermiducal vesicles from in front.

The female gonopore lies well behind the male pore and opens into a sacciform antrum that is not, as might be supposed, a cement pouch and does not receive cement glands. Instead the cement glands open into a vertical narrow vagina extending dorsally from the antrum and acting as a cement duct. From this the vagina continues dorsally as a widened tube that turns back and receives the uteri. A pair of very large uterine vesicles, one of which is shown on figure 88,*a*, was evident in the live specimen (Hyman, 1952, fig. 3) and in the set of sagittal sections but cannot be seen on the preserved whole specimens nor in the set of transverse sections. The latter, however, is badly broken in the region of the vesicles. The vesicles are packed with eosinophilous material of indeterminable nature. The connection of the uterine vesicles with the rest of the female apparatus could not be traced in the available material.

Differential diagnosis: *Acerotisa multicelis* differs from other species of the genus in the large size, numerous eyes, and provision of the margin with a row of flask-shaped glands.

Distribution: Florida, West Indies. A specimen collected Apr. 16, 1951, at Alligator Harbor, northwest coast of Florida, was sent alive by H. Humm. Two preserved specimens, taken Aug. 1, 1951, by F. M. Bayer in the Biscayne Bay region of Florida, were sent preserved by the U. S. National Museum. From the same institution came four preserved specimens collected Mar. 29, 1937, by the Smithsonian-Hartford Expedition along the shore of San Juan Harbor, Puerto Rico.

Holotype: One whole mount deposited in the U. S. National Museum, No. 24627; also one other whole mount and one set of transverse sections (six slides) to that institution, Nos. 24628, 24629.

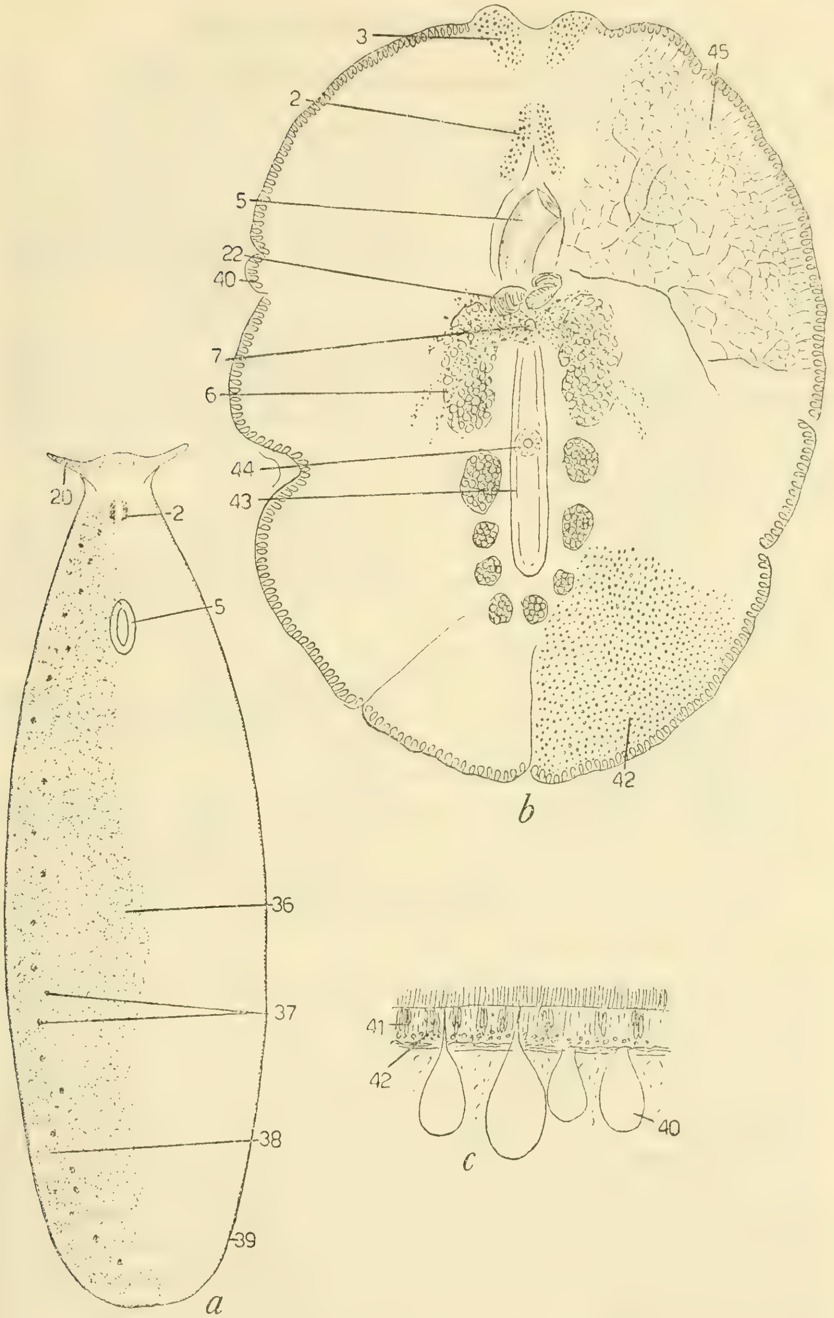

FIGURE 87.—*a*, *Prostheceraeus floridanus*, dorsal view, living specimen, crawling extended *b*,*c*, *Acerotisa multicelis*: *b*, dorsal view; *c*, marginal glands. (For explanation see page 116.)

Family PROSTHIOSTOMIDAE Lang, 1884

Genus *Prosthiostomum* Quatrefages, 1845

Prosthiostomum pulchrum Bock, 1913

FIGURES 88,*b*; 89,*a*

Prosthiostomum pulchrum Bock, 1913, p. 285, text figs. 62, 63; pl. 5, fig. 10.

MATERIAL: Five specimens from the Smithsonian-Hartford Expedition (Nos. 23, 32, 66).

FORM: Typical of the genus, slender, elongated (fig. 88,*b*); of small size, largest specimen 9 mm. long by about 1.5 mm. wide; type specimen was 12 mm. long. Bock's statement that the species is relatively broad and short for the genus is not upheld by the specimens available to me, which show the usual long slender shape. No doubt the single specimen he had was contracted.

EYES: The rather large cerebral eyes form two wedge-shaped groups, not well separated from each other, of about 40 eyes each, in the larger specimens; the band of eyes along the anterior margin contrasts with the cerebral eyes by the small size of its members (fig. 88,*b*). The marginal band is also very short, not extending beyond the anterior end of the cerebral groups.

COLOR: Apparently a dirty tan with brown or black spots. The spots are evident in some of the specimens.

DIGESTIVE TRACT: Typical of the genus.

COPULATORY APPARATUS: The postpharyngeal part of one specimen was sectioned sagittally and proved in good condition. A sagittal view of the copulatory apparatuses is shown in figure 89,*a*.

As Bock's specimen was imperfect in the male region and his figure small and lacking in detail, it appears desirable to give a figure here. As found by Bock, the male and female gonopores and the large sucker are close together. The male pore leads into a long antrum slanting markedly forward; this has a rather thick muscular layer outside the lining epithelium. At its anterior end it enlarges and curves posteriorly, terminating with the penis. The penis papilla is a small eminence bearing the penis stylet, which is surrounded distally by the usual penis sheath. The male antrum is continued as a narrow cavity around the penis papilla, and that portion of this cavity traversed by the base of the penis stylet is provided, as usual in the genus, with prostatic glands. Three ducts unite inside the penis papilla—a larger ejaculatory duct, and two smaller ducts, one from each of the accessory vesicles. The latter are, as usual in the genus,

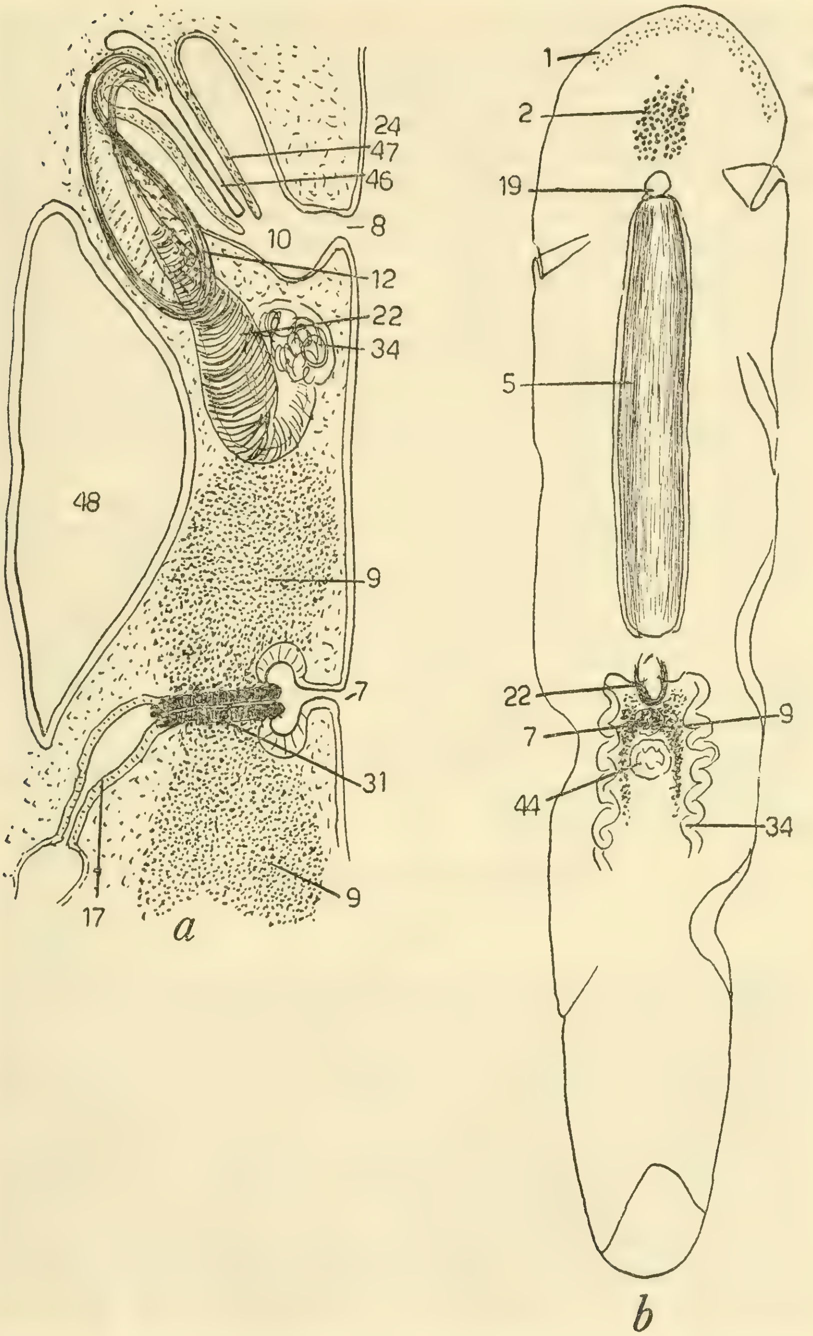

FIGURE 88.—*a*, *Acerotisa multicelis*, sagittal view of copulatory apparatuses; *b*, *Prosthiostomum pulchrum*, dorsal view. (For explanation see page 116.)

spherical muscular bodies with a small central lumen from which the duct leads to the penis papilla. One of the vesicles is situated below the anterior part of the seminal vesicle, the other between this and the penis papilla. The seminal vesicle is of long oval shape with a thick muscular wall that receives the two sperm ducts separately into its ventral wall at about its middle. From the anterior narrowed end of the seminal vesicle the sinuous ejaculatory duct proceeds into the penis papilla. The female apparatus lies close behind the posterior blind end of the seminal vesicle. The female gonopore leads into a pouchlike female antrum from which the vagina ascends, presenting immediately a pouchlike expansion and then narrowing to a short duct receiving the uteri. The sucker is a very large pouch, larger than the female apparatus, and lies shortly behind the latter, slightly closer to it than the distance between the two gonopores (fig. 89,*a*).

Distribution: West Indies. The type specimen came from Andros Island, in the Bahamas. The present specimens were collected by W. L. Schmitt on the Smithsonian-Hartford Expedition. Three came from the eastern shore of the harbor at Charlotte Amalie, St. Thomas, Virgin Islands, Apr. 4, 1937; one from a coral reef at St. Croix, Virgin Islands, Apr. 8, 1937; and the fifth from the shore at Banana Bay, Water Island, St. Thomas, Virgin Islands. The species appears common in the West Indies.

Specimens: Three whole specimens on two slides and one set of sagittal sections of the sexual region (one slide) have been returned to the U. S. National Museum.

Genus Prosthiostomum, juvenile

Figure 89,*b*

Remarks: In the material from the Smithsonian-Hartford Expedition there was found a very small juvenile specimen of a *Prosthiostomum* that did not seem to belong to *P. pulchrum*. The eyes of this specimen are shown in figure 89,*b*. The number of eyes is not significant as the eyes increase with age, but the large size of the marginal eyes in comparison with the cerebral eyes and the division of the marginal eyes into two groups by a median gap indicate that the worm belongs to some other species than *pulchrum*. The specimen also does not fit into the other species of *Prosthiostomum* known from the West Indies, *P. angustum* Bock, 1913. There is considerable resemblance as to eye arrangement with *P. lobatum* Pearse, 1938, from Florida. The speci-

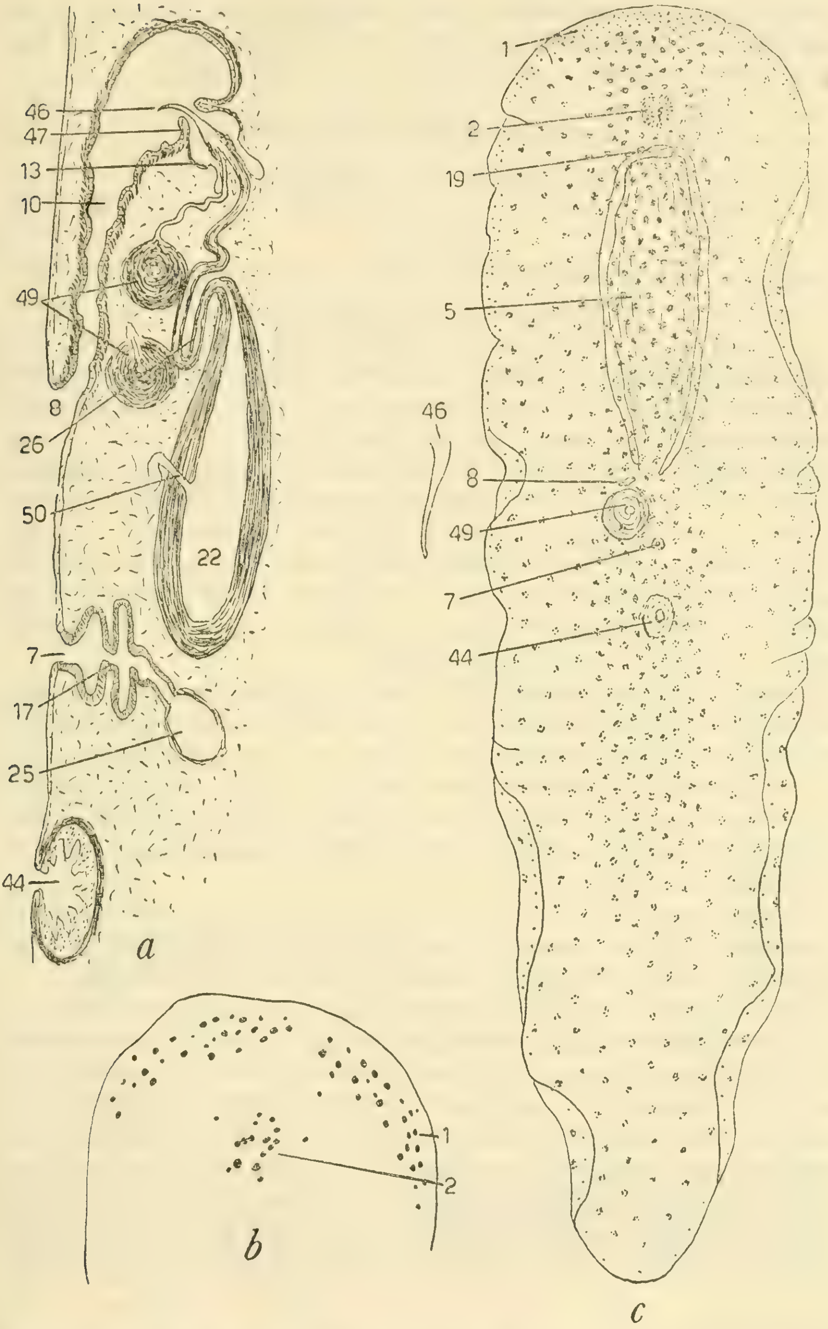

FIGURE 89.—*a*, *Prosthiostomum pulchrum*, sagittal view of copulatory apparatuses; *b*, *Prosthiostomum*, juvenile; *c*, *Enchiridium periommatum*. (For explanation see page 116.)

men was taken in the vicinity of Fort San Gerónimo, west end of San Juan Island, Puerto Rico, Mar. 27, 1937. The specimen shattered on an attempt to mount it whole and had to be discarded.

Genus *Enchiridium* Bock, 1913

Enchiridium periommatum Bock, 1913

Figure 89,*c*

Enchiridium periommatum Bock, 1913, p. 287, text figs. 64–66, pl. 5, fig. 6.

Material: One preserved specimen sent by H. J. Humm.

Form: Typical of the genus, elongate, with rounded anterior end and bluntly pointed posterior end (fig. 89,*c*). The specimen was 30 to 40 mm. long, alive, when moving, by 10 to 12 mm. wide; on preservation the animal contracted to a length of 23 mm.

Eyes: There is the usual pair of cerebral clusters, close together; they contain more eyes than as depicted by Bock. The marginal eyes completely encircle the margin, as diagnostic of the genus, and the arrangement is similar throughout the genus, that is, the marginal band is wide around the anterior end but, at about the level of the anterior part of the pharynx, rapidly thins to a single file of eyes that continues along the rest of the margin.

Color: Bock was unable to give the color of his specimen. Thanks to notes furnished by Dr. Humm, it can be stated that the species is white, dotted with rounded brown spots that are more concentrated in the middorsal region and more scattered towards the margin and posterior end, as shown in figure 89*c*. It appears that all three species of *Enchiridium* known from the shores of the American continent have the same color pattern.

Digestive tract: Identical throughout the family, with long tubular pharynx in the anterior region opening by the mouth shortly behind the brain and long main intestine giving off side branches.

Copulatory apparatus: Removed from the specimen and sectioned and found in good histological condition. As Bock has figured the apparatus, it appears unnecessary to illustrate it here or give a detailed description. The female gonopore is half way between the male gonopore and the sucker as shown in figure 89,*c;* the male apparatus and gonopore were displaced laterally in the specimen, no doubt as a result of distortion during fixation. The male antrum leans forward more in the specimen than as shown in Bock's figure but otherwise there is good agreement with Bock's figures. The very elongate penis papilla appears to be the chief distinguishing feature of this species. The penis stylet as seen in the whole specimen is drawn to the side of figure 89,*c*.

Distribution: The original specimen came from Thatch Island, in the Danish West Indies. The present specimen was taken with a dredge at about 40 feet in the Gulf of Mexico about 12 miles southeast of Alligator Point in Franklin County, northwestern Florida, Dec. 20, 1952.

Specimen: The specimen remains in my possession.

Summarizing remarks

There are herein reported 15 species of polyclads taken in the West Indies. Two other species known to occur in the West Indies have since been taken on the Gulf coast of Florida but were not refound in the present collections from the West Indies. The species taken from the West Indies may be tabulated as follows:

Acotylea
- Discocelidae
  - *Adenoplana antillarum*, new species
- Stylochidae
  - *Stylochus megalops* (Schmarda), 1859.
  - *Stylochus oculiferus* (Girard), 1853
  - *Indistylochus hewatti*, new genus, new species.
- Cryptocelidae
  - *Anandroplana muscularis*, new genus, new species.
  - *Anandroplana portoricensis*, new species.
- Leptoplanidae
  - *Notoplana insularis* Hyman, 1939
  - *Notoplana ferruginea* (Schmarda), 1859.
  - *Crassandros dominicanus*, new genus, new species.
- Planoceridae
  - *Gnesioceros floridana* (Pearse), 1938
  - *Styloplanocera fasciata* (Schmarda), 1859.

Cotylea
- Pseudoceridae
  - *Thysanozoon nigrum* Girard, 1851
  - *Pseudoceros splendidus* Stummer-Traunfels, 1933.
- Euryleptidae
  - *Acerotisa multicelis*, new species
- Prosthiostomidae
  - *Prosthiostomum pulchrum* Bock, 1913.

It may be useful to others to list here additional species that have been reported from the West Indies in the literature but that were not refound in the present material, although two of them have since been taken in the Gulf of Mexico:

Stylochidae
Woodworthia atlantica Bock, 1913
Cryptocelidae
Phenocelis purpurea (Schmarda), 1859
Leptoplanidae
Phylloplana purpurea (Schmarda), 1859
Prosthiostomidae
Prosthiostomum angustum Bock, 1913
Enchiridium periommatum Bock, 1913

There are two more Schmarda species reported from Jamaica, *Leptoplana macrosora* and *Stylochus dictyotus*, the types of which could not be found by Stummer-Traunfels (1933) when reinvestigating the Schmarda material. The colored figures in the Schmarda publication suggest that *Stylochus dictyotus* is identical with *Stylochus megalops*. *Leptoplana macrosora* is probably unrecognizable and the same may be said of *Leptoplana* sp. recorded from Jamaica by Andrews (1892).

Therefore 20 recognizable species of polyclads are now known from the West Indies. Seven of these occur on the coast of Florida: *Stylochus oculiferus*, *Phaenocelis purpurea*, *Notoplana insularis*, *Gnesioceros floridana*, *Acerotisa multicelis*, *Thysanozoon nigrum*, and *Enchiridium periommatum*. These same species occur in the Gulf of Mexico, at least near the Florida coast, but, in fact, the polyclad fauna of the Gulf of Mexico is poorly known. *Notoplana ferruginea*, *Pseudoceros splendidus*, and *Thysanozoon nigrum* are found at Bermuda, and *Notoplana insularis*, *Notoplana ferruginea*, and *Gnesioceros floridana* are probably spread throughout the Caribbean. The available data indicate the existence of a polyclad fauna centering in the West Indies and spreading from there slightly into the Bermudas, more extensively onto the coasts of Florida and into the Caribbean, and slightly into the Gulf of Mexico.

A surprising feature of the West Indian polyclad fauna is the dearth of the cotylean polyclads of the families Pseudoceridae and Euryleptidae that are usually a conspicuous element in tropical and subtropical waters. In this respect the West Indies are inferior to southern California and the Gulf of California, although having a more southerly location, and also inferior to the Bermudas.

A further peculiarity of West Indian polyclads is the tendency to an excessive muscularity of the male apparatus, seen in no less than four species: *Anandroplana muscularis*, *A. portoricensis*, *Notoplana ferruginea*, and *Crassandros dominicanus*.

A new euryleptid cotylean, *Prostheceraeus floridanus*, is described from the Gulf coast of Florida.

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BIOLOGY AND TAXONOMY OF NORTH AMERICAN BEETLES OF THE SUBFAMILY GEOTRUPINAE, WITH REVISIONS OF THE GENERA BOLBOCEROSOMA, EUCANTHUS, GEOTRUPES, AND PELTOTRUPES (SCARABAEIDAE)

By Henry F. Howden [1]

Introduction

A number of entomologists have been interested in the biology and taxonomy of the beetles in the subfamily Geotrupinae, family Scarabaeidae. While the adults have been collected and their habits recorded, little has been published on the biology of the larvae of these elusive beetles.

Revisions of the genera *Eucanthus*, *Bolbocerosoma*, *Geotrupes*, and *Peltotrupes* are included, with descriptions of seven new species and subspecies. Also, two previously unrecognized subspecies of *Geotrupes* are described.

The key to the tribes and genera of North American Geotrupinae is on page 161, and in the review of the subfamily the genera and species are treated in the following order:

Bolbocerosoma Schaeffer
- *B. farctum* (Fabricius)
- *B. confusum* Brown
- *B. tumefactum* (Palisot de Beauvois)
- *B. bruneri* Dawson and McColloch
- *B. hamatum* Brown
- *B. lepidissimum* Brown
- *B. biplagiatum* Dawson and McColloch
- *B. pusillum* Dawson and McColloch
- *B. pusillum townesi*, new subspecies
- *B. quadricornum* Robinson
- *B. ritcheri*, new species
- *B. cartwrighti*, new species
- *B. elongatum*, new species

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Bradycinetulus Cockerell
B. fossatus (Haldeman)
B. ferrugineus (Palisot de Beauvois)
B. rex Cartwright
Bolborhombus Cartwright
B. carinatus (Schaeffer)
B. angulus (Robinson)
B. parvulus Cartwright
Bolbocerastes Cartwright
B. regalis Cartwright
B. imperialis Cartwright
B. imperialis kansanus Cartwright
B. serratus (LeConte)
B. peninsularis (Schaeffer)
Bolbelasmus Boucomont
B. arcuatus (Bates)
B. minor (Linell)
B. hornii (Rivers)
Eucanthus Westwood
E. lazarus (Fabricius)
E. lazarus subtropicus, new subspecies
E. alutaceus Cartwright
E. greeni Robinson
Bolboceras Kirby
B. obesus (LeConte)
B. falli (Wallis)
B. thoracicornis (Wallis)
B. cornigerus Melsheimer
B. liebecki (Wallis)
B. filicornis (Say)
B. floridensis (Wallis)
B. simi (Wallis)
B. darlingtoni (Wallis)
B. alabamensis (Wallis)
Geotrupes Latreille
G. opacus Haldeman
G. ulkei Blanchard
G. blackburnii (Fabricius)
G. blackburnii excrementi Say
G. egeriei Germar
G. hornii Blanchard
G. balyi Jekel
G. stercorarius (Linnaeus)
G. splendidus (Fabricius)
G. splendidus miarophagus Say
G. semiopacus Jekel
Peltotrupes Blanchard
P. profundus Howden
P. profundus dubius, new subspecies
P. youngi, new species
Mycotrupes LeConte
M. retusus LeConte
M. lethroides Westwood
M. gaigei Olson and Hubbell
M. cartwrighti Olson and Hubbell
M. pedester Howden

In the discussion, an attempt is made to compare the habits of North American Geotrupinae with the habits of Geotrupinae from other continents, particularly Europe. The feasibility of using food and burrowing habits as aids in taxonomic and phylogenetic investigations are discussed, and one case is pointed out where they could be applied.

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REVIEW OF LITERATURE

Latreille (1796) was the first to propose the genus *Geotrupes* in the Scarabaeidae, not placing, at that time, any species in the genus. Two years later Fabricius (1798) again proposed the name *Geotrupes* with 65 included species, but used the name with an entirely different connotation than did Latreille. Latreille (1802, 1804) repudiated the Fabrician application of the name and listed some species that he believed should be included in the genus, and it has been his concept, and not that of Fabricius, that has been followed by subsequent authors.

Recently, Potts (1948, 1951) has raised the question of the validity of the acceptance of *G. stercorarius* Linné as type of the genus, for it was not included in the Fabrician list of species in 1798. I believe, however, as did Latreille (1802), that the *Geotrupes* of Fabricius was not intended to be that of Latreille and is therefore a primary homonym, invalidating the Fabrician list for genotype selection in this case and leaving *G. stercorarius* Linné as type of the genus.

This problem has been more fully discussed by Townes and Howden (1952) and has been referred to the International Commission of Zoological Nomenclature. It is still under consideration by the Commission.

The erection of the subfamily (or family) Geotrupinae was credited to Latreille (1804). Following Latreille there were a number of more or less comprehensive taxonomic works on the subfamily which included the tribes Bolboceratini, Geotrupini, and Lethrini. Little of this work, however, dealt even sparingly with North American forms. The first comprehensive paper on North and Central American species was a monograph by Jekel (1865) that dealt solely with the tribe Geotrupini. This paper incited considerable interest and Horn (1868, pp. 313–322) published what is essentially a supplement to this work, commenting on synonymy and pointing out varieties within some of the species. He followed this in 1870 (pp. 48–50) with a key to the other North American genera, exclusive of *Geotrupes*, for which he subsequently published a key (1880, pp. 144–145). The information on the Central American Geotrupinae was assembled by Bates (1887), and one year later Blanchard (1888) published the most recent comprehensive work on the North American species in the genus *Geotrupes*. Bradley (1944) published a key to the species of *Geotrupes* as given by Blanchard, but without any consideration of synonymy or undescribed species.

The information that had been rapidly accumulating before 1900 was finally brought together and greatly augmented by a series of extensive papers, worldwide in scope, by Boucomont. In 1902, in Wytsman's "Genera Insectorum," he set forth the genera and listed the described species under each. This was followed by a paper by Schaeffer (1906) in which was published a revision of the North American genera and species in the tribe Bolboceratini. In the same year Boucomont (1906) published his "Catalogue Provisoire des Geotrupidae." Then, in 1911, Boucomont published a revision of the genera of the Geotrupinae, dealing in large part with the Bolboceratini, in which he discussed Schaeffer's paper and proposed a number of new genera and subgenera. Perhaps the most useful part of Boucomont's work was his catalog of the literature of the subfamily published in 1912 in Schenkling's "Coleopterorum Catalogus." He subsequently published a number of other papers, none of which dealt with the American fauna.

Following this flurry of papers there have been only a few revisions of North American genera. Descriptions and keys to the species of *Bolbocerosoma* were published by Dawson and McColloch (1924) and later revised by Brown (1928, 1929). The genus *Bolboceras* (formerly *Odontaeus*) was very carefully worked up by Wallis (1928, 1929). Blatchley (1910, 1928) published keys to local species of Geotrupinae in Indiana and Florida. These were the major contributions to the taxonomy of the adult Geotrupinae until the present. O. L. Cartwright has completed (1953) a revision of the genera *Bradycinetulus*, *Bolbelasmus*, *Bolbocerastes*, and *Bolborhombus* in North America, and Olson, Hubbell, and Howden (1954) have discussed the genus *Mycotrupes*.

Information about the biology of the immature stages has accumulated very slowly and almost all of the investigations have been by Europeans. The earliest known biological observation was by Johann L. Frisch in 1736. He not only discussed the biology, supposedly of *Geotrupes stercorarius* Linné, but also crudely pictured the larva.

Following this early work by Frisch, there were only a few scattered notes on the biology for a number of years. Mulsant (1842) briefly mentioned the biology and the odd larva of *Geotrupes*, but the first fairly accurate drawings of the larva of any species of *Geotrupes* were done by Schiødte (1874). Unfortunately, the least accurate of his drawings, the epipharynx of *Geotrupes stercorarius* Linné, was the only one that has been reproduced on later occasions. In 1880, Rupertsberger made a valuable contribution with a bibliography on the biological work done up to that time on European Coleoptera. He followed this with a supplement in 1894. In 1905 Kolbe discussed the biology of some of the species of Geotrupinae, and in 1929 he published a paper on the distribution of species of *Geotrupes* and the evolution of their antennae. Spaney (1910) published an excellent account of adult and larval biology, with drawings of larvae and pupae of three species of European *Geotrupes* and of *Typhoeus typhoeus*. Several other excellent papers appeared, at almost the same time, by Fabre (1918), Sano (1915–1916), Main (1917, 1918), and Schjelderup-Ebbe (1925). Main's observations were the most comprehensive of the biological studies done in Europe. Recently, von Lengerken (1952) published on the biologies of several species of Geotrupinae. While most of the work was done on the Geotrupini, the tribe Lethrini received some early attention. Emich (1884) discussed the metamorphosis of *Lethrus apterus*, and other works on single species of *Lethrus* were done by Shipley (1887), Schreiner (1906), and Reymond (1933). Fabre (1912, 1919, 1922) discussed the habits mainly of the adults of *Bolbelasmus* and *Typhoeus* (under the name *Minotaurus*). The biology of the single European species of *Odontaeus* (now *Bolboceras*) has been discussed by Bedel (1911), Arens (1922), and Muller (1948). The information on larval morphology of the British Geotrupinae has been ably compiled and summarized by van Emden (1941) with descriptions and keys to all known larvae. He did not, however, include biological data.

Despite the amount of work on European species, very little has been written concerning the habits of American species. Sim (1930) made some careful studies of a number of species of *Bolboceras*, but was not fortunate enough to work out the biology of the immature stages. The first mention of the biology of the larva of a species of North American *Geotrupes* was a brief account by Loding (1935) of *Geotrupes ulkei*. This was followed by a very detailed and comprehensive paper by Ritcher (1947) in which were given descriptions and biological notes of the known larvae of North American Geotrupinae and keys to all known genera. It was in this paper that the larvae of the genera *Bolbocerosoma* and *Bolboceras* were accurately described for the first time.

Before the appearance of Ritcher's paper, a number of authors—Böving and Craighead (1930–1931), Paulian (1939), Hays (1929), and later Edwards (1949)—had stated the necessity of erecting the family Geotrupidae based in large part on the reduced third leg of the larva of *Geotrupes*. While the question of family rank will not be settled for some time, Ritcher added a number of new facts to be considered, which make the writer doubt the validity of family rank. The group is at present treated as a subfamily.

The most recent work that included some biology was a compilation of information by Arrow (1951). While this work contained a large amount of data, it was unfortunate that there was not more originality in the biological observations. All of the portions on biology of the Geotrupinae were either taken from other sources, many of them faulty, or were poorly based suppositions. It is unfortunate that so many erroneous observations had to be preserved in an otherwise interesting book by a well known worker.

Besides the papers already mentioned there have been a few others that have added materially to our information on the Geotrupinae. Very interesting papers and notes on the physiology of *Geotrupes*, some dealing with their reaction to odors, have been published by Vaternahn (1924), Warnke (1931, 1934), Dethier (1947), and Brues (1946). Arrow (1904) discussed sonification in some of the genera. The morphology of the mouthparts of North American genera was discussed and illustrated by Hardenburg (1907), and the structure of the male genital tube of some European species was discussed by Sharp and Muir (1912). There have also been a number of papers on the parasites of adult and larval Geotrupinae by Chapman (1869–1870), Hall (1929), Wetzel (1935), Theodorides (1949, 1950a, 1950b, 1951), and van Emden (1950). The most interesting and unusual of these papers are those by Chapman (1869–1870). These and many other papers mentioned will be discussed in greater length in a more appropriate place.

METHODS AND MATERIALS

Horn (1868, p. 321) made the statement that he had never seen a good series of all the species of *Geotrupes* in any collection, and the situation to which this statement applied was still true in 1950. However, many of the collections had excellent series of some of the species, and through the generous loan of specimens from institutions and individuals mentioned previously I was able to examine large series of most of the species.

Almost all of the distributional data contained in this paper were taken from specimens personally examined, and all localities were checked in the U. S. Postal Guide or Rand McNally Atlas. Because of the large number of errors found in Brimley's "Insects of North Carolina" (1938, pp. 201–202), it was decided not to use records in any local state lists. Some little known or unusual records can be found in the following works: Beaulne (1942, p. 12), Brown (1940, p. 74), Cartwright (1934, pp. 239–240), Davis (1904), Easton (1909, p. 51), Frost (1920, p. 251), Gardiner (1879, p. 213), Gorham, Walker, and Simpson (1929, p. 15), Loding (1933, p. 147), Nicolay (1913, p. 125), Nylen (1929, p. 219), Snow (1904, p. 197), Townsend (1889, p. 233), and Wickham (1894, p. 197).

In addition to borrowed material, all of the type material that was available in the eastern United States was studied. In some instances where the type was not readily available, I was able to see paratypes. Dr. Tuxen, of the Zoologische Museum, Copenhagen, and Dr. van Emden, British Museum (Natural History), were extremely helpful in comparing material with some of the Fabrician types.

It should be mentioned here that the types of several of the species described in this paper, along with most of the larvae collected during the study, have been deposited in the collection of the U. S. National Museum.

In studying many of the specimens, it was necessary to extract the genitalia, particularly of the males. This was done by relaxing the specimens in a humidor for several days and then removing the genital caspule and genitalia under a dissecting microscope. The capsule and genitalia were then mounted on a card point on the pin beneath the specimen. When it was necessary to relax a specimen rapidly, it was placed in water just at the boiling point for three minutes, which was ordinarily enough time to completely relax it. Unfortunately, this method usually changed the hue of iridescent species.

In studying the genitalia a few were cleared in potassium hydroxide, but all drawings were made from genitalia that had not been cleared. The drawings were made using a binocular dissecting microscope with a net reticule at magnifications of 45$\times$ and 90$\times$. In some of the larval illustrations a compound microscope was used to check and to fill in detailed structures. Larval dissections were done with a small blade-like probe, several insect pins, and a fine pair of dissecting scissors.

The problems encountered in the biological studies were numerous and sometimes exasperating. The adult Geotrupinae are quite secretive, spending much of their life in deep burrows. There have been a number of notes, written by Mohr (1943), Frost (1929), Park (1931), Young (1950), and others, on collecting the adults at dung, fungi, and decomposing animal and vegetable matter. At first, collecting was done by looking for the burrows near dung and fungi. However, this method was slow and much time was consumed digging out a few beetles. In sandy areas the time necessary for digging was greatly shortened by the use of a posthole digger. There the burrows were almost vertical, and, when marked with a straw thrust into them, they could be easily followed by digging beside the burrow with a posthole digger and using a trowel to follow the burrow. If it was a question of merely obtaining the specimen at the bottom of the burrow, it was excavated with the posthole digger and the dirt sifted through a quarter-inch mesh screen.

In many cases it was difficult to locate burrows, particularly when the ground was covered with litter. In order to obtain a sufficient number of adults to use in rearing cages, various methods of trapping were tried. Spector (1943) noted a number of *Geotrupes* attracted to chicken feathers. Elaborating on Spector's observation, I covered the bottoms of apple crates with fine screen wire. These were sunk into the ground, partially filled with soil, and a layer of chicken feathers and entrails placed on top of this. This method of trapping yielded some specimens, but not in the numbers desired. Another technique employed gallon cans partially filled with dirt that were sunk into the gound and then baited with fungi and dung. While producing a number of specimens, these methods were still not satisfactory.

Young (1950) had mentioned the attractive power of molasses, and several types of molasseslike substances were tried. The most successful of these was found to be one part of triple malt extract to three parts of water with a little yeast added. This was a very good method for determining the species in an area. Also malt was the best attractant found for use in very xeric habitats in the summer. Other advantages were that the attractiveness lasted over a long period and once the beetle fell into the mixture it did not escape. However, although the malt traps were very successful, specimens captured were invariably drowned and the method is not recommended for obtaining live specimens. A screen to keep the beetles out of the malt was added but for some reason the trap then lost some of its effectiveness. Also, it is apparently necessary for the malt to ferment for a number of days before becoming fully effective and some other attractant was needed when the collector was only staying in an area overnight.

Shortly before the conclusion of this work, a number of adult *Geotrupes* were procured in an interesting manner. At Faison, N. C., some work was in progress on the control of the fall army worm. In August and September several applications of Endrin (Julius Hyman Compound 269) were made on corn at the rate of one-eighth pound of insecticide per acre. Three weeks following the last treatment, on Oct. 28, 1952, a large number of dead and dying *Geotrupes blackburnii* were noted in a small area of the corn field. On closer examination, some human dung was found between the rows of corn. In, under, and around the dung were many dead and dying dung-inhabiting insects (including about 40 *G. blackburnii*). The only apparent explanation for the death of the beetles appears to be the residual action of the insecticide. I have not been able to further pursue this seemingly productive method of collecting some of the dung- and ground-inhabiting Scarabaeidae.

Finally, a trap was devised that attracted numbers of *Geotrupes* and did not kill or injure them. It consisted of a can containing an attractant and a funnel top. The top was cut out of a gallon can and holes were punched in the bottom with a nail to permit drainage. Two holes were made 2 inches above the bottom for attaching a small vial of attractant. Then three holes, for wire hooks to hold a funnel, were punched around the top of the can. A piece of cardboard was cut out to form a shallow funnel with a central opening 1 inch in diameter and sides overlapping the can by 1 inch. The cardboard was turned to form the funnel, stapled, and given several coats of brown outdoor paint on both sides. The finished funnel presented a smooth surface and lasted for well over a year. The funnel was held in place by the three wire hooks at the top of the can. The trap was complete when a small vial of attractant was fastened to the inside of the can by a piece of string passed through the holes in the side near the bottom. It was then sunk until its top was level with the surface of the ground. Water did not reach the attractant nor accumulate in the can and *Geotrupes* would survive for a week or more.

The greatest problem was to find suitable attractants. Warnke (1931) had shown that some chemical products of decomposition were attractive to *Geotrupes*. The chemicals mentioned by him, plus a number of others recorded as products of the decomposition of plant or animal matter, were tried. There was no attempt made to vary concentrations, as the major purpose was merely to find a material to attract *Geotrupes*. Three of the materials, isoamylamine, butyric acid, and propionic acid, proved very successful. The only objection to the use of chemicals was that anything coming in contact with them retained the odor for some time. The chemicals were tried at Raleigh, N. C., by using them in bait cans placed in a large circle 6 feet apart. Materials that did not prove attractive were discontinued after several months and others substituted. The data from these traps are summarized in tables 3 and 4 (pp. 241, 267). Some of the better materials were used at Faison and Southern Pines, N. C., with good results. Oddly enough, *Geotrupes egeriei* would come in numbers to malt, but was not attracted by any of the chemicals. A few species, especially in genera other than *Geotrupes*, were most readily taken in light traps.

The species collected by these traps and by observation were separated and placed in rearing cages constructed by sinking 12-inch boards 8 inches into the ground, making an enclosure about 2 or 3 feet wide by 6 feet long. The soil was disturbed as little as possible in the center of the cages, allowing the adults to burrow to any depth they wished. The beetles were kept supplied with decomposing leaves, cow dung, and fungi or rotting bananas. The enclosures were kept tightly covered with galvanized wire screen.

In sandy areas, where the species present burrowed to considerable depths, a different type of cage was used that was extremely simple to make. It was merely a tube of galvanized wire screen, 3 feet deep with a varying diameter which averaged about 1 foot. The sides of the tube were fastened together by pulling off a few strands of wire parallel to the cut edges, then pushing the protruding wires through the holes in the screen on the opposite edge and bending them over. A screen top and bottom were fastened on in the same way, making a strong, light, cylindrical cage which was easily sunk to the desired depth by use of a posthole digger.

After the adult beetles had been in the cages for a month or more, a portion of each cage was carefully investigated. If larvae were found, they were removed along with the food material provisioned by the adult and placed in 2-ounce, metal, salve boxes in which they were easily observed and reared. Depth of the larval cell, instar, food, and other information were recorded. Larvae were preserved by placing them alive in hot water kept just under boiling, leaving them there for 3 minutes, and then dropping them into vials of 70 percent alcohol. Various larval preservatives that contain acetic acid, kerosene, and alcohol in varying proportions were not employed because such preservatives caused undesirable distension of the larvae.

Review of the subfamily Geotrupinae

ADULT CHARACTERISTICS

The North American representatives of the subfamily Geotrupinae can be separated from other Scarabaeidae by the following characteristics.

Antennae 11-segmented with 3-jointed club, mandibles not hidden by the clypeus, clypeus sharply delimited from the vertex, often with a tubercle or horn, anterior femora with a silky spot on anterior surface, pygidium largely hidden by the elytra, abdominal spiracles on the membrane between sclerites, male genital armature enclosed in a definite sclerotized genital capsule.

The genus *Pleocoma* appears very closely related to the Geotrupinae but has been omitted from the present work.

Key to North American tribes of the subfamily Geotrupinae

Antennal club large, about as long as the basal eight segments, rounded, convex on both sides . . . . **I. Bolboceratini**
Antennal club small, about half as long as the basal eight segments, elongate, not convex on both sides . . . . **II. Geotrupini**

I. Key to genera of North and Central American Bolboceratini

1. Eyes entirely divided by canthus; color sometimes variegated 2
   Eyes only partially divided by canthus; color uniform brown to black . . 4
2. Scutellum very elongate and narrow. (Central and South America). **Athyreus**
   Scutellum triangular 3
3. Color brownish orange varied with areas of black or dark brown; middle coxae narrowly separated by slender projection of mesosternal plate. **Bolbocerosoma**
   Color uniformly brown to black; middle coxae contiguous, not separated by projection of mesosternal plate . . . . . **Bolboceras** (formerly *Odontaeus*)

4. Margin on posterior edge of pronotum broadly interrupted medially. (Central America) . . . . **Bolbelasmus** (formerly *Kolbeus*) **arcuatus** Bates
   Margin on posterior edge of pronotum complete 5
5. Elytron with five striae between suture and humeral umbone; humeral angle of elytron not broadly rounded, the margin almost always produced into a tubercle at the angle . . . . **Eucanthus**
   Elytron with seven striae between suture and humeral umbone; humeral angle of elytron broadly rounded, the margin never produced into a tubercle at the angle 6
6. Middle coxae nearly contiguous, intercoxal process less than 0.3 mm. wide and linear between coxae . . . . **Bolbelasmus**
   Middle coxae well separated, intercoxal process more than 0.3 mm. wide and never linear 7
7. Base of elytron margined; pronotum without postapical carina 8
   Base of elytron not margined; pronotum with a postapical carina extending almost to side margins . . . **Bolborhombus** (*Bolboceras* of authors in part)
8. Apex of tibia of middle and hind legs deeply emarginate on outer side, the angle adjacent to spurs appearing almost as a fixed spur; without prosternal spine . . . . **Bradycinetulus**
   Apex of tibia of middle and hind legs obliquely truncate, prosternal spine behind anterior coxae transverse, doubly pointed and remote from acutely angled intercoxal piece . . . . **Bolbocerastes**

II. Key to genera of North and Central American Geotrupini

1. Elytra fused, connate, their surfaces roughly granulate; flightless species. (Southeastern U. S.) . . . . **Mycotrupes**
   Elytra free, if connate not roughly granulate 2
2. Eye canthus abruptly angulate anteriorly, clypeus V-shaped, with horn or raised longitudinal carina running its length; thorax anteriorly with horn in males, merely slight postmarginal protrusion in the females. (México.) **Ceratotrupes**
   Eye canthus broadly arcuate anteriorly, clypeus usually approximately U-shaped, with small median tubercle posteriorly, but no longitudinal carina; thorax anteriorly without horn or postmarginal protrusion in either sex . 3
3. Middle and hind tibiae each with a pronounced transverse apical carina; margin of elytron not widely flared. (North and Central America.) **Geotrupes**
   Middle and hind tibiae with only a trace of an external transverse apical carina; margin of elytron widely flared. (Florida) . . . . **Peltotrupes**

LARVAL CHARACTERISTICS

The larvae of the North American Geotrupinae can be distinguished from the larvae of other North American Scarabaeidae by the following characteristics.

Antennae 3-segmented, the penultimate segment bearing one or more conical sense organs. Third segment greatly reduced in diameter. Inner and outer lobes of the maxillae entirely free. Teeth present on maxillary stridulatory area. Hypopharynx with oncyli. Terga of abdominal segments 3 to 7 with two dorsal annulets. Mesothoracic and metathoracic legs often with stridulatory organs (*Bolboceras*, *Peltotrupes*, *Geotrupes*).

The genus *Pleocoma* was included in Ritcher's (1947, p. 5) key to Geotrupinae, as were the known European forms. *Pleocoma* has been omitted because of the present uncertainty over its inclusion in the subfamily Geotrupinae. For descriptions of the larvae in the genus *Pleocoma* and the European genera *Lethrus* and *Typhoeus* the reader is referred to Ritcher's (1947) excellent paper.

Key to the North American tribes and genera of known Geotrupinae larvae

1. Metathoracic legs greatly reduced; last abdominal segment obliquely flattened; body sharply bent with swollen abdomen (pl. 11, figs. 1, 2). (Geotrupini) . 2
   Metathoracic legs not reduced; last abdominal segment rounded posteriorly; body slightly bent without enlarged abdomen (pl. 12, figs. 1, 2; pl. 13, fig. 1). (Bolboceratini) 4
2. Third antennal segment less than one-sixth as long as second segment (pl. 7, fig. 6); abdomen greatly swollen . . . . **Peltotrupes**
   Third antennal segment at least one-fourth as long as second segment; abdomen moderately swollen 3
3. Endoskeletal figure of ventral anal lobe below anal opening laterally expanded with sharp, fairly truncate angles . . . . **Geotrupes**
   Endoskeletal figure of ventral anal lobe below anal opening lacking sharp angles, broadly rounded . . . . **Mycotrupes**
4. Legs lack claws, 2-segmented; penultimate segment of antenna (pl. 6, fig. 3) bearing a single conical sense organ; lower anal lobe single (pl. 6, fig. 10). **Bolboceras**
   Legs with claws, 3- or 4-segmented; penultimate segment of antenna with two or more conical sense organs; lower anal lobes paired 5
5. Penultimate segment of antenna (pl. 6, fig. 2) with two conical sense organs; galea emarginate; legs 4-segmented . . . . **Bolbocerosoma**
   Penultimate segment of antenna (pl. 6, fig. 1) with more than two (usually four) conical sense organs; galea not emarginate (pl. 6, fig. 6); legs 3-segmented. **Eucanthus**

(Larvae of the following genera are unknown: *Bolbelasmus*, *Bolborhombus*, *Bradycinetulus* and *Bolbocerastes*.)

Genus *Bolbocerosoma* Schaeffer

Bolbocerosoma Schaeffer, 1906, p. 254.—Boucomont, 1911, pp. 332–350.—Blatchley, 1910, p. 937; 1928, p. 29.—Dawson, 1922, p. 194.—Dawson and McColloch, 1924, pp. 9–15. Brown, 1928, pp. 192–195; 1929, p. 213.—Robinson, 1941, p. 132.—Ritcher, 1947, pp. 11–12.

Genotype: *Scarabaeus farctus* Fabricius, designated by Schaeffer (1906).

Generic limitations: Given by Schaeffer (1906, p. 254): "Eyes completely divided, intermediate intercoxal process between the coxae with a tooth-like elevation, intermediate coxae very narrowly separated, nearly contiguous."

Other useful characteristics are: Yellow or red-brown color, dorsally with black markings, lateral pronotal carinae no wider than head, at least a few deep coarse median punctures on pronotum, elytral base not margined.

Male Genitalia: The genital capsule of the male is the most conspicuous part of the genital structures. The genitalia itself is rather simple, with symmetrical pointed parameres and a central spiculate aedeagus. Characteristics useful in differentiating various species were found mainly in the size and shape of the lateral lobes of genital capsule. The capsule readily separates the genus into the following species groups:

(A) Capsule large, heavily sclerotized, lateral lobes elongately (over twice as long as wide) triangular, narrowly separated at tip, lobate basally. **farctum, confusum**

(B) Capsule slightly smaller and less sclerotized, lateral lobes with bluntly angulate tips, widely separated, not lobate basally . . **tumefactum, bruneri**

(C) Capsule small with lateral lobes deflexed at tips to form hooks . **hamatum**

(D) Capsule small, moderately sclerotized, lateral lobes with tips blunt and broadly rounded. . . . . **All remaining species**

In the genus *Bolbocerosoma* intraspecific variation, particularly in males, is very evident, expressing itself in the size of the tubercle on the eye canthus, the tubercle at the midline of the clypeus, the horn of the vertex, and the development of the pronotal modification. Generally, the modifications of the head and pronotum of the males are well developed, only occasionally being very small, with the pronotal modification quite similar to those of the female. In the females variation is much less noticeable.

Descriptions have been based, whenever possible, on well-developed individuals. Variations in size, color pattern, and punctation occur and are noted for each species whenever variation is evident.

Known larvae in this genus may be distinguished from related genera by the following characteristics: Antennae 3-segmented, penultimate segment with two conical sense organs, galea emarginate, legs 4-segmented with pronounced claws, metathoracic legs not reduced, and abdomen not enlarged.

Key to the North and Central American species of Bolbocerosoma

1. Elytron with seven deep and strongly punctured striae between suture and humeral umbone 2

   Elytron with five deep and strongly punctured striae between suture and humeral umbone, the second and fifth striae feeble or obsolete 3

2. Pronotum never with a black median spot or stripe, distal black area of elytron confluent with the black sutural stripe. **bruneri** Dawson and McColloch

Pronotum with black median spot or stripe, black distal area of elytron usually well separated from the black sutural stripe.
tumefactum (Palisot de Beauvois)

3. Punctures of elytral striae and dorsal surface (besides some of the marginal punctures) bearing at least a few fine long erect yellow hairs 4
Punctures of elytral striae and dorsal surface (except in some cases the marginal punctures) without hairs 8
4. Elytron with a large distal black area which is confluent with posterior half of black sutural stripe . . . . **pusillum** Dawson and McColloch
Elytron with black spot which is separated from both sutural stripe and lateral margin 5
5. Black spot of elytron almost twice as long as wide; black sutural stripe of elytron continuing around the posterior half of lateral margin; posterior of pronotum with black markings pronounced and extending beyond margined edge 6
Black spot of elytron almost circular; black sutural stripe of elytron not extending around lateral margin; posterior of pronotum with only a vague black line 7
6. Pronotum and elytra with many long hairs; portions of lateral margins of pronotum black; entire posterior pronotal margin black with median black toothlike mark . . . . **cartwrighti**, new species
Pronotum and elytra with a few short hairs; lateral margins of pronotum without any trace of black; only lateral portions of posterior margin of pronotum black . . . . **ritcheri**, new species
7. Body shape oval; vertex and pronotum densely, coarsely punctured; vague circular postmedian elytral spot confined to posterior half of elytron; lateral lobe of male genital capsule about 1.3 times as long as wide.
quadricornum Robinson
Body shape elongate; vertex and pronotum at most moderately coarsely punctured; vague circular postmedian elytral spot confined to posterior third of elytron; lateral lobe of male genital capsule about 1.8 times as long as wide . . . . **elongatum**, new species
8. Elytron with slightly postmedian black spot which is separated by approximately its own width from both the black sutural stripe and the lateral margin. 9
Elytron with distal black area which is confluent with apical half of either sutural stripe, or with lateral margin, or with both 10
9. Elytral spot almost circular; black border at posterior of pronotum usually extended forward at the midline, making a spikelike pattern; pronotal declivity coarsely punctate only in apical half.
biplagiatum Dawson and McColloch
Elytral spot almost twice as long as wide; basal black border of pronotum not projecting forward at midline; pronotal declivity with at least the apical two-thirds coarsely punctate . . . . **confusum** Brown
10. Lateral margin of elytron in front of distal black area with at least a faint black band extending forward to the humeral angle 11
Lateral margin of elytron in front of distal black area without any black markings (Arizona and México) . . . **pusillum townesi**, new subspecies
11. Vertex of head closely covered with coarse punctures; second elytral stria very feeble, but evident 12
Vertex of head sparsely covered with fine punctures; second elytral stria absent . . . . **lepidissimum** Brown

12. Lateral lobes of genital capsule of male deflexed at apices to form hooks; in the female the distal black area of elytron is usually confluent only with sutural stripe and not with the black marginal stripe; general form often somewhat elongate (Georgia and Florida) . . . . . . **hamatum** Brown

Lateral lobes of genital capsule of male elongate, not deflexed; in the female the distal black area is usually confluent with both sutural stripe and black marginal stripe; general form oval . . . . **farctum** (Fabricius)

To my knowledge, only two larvae in this genus have been collected. One larva was described by Ritcher (1947, pp. 11, 12) and tentatively identified as *tumefactum*. The second, procured by Ritcher and myself, is the larva of *farctum*. The two larvae are so close morphologically that I doubt that there is a specific difference.

If the larvae do represent two species, they may be separated by the following characteristic of doubtful constancy.

Labrum broadly rounded . . . . **tumefactum**
Labrum truncate (pl. 6, fig. 4) . . . . **farctum**

Bolbocerosoma farctum (Fabricius)

Scarabaeus farctus Fabricius, 1775, p. 14, No. 43; 1781, p. 14, No. 53; 1787, p. 7, No. 56; 1792, p. 22, No. 65.—Herbst, 1789, p. 112, No. 80.—Panzer, 1794, p. 3, No. 8.

Geotrupes farctus (Fabricius) Fabricius, 1798, p. 21, No. 58.

Bolboceras farctus (Fabricius) Kirby, 1818, p. 460.—Klug, 1845, p. 51.

Bolbocerosoma farctum (Fabricius) Schaeffer, 1906, p. 254.—Boucomont, 1911, p. 341.—Dawson and McColloch, 1924, p. 10.—Blatchley, 1928, p. 29 (probably referable to *hamatum*).—Brown, 1928, p. 193.

Scarabaeus cephus Fabricius, 1775, p. 18, No. 64; 1781, p. 19, No. 78; 1787, p. 10, No. 85.—Herbst, 1789, p. 286, No. 177.—Olivier, 1789, genus 3, p. 68.—Palisot de Beauvois, 1805, p. 90, pl. 2b, fig. 5.—Klug, 1845, p. 51.

Length 9 to 13 mm., greatest width 7 to 8 mm.

Dorsum yellow-brown to red-brown, marked with black as follows in male: Eye, vertex, tip of horn, tip of clypeus and eye canthus, transverse pronotal carina, lateral limiting grooves, apical pronotal margin between lateral carinae, band on pronotal base extending laterally no farther than elytral margin, scutellum, sutural intervals, extreme base of elytron, elytral margins, and entire posterior half of elytron forward to subapical umbone. Black area may not extend to subapical umbone in some cases, nor completely suffuse entire posterior portion of elytron, leaving a blackish brown area adjacent to the black margin. Female marked as male; in a few cases the black area of the vague lateral limiting grooves absent. In both sexes ventral portion of head and thorax is yellow to red-brown, with abdomen blackish brown. Foretibia fringed with black. Vortex coarsely, sparsely punctured; punctures of clypeus irregular, dense, and sometimes confluent. Pronotum coarsely, irregularly punctate medially, posterior black area impunctate, lateral portion more finely, closely punctate, more so anteriorly. Minute secondary punctures evenly distributed over pronotum. Declivity of pronotal modification coarsely punctured only in lower half. Scutellum usually with two or three coarse punctures and numerous minute secondary punctures. The second, fifth, and eighth elytral striae almost obsolete, indicated by a few punctures; second stria having 6 to 12 punctures. Punctures in elytral striae separated by about their own diameter; without setae. Epipleuron and elytral margin each bear a row of long setae. Foretibia usually armed with eight teeth on outer margin. Mesosternal prominence in front of middle coxae only slightly elevated, above metasternal plane. Hair of underside moderately long and dense.

Head of male having a tubercle formed by anterior margin of each eye canthus and one on the median anterior margin of clypeus. Horn in center of vertex pronounced, almost twice as long as tubercle of clypeus and usually slightly bifid at tip (except in worn specimens). Head of female lacking the tubercles on eye canthi and clypeus. Horn of vertex replaced by transverse carina in front of eyes. The carina higher in center with two vague elevations and ending in a small tubercle on each side (usually not noticeable in worn specimens). Pronotal modification of male with transverse carina feebly emarginate. Lateral limiting grooves shallow, lateral carinae small. In the female the transverse carina is slightly developed and evenly arcuate, highest at the midline. The lateral carinae and limiting grooves only barely indicated.

Genital capsule of male elongate, lateral lobes lobate basally, almost three times as long as wide, tipped with a number of long setae (pl. 3, fig. 3).

Variation is mainly evident in the black area of the elytra. Usually the black area covers at least half the area of each elytron, but in a few cases the area may be reduced to vague black spots barely confluent with the sutural and marginal stripes, and then only in anterior portions.

Bolbocerosoma farctum is a wide-ranging eastern species, nowhere common. Other than an occasional reference to its occurrence in local lists of species, nothing has been published on its biology.

In North Carolina the species has been collected in some areas of the mountains, the piedmont plateau, and two localities on the coastal plain. In the localities where I have collected specimens the immediate vicinity has been rather sandy. Specimens have been taken in February, April, May, June, July, August, September, and October, indicating a long period of adult activity. At Oxford, N. C., several light traps were run by the Tobacco Experiment Station for much of the summer, and between Aug. 2–13, 1951, 12 specimens of *farctum* were taken in the traps. After mid-August, no other specimens were taken. This might indicate a long period of burrowing activity from February to October, but a relatively short time for above-ground activity, in which specimens would come to light. However, an occasional specimen may be taken at light on any warm summer night.

While the adults were fairly commonly collected at light at Oxford, I was never able to locate burrows in the neighboring pasture or woodland. Attempts to make the adults oviposit in cages were completely unsuccessful, and it was only by chance that any information concerning the larval habits was obtained.

In a small, rather open pine woods on the inner coastal plain at Faison, N. C., P. O. Ritcher and I located a colony of *Bolboceras* (formerly *Odontaeus*) *darlingtoni* (Wallis). While digging up this species, larval cells of *Geotrupes blackburnii* were found. Over a period of a month, in two areas about 20 feet apart, we did considerable digging for these species, disturbing a large amount of surface soil. In these areas most of the ground vegetation had been killed or pulled up. In one spot that had been disturbed a month previously, a fresh burrow was noted on Sept. 4, 1951, and dug up. The burrow, containing a female *farctum*, was almost vertical with a plug of yellow sand at its opening, which was at the center of a typical push-up. About 14 inches below the ground surface the female had the burrow packed with very finely divided, black surface humus mixed with sand. As this was the same material that *Bolboceras darlingtoni* (Wallis) had been noted to provision for its larva, a very careful examination of the material was made, but with no results.

A further examination of the entire area was made on September 4, but no additional burrows were discovered until September 11 when a fresh burrow was noted and marked with a stake. This burrow was not disturbed until Oct. 31, 1951, when it was carefully excavated.

The burrow itself was at the edge of an old dirt road that ran through the area (pl. 16, figs. 1, 2). Vegetation was rather sparse in the sandy soil, but the immediate area had not been disturbed by previous digging. Partial shade was afforded by a single loblolly pine, and there were a few clumps of *Andropogon*. Other than that the ground was bare. The entrance of the burrow was marked by the usual push-up, a mound of yellow sand 3 to 4 inches in diameter and about 2 inches high. When the burrow was excavated the rain had almost obliterated the push-up and burrow entrance.

The vertical burrow (diagrammed on pl. 10, fig. 3) was open 8 inches. It then was filled with sand that was slightly darker than the sand of the surrounding subsoil. This portion continued to a depth of 16 inches and was slightly sinuate, but generally vertical. At the 16-inch level all trace of the burrow was lost, but digging was continued. At 18 inches the burrow suddenly reappeared, this time filled with very finely divided, black surface humus and sand. The burrow was no longer vertical, having veered to one side at an angle of approximately 40 degrees. Also, the subsoil had suddenly become considerably damper. The portion of the burrow packed with the black humus was slightly over 3 inches long, going to a depth of 22 inches. In its slightly tapered lower end was a fully grown third-stage larva. The larva appeared to be in an oval pupal cell, 17 by 10 mm. at its widest point, and within one-half inch of the lower end of the burrow. The position of the pupal cell can be noted in the diagram (pl. 10, fig. 3). Plate 13, figure 2, shows the larva as it was found in the burrow. Most of the black humus in the burrow, about 60 mm. of it, had been in large part consumed, being replaced by very small, scattered, dry, black fecal pellets. The food cell (pl. 13, fig. 2), even though largely consumed, had the same general appearance as the unconsumed humus noted in the burrow dug on Sept. 4, 1951. The larva was immediately preserved and is subsequently described. It is evident that the larva of *farctum*, as in other Geotrupinae, has a rapid development. The burrow was made between Sept. 4–11, 1951, and the full grown larva was found on October 31; this indicates a maximum period of development of slightly under two months.

On the same date, Oct. 31, two other fresh burrows were discovered. The first burrow, largely concealed by a covering of dead oak leaves, was in a rather shaded spot. The burrow yielded a single, newly emerged female at a depth of 14 inches. The excavation of the second burrow produced a slightly teneral male at a depth of 11 inches. Both specimens, apparently newly transformed, were making fresh burrows, but no evidence of any old burrows could be found.

Further careful search of the area and subsequent visits in 1951 and 1952 did not yield further specimens.

The following description of the larva of *Bolbocerosoma farctum* is based on one third-stage larva collected Oct. 31, 1951, at Faison, N. C., by H. Howden and P. O. Ritcher, from a burrow previously marked.

The larva differs from Ritcher's (1947, pp. 11, 12) description of *Bolbocerosoma* in the following respects: Maximum width of head capsule 3.4 mm. Antennae (pl. 6, fig. 2) and head capsule almost identical except for an additional exterior frontal seta on one side (making the number 2 or 3), and 4 to 6 anterior frontal setae. Labrum entire, truncate (pl. 6, fig. 4), width 2½ times greater than length. Mandibles, maxillae, hypopharynx, and glossa not varying in any particular from Ritcher's description. Tormae of epipharynx (pl. 6, fig. 4) not united mesally, each with a pternotorma, on the inside of which are found 3 to 5 sensilla. Otherwise epipharynx is similar.

Morphological characteristics of spiracles, body (pl. 13, fig. 1), and legs do not vary from Ritcher's description.

The single unassociated larva which Ritcher described was collected at Dover, Del., October–November 1941. Ritcher believed it was probably the larva of *Bolbocerosoma tumefactum* as it is the common species in that area. However, the larva upon which Ritcher based his description was compared with the Faison specimen of *B. farctum* and was found to be almost identical. The few differences noted, with the possible exception of the truncate labrum, could very easily be normal variation within a species. In *Bolboceras* (and perhaps *Eucanthus*) the known larvae show a number of interspecific differences, and I would suspect this to be true in *Bolbocerosoma*. Certainly, more information is needed concerning the larvae of this interesting group.

Specimens examined: 93 males, 89 females.

CONNECTICUT: 1 female. Bridgeport; (1) July.
DISTRICT OF COLUMBIA: 3 females. Rock Creek; (2) July, (1) August.
GEORGIA: 3 females. Atlanta, Thomasville (?), (2) September.
KENTUCKY: 1 male. Eden; (1) July.
LOUISIANA: 2 males, 2 females. Baton Rouge, Covington, Shreveport; (1) April, (2) March.
MARYLAND: 4 males, 7 females. Cabin John (Burning Tree Golf Links), Chevy Chase, Edgewood, Plum Point, Towson; (7) June, (1) July, (1) August, (1) September, (1) October.
MISSISSIPPI: 7 males, 3 females. Camp Shelby, Harrison County, Leakesville, Lucedale, Starkville; (1) April, (2) May, (1) June, (1) July, (1) September, (2) October.
NEW JERSEY: 20 males, 21 females. Merchantville, Newark, Rancocas; (2) June, (2) July, (24) August, (10) September, (1) October.
NEW YORK: 6 males, 6 females. Babylon, Cold Spring Harbor, Flushing, Southold, West Point; (2) August.
NORTH CAROLINA: 25 males, 14 females. Asheville, Faison, Hickory, Hillsboro, Julian, Monroe, Oxford, Raleigh; (1) February, (2) April, (6) May, (3) June, (4) July, (18) August, (2) September, (2) October.
OHIO: 1 female. No data.
PENNSYLVANIA: 3 males, 4 females. Delaware County, Frankford, Germantown, Glen Olden, Jeannette; (1) April, (2) July, (1) October.
SOUTH CAROLINA: 20 males, 9 females. Chesterfield, Clemson College, Greenville, Jocassee, Oconee County, Rocky Bottom, Table Rock, Tunnel Walhalla; (1) May, (1) June, (14) July, (13) August.
TENNESSEE: 3 males, 6 females. Clarksville, Deer Lodge; (7) July.
VIRGINIA: 2 males, 8 females. Falls Church, Fredericksburg, Herndon, Nelson County; (1) May, (1) June, (1) July, (8) August, (1) October.
WEST VIRGINIA: 1 female, White Sulphur Springs; (1) August.

***Bolbocerosoma confusum* Brown**

Bolbocerosoma confusum Brown, 1928, p. 194. Type, male, Oklahoma (CC).

Length 10 to 12 mm., greatest width 7 to 8.5 mm.

Dorsum reddish brown, marked with black as follows in male: Vertex and at least part of the clypeus, eyes, eye canthi, apical pronotal margin between lateral carinae, all of pronotal declivity except at midline, lateral limiting grooves, band on pronotal base not extending forward at midline and extending laterally no farther than elytral margin, scutellum, sutural intervals, extreme base of elytron, usually apical half of elytral margin, and an oval spot. Oval spot slightly postmedian, parallel to the striae, extending from fourth to eighth elytral striae, almost twice as long as wide (figured by Brown). Spot is not confluent with any other black area, and is not vague in outline. Female marked as male. In both sexes ventral thoracic sclerites and legs except femora in part, blackish; abdomen brown or brownish yellow. Vertex coarsely, somewhat sparsely punctate; punctures of clypeus slightly irregular, dense, generally not confluent. Pronotum coarsely, moderately, irregularly punctate medially, punctures becoming fine, close laterally. Minute secondary punctures evenly distributed over pronotum. Lower half or two-thirds of declivity of pronotal modification coarsely punctured. Scutellum, usually with only minute secondary punctures. The second, fifth, and eighth elytral striae obsolete, indicated by a few punctures. Second stria indicated by 8 to 10 punctures, fifth and eighth striae slightly more pronounced. Punctures in striae moderate, usually separated by distance of about 1.5 times their diameter, without setae. Epipleuron with a few long and numerous short setae. Margin of elytron with only a very few long setae and a number of minute ones. Mesosternal prominence in front of middle coxae slightly elevated above plane of metasternum. Hair of underside long and moderately dense.

Head of male with tubercles on eye canthi and clypeus small. Horn in center of vertex moderate, slightly smaller than in *B. farctum* Fabricius, slightly bifid at tip (except in worn specimens). Head of female lacks tubercle, but has carina similar to females of *farctum*. Pronotal modification of male with transverse carina feebly emarginate. Lateral limiting grooves shallow to moderate, lateral carinae small. In the female the transverse carina less developed and evenly arcuate. The lateral carinae and limiting grooves only barely indicated.

Genital capsule of male somewhat elongate, lateral lobes approximately twice as long as wide, apical angle less prolonged than in *B. farctum*, tipped with a few long setae (figured by Brown).

Variation in elytral maculation is moderate; the oblong spot is fairly uniform, but the elytral margins may or may not be marked with black. *B. confusum* may be distinguished from other species having elytral spots by the absence of a median forward dentiform projection of the posterior pronotal black area and by the lack of any setae in the elytral punctures, except for a few seta-bearing punctures at the margin and on the epipleuron.

Biologically, little is known about this species. Brown (1928, p. 192) mentions collecting *B. confusum* in a mixed aggregation with *B. biplagiatum.* Occasional specimens have been collected at light, indicating at least some nocturnal activity. From the label data on specimens examined, the adults appear to be active during March, April, May, August, September, October, and November, with the fall months being the period of greatest activity.

Specimens examined: 27 males, 22 females.

ARKANSAS: 10 males, 6 females. Fayetteville, Hope, Imboden, Washington County: (2) August, (1) September, (4) October, (2) November.

ILLINOIS: 2 males, 1 female. Olney.

IOWA: 1 male. Ames. Paratype, from literature.

LOUISIANA: 2 males, 2 females. Camp Claiborne, Lafayette, Opelousas; (1) October.

MISSOURI: 2 males, 2 females. Columbia, Scott County, Springfield; (1) May, (3) November.

OKLAHOMA: 4 males, 4 females. Payne County, Stillwater; (1) May, (1) September, (4) October.

TEXAS: 6 males, 7 females. Brazos County, College Station, Dallas County, Rockwall; (2) March, (1) April, (1) May, (1) September, (2) November.

Bolbocerosoma tumefactum (Palisot de Beauvois)

Scarabaeus tumefactus Palisot de Beauvois, 1805, p. 91, pl. 2, fig. 6.

Bolboceras tumefactus (Palisot de Beauvois) Klug, 1845, p. 50.

Bolbocerosoma tumefactum (Palisot de Beauvois) Schaeffer, 1906, p. 254.—Dawson and McColloch, 1924, p. 13.—Brown, 1928, p. 193.—Ritcher, 1947, pp. 11–12.

Length 8 to 11 mm., greatest width 5.5 to 8 mm.

Dorsum orange-brown to red-brown, marked with black as follows in male: Eye, eye canthus, vertex, tubercles, horn, usually most of clypeus, tips of carinae of pronotal modification, basal portion of lateral limiting grooves, apical pronotal margin between lateral carinae, median spot behind pronotal modification, narrow band widest medially, extending laterally no farther than elytral margin, scutellum, extreme base of elytra, elytral margin, sutural intervals, and postmedian spot normally confluent only with elytral margin. Postmedian spot in a few instances touching black sutural interval in posterior third. In females, the only black pronotal markings may be medial pronotal spot behind the transverse carina, or in some cases the spot is produced into a broad band running the length of the pronotum; otherwise markings are similar to male. Ventral portions of thorax and abdomen brownish yellow. Tibia reddish brown to black. Vertex and clypeus densely, coarsely, irregularly punctured, least in posterior portion of vertex, more so on clypeus. Pronotum coarsely, irregularly punctate medially, lateral portions more finely, closely punctured, more so anteriorly. Minute secondary punctures evenly distributed over pronotum. Declivity of pronotal modification coarsely punctured mainly in lower half, but with a few punctures scattered over entire face in some cases. Scutellum with vague, median indentation running its length and with minute secondary punctures. All elytral striae well developed except basal portion of eighth. Poorly delimited punctures usually separated by slightly less than own diameter, closer together than in *farctum.* Elytron without setae, except epipleuron and elytral margin each bearing a row of long setae. Foretibia armed with seven or eight teeth on outer margin. Mesosternal prominence in front of middle coxae well developed, only slightly concave on anterior face, elevated above mesosternal plane.

Head of males with tubercles moderate, horn well developed, not generally bifid at tip. In male, pronotal modification well developed; pronounced transverse carina moderately emarginate, scarcely wider than upper portion of lateral limiting groove, much narrower than in *B. bruneri.* Lateral carinae and limiting grooves well developed. In female transverse carina small and evenly arcuate, lateral carinae and limiting grooves obsolete.

Genital capsule of male (pl. 3, fig. 1) moderately elongate, not lobate basally, tip of lateral lobe rounded, not prolonged as in *B. farctum,* similar to *B. bruneri.*

One of the most variable species of *Bolbocerosoma* in extent of the black markings, it is still easily distinguished by the median black pronotal spot or stripe, the well developed elytral striae, and usually by the postmedian black spot confluent with elytral margin, but not with sutural interval.

Bolbocerosoma tumefactum, the most common northeastern species, is particularly abundant in some areas of New Jersey, Maryland, and Pennsylvania, where on occasion it has been found burrowing in golf courses to such an extent that it was considered a pest.

The species is active from May until October, with the majority of specimens being collected in July and August. A few specimens were collected at light, indicating some nocturnal surface activity. Sim (1930, pp. 139–147) mentioned collecting many specimens near

Rancocas, N. J. They were commonly taken at the golf course and along old sandy roadways which were not too well shaded. This was the same type of habitat where Sim also found *Bolboceras* and *Eucanthus*. Between Aug. 21 and Oct. 3, 1927, in this locality, Sim was able to collect 75 specimens of *tumefactum*.

In North Carolina, South Carolina, and Georgia, *tumefactum* appears to be limited to the mountains and upper piedmont regions, while in more northern states it can be found on the sandy coastal plain.

Nothing is known of the larval food or habits.

Ritcher (1947, pp. 11, 12) described a single larva of *Bolbocerosoma tumefactum* collected near Dover, Del. I have already expressed doubt over the specific value of the vague differences between this larva and that of *farctum*. However, the broadly rounded labrum may be a consistent difference. Additional larvae are needed to decide the limitations of intraspecific variation.

Specimens examined: 96 males, 111 females.

CONNECTICUT: 2 males, 2 females. East Norwalk, Hamden, Hartford; (2) June, (2) July.

DELAWARE: 1 male. No data.

DISTRICT OF COLUMBIA: 1 male, 2 females. Rock Creek; (2) June.

GEORGIA: 2 females. Blue Mountain (Towns County); (1) August.

MARYLAND: 19 males, 23 females. Bryantown, Cabin John (Burning Tree Golf Links), College Park, Glen Echo, Mountain Lake Park, Sandy Springs, T. B. Junction; (8) May, (28) June, (2) July, (1) September, (1) October.

MASSACHUSETTS: 3 females. Amherst; (3) June.

NEW HAMPSHIRE: 1 female. Lyme; (1) June.

NEW JERSEY: 9 males, 15 females. Alpine, Hewitt, Hopatcong, Newark, Passaic, Paterson, Ramsey, Rancocas, Westwood; (2) June, (3) July, (10) August, (5) September.

NEW YORK: 5 males, 2 females. Babylon, Cold Spring Harbor, Farmingdale, Flushing, New York City, Pelham; (3) June, (3) July, (1) August.

NORTH CAROLINA: 15 males, 19 females. Balsam, Black Mountains, Blowing Rock, Cranberry, Marion, Raleigh, Sunburst, Waynesville; (9) June, (8) July, (11) August, (3) September.

OHIO: 2 males. Holmes County, Springfield (Muskingum County); (1) June, (1) September.

PENNSYLVANIA: 25 males, 20 females. Allegheny County, Angora, Aspinwall, Broomall, Chester County, Clarkes Valley, Delaware County, Downington (=Downingtown?), Germantown, Green Lane, Harrisburg, Jeannette, Lebanon County, Lehigh Gap, Nicktown, Philadelphia, Pittsburgh, Somerset County, Springfield, Swarthmore, Water Gap, "Westtown Sch.," Windgap; (1) May, (7) June, (13) July, (5) August, (1) September.

SOUTH CAROLINA: 5 males, 6 females. Kings Creek (Oconee County), Oconee County, River Falls, Rocky Bottom, Sassafras Mountain, Tunnel Walhalla; (2) June, (4) July, (3) August, (2) September.

VIRGINIA: 7 males, 9 females. Cobham, Falls Church, Glen Lyn, Middletown, Mountain Lake Biological Station (Giles County), Nelson County, Warrenton; (1) May, (2) June, (5) July, (5) August, (1) September.

WEST VIRGINIA: 5 males, 7 females. Beckley, Lewisburg, White Sulphur Springs; (9) July, (2) August.

Bolbocerosoma bruneri Dawson and McColloch

Bolbocersoma bruneri Dawson and McColloch, 1924, p. 14 (type, male, Nebraska (UnNeb)).—Dawson, 1922, p. 194.—Brown, 1928, pp. 192–193.
Bolbocerosoma farctum Blatchley (not Fabricius), 1910, p. 937.

Length 8.5 to 14.5 mm., greatest width 6.5 to 9.5 mm.

Dorsum yellow to reddish brown, marked with black as follows in male: Eyes, vertex of canthus, tubercles, horn, part of clypeus, tips of tubercles of pronotal modification, lateral limiting grooves, apical pronotal margin between lateral carinae, band on pronotal base extending laterally no farther than elytral margin, scutellum, extreme base of elytra, sutural stripe, margin of elytra below humeri extending in a few cases to apex and large posterior spot confluent with sutural stripe. Posterior spot usually not confluent with elytral margin except at apex. Female marked as male except the only black on pronotal modification is trace along transverse carina. In both sexes ventral surface reddish brown, slightly darker on abdomen. Tibia edged with dark brown. Vertex and clypeus coarsely and densely punctured. Pronotum coarsely, irregularly punctate medially, more so than in either *farctum* or *tumefactum.* Lateral portion of pronotum more finely, closely punctate, more so anteriorly. Minute secondary punctures evenly, rather densely distributed over pronotum. Declivity of pronotal modification coarsely punctured only in lower half. Scutellum with numerous secondary punctures. All elytral striae well developed, except basal portion of eighth. Punctures in elytral striae separated by about one-half their diameter, without setae. Epipleuron and elytral margin each bear a row of long setae. Foretibia usually armed with eight teeth on outer margin, sometimes with seven or nine. Mesosternal prominence in front of middle coxae well developed, concave on anterior face and elevated above metasternal plane. Hair of underside long, not dense.

Head of male with pronounced tubercles and horn, not bifid at tip. In male, pronotal modification well developed. Pronounced transverse carina widely emarginate, more so than in *tumefactum.* Lateral limiting grooves deep, lateral carinae moderate. In female, transverse carinae small, evenly arcuate. Lateral limiting grooves and lateral carina obsolete.

Genital capsule of male (figured by Brown) moderately elongate, not lobate basally, tip of lateral lobe rounded, not prolonged as in *B. farctum.* Similar to *B. tumefactum.*

Variation of pattern is quite pronounced, clypeus either entirely black or brown. One-third to one-half of the posterior portion of elytra is black, and elytral margin may be entirely black or brown.

Despite variation the species is easily recognized by the well developed striae and the lack of the median pronotal spot or band present in *tumefactum*.

Bolbocerosoma bruneri is the common midwestern species of *Bolbocerosoma*, apparently taking the place of the closely related common northeastern species *tumefactum*.

The habits of the species appear in general to be similar to other species in the genus. Brown (1927, p. 27) found them making burrows 4 to 18 inches deep in pastures and old roads where the soil was rather sandy. His observations were made in Payne County, Okla., where that species was rather uncommon, being collected only in June and October.

Later, Brown (1928, p. 192) mentions that the species is nocturnal and colonial, often being found in an aggregation containing several species of *Bolbocerosoma*, and sometimes other Geotrupinae.

In other localities, particularly in Illinois and Iowa, the species is active from April until November, being most often collected in June, July, and August. A number of the specimens examined were collected at light, but this fact adds little to the biological knowledge of the species.

To my knowledge, no accurate observations of an adult *Bolbocerosoma* feeding have been made. Mohr (1930, p. 265) seems to infer (in my opinion, incorrectly) that *bruneri* feeds on dung. He conducted a study of the morphology of the forelegs and mouthparts, and, because of their structure rather than on biological observation, included *B. bruneri* with the dung feeders.

Little else is known about the habits of this species; the larva has never been described.

Specimens examined: 145 males, 130 females.

CANADA

MANITOBA: 1 male. Woburn.

UNITED STATES

ARKANSAS: 4 females. Imboden.

ILLINOIS: 37 males, 29 females. Algonquin, Carthage, Chicago, Cook County, De Kalb County, Homer, Kankakee, Lacon, Lake Forest, Ogle County, Olive Branch, Olney, Pittsfield, Putnam County, Quincy, Rogers Park, Springfield, Urbana, West Northfield, Willow Springs; (1) April, (2) May, (6) June, (2) July, (5) August, (4) September, (2) October, (1) November.

INDIANA: 4 males, 4 females. Bedford, Beverly Shores, Knox County, Michigan City, Vincennes; (1) May, (4) June, (3) July.

IOWA: 35 males, 35 females. Ames, Cedar Rapids, Cherokee, Clear Lake, Clermont, "Counties #3, #87, #89, #94," Crawford County, Dallas County, Davis County, Delaware County, Elma, Iowa City, Moulton, Mount Pleasant, Randolph, Union County; (3) May, (11) June, (15) July, (9) August, (4) September, (8) October.

KANSAS: 17 males, 9 females. Atchison County, Douglas County, Fort Leavenworth, Johnson County, Lawrence, Manhattan, Onaga, Wallace County, west Kansas; (2) June, (3) July, (2) August (3) September,

KENTUCKY: 8 males, 11 females. Lexington, Louisville, Nicholasville, Paris, Princetown, Sadieville; (3) May, (1) June, (3) July, (3) August, (5) September, (2) October.

MICHIGAN: 2 males, 4 females. Detroit, Livingston County, Macatawa Beach; (1) May, (1) July.

MINNESOTA: 5 males, 3 females. Fort Snelling, Minneapolis, Red Wing, St. Paul; (1) June, (1) July.

MISSOURI: 12 males, 8 females. Affton, Columbia, Kirkwood, New Hartford, St. Louis, Springfield, Willard; (2) May, (4) June, (4) July, (2) August, (2) October.

NEBRASKA: 2 males, 4 females. Bennet, Lincoln, Malcolm, Norfolk; (2) June, (1) September.

NEW MEXICO: 1 male. No data.

OHIO: 4 males, 2 females. Columbus, Pickaway County; (1) June.

OKLAHOMA: 1 male. Wichita National Forest; (1) June.

SOUTH DAKOTA: 5 males, 3 females. Elk Point, Interia (Stanley County), Volga; (1) June, (1) August.

TEXAS: 2 males, 3 females. Fedor.

WISCONSIN: 8 males, 10 females. Gays Mills, Madison, Milwaukee, Neillsville, Oshkosh, Racine; (1) April, (2) May, (9) June, (1) July, (1) August, (2) September, (1) October.

WYOMING: 1 male, 1 female. Bridger Basin.

Bolbocerosoma hamatum Brown

Bolbocerosoma hamatum Brown, 1929, p. 213. Type, male, Georgia (CU).

Length 10 to 11 mm.; greatest width 7 to 8 mm.

Dorsum reddish brown, male marked with black as follows: Vertex, eye canthi, margin of clypeus, tubercles and limiting concavities of pronotal carina, entire anterior margin of pronotum, broad band on pronotal base between the elytral humeri, scutellum, extreme base of elytra except the humeri, sutural intervals, and about two-thirds of each elytron with an area extending from humerus and sutural interval at basal fourth to apex, not including the apical umbone; ventral surfaces light orange-yellow; outer margin of tibia blackish brown. Female with markings similar to male, except on the elytron where the large posterior black elytral markings are only vaguely confluent with black elytral margin; a thin brownish red band running just above elytral margin nearly to apex. Vertex coarsely, sparsely punctured, punctures of clypeus irregular, dense, sometimes confluent. Pronotum rather heavily, coarsely, irregularly punctured medially, posterior black area lacking punctures except at anterior edge, lateral portions of pronotum with punctures becoming finer, dense and feebly impressed, more so anteriorly. Minute secondary punctures evenly distributed over pronotum. Declivity of pronotal modification coarsely, indistinctly, and sparsely punctured only in lower half.

Scutellum with small coarse punctures present, but vague. Second elytral stria obsolete, represented basally by four or five fine and very feeble punctures. Fifth and eighth striae obsolete, represented by a vague row of fine punctures; the five well-developed striae between suture and humeral umbone deep and coarsely punctured, dorsally without hairs. Punctures separated by slightly more than their diameter. Epipleuron and elytral margin each bear a row of setae. Foretibia usually armed with eight or nine teeth on outer margin. Mesosternal prominence in front of middle coxae acute, not elevated above the plane of the metasternum. Hair of underside not dense.

Head of both sexes similar to that of *Bolbocerosoma farctum* Fabricius. The transverse carina of female with only a trace of the small lateral tubercle. Pronotal modification of male poorly developed; the carina somewhat emarginate medially, the tubercle at each end very small and vague. Pronotal disk of holotype with a broad, rather feeble, but distinct depression on each side midway between the pronotal modification and humeral umbone of elytron. This depression is lacking in some of the other specimens examined. In the female the carina is evenly arcuate, with lateral carinae obsolete, barely indicated by slight swellings.

Genital capsule of male short, lateral lobes no longer than wide. The distinctive characteristic of the species is the lateral lobes of the genitalia which are deflexed at their apices to form hooks. (Figured by Brown.)

Variation was slight in the few specimens examined. The pronotal depressions do not appear too consistent, but the pattern seems fairly constant, with the large black area of the elytron usually separated in the females from the black elytral margin except at the apex.

B. hamatum was probably the species mentioned in Blatchley (1928, p. 29) as *farctum:* Collected at "Gainesville, one, July 30, flying over grass of wet prairie; one, Aug. 3, beneath loose bark of pine (Doz.)" (Dozier, 1920). From the data on the few specimens examined, the adults appear to be active for a large part of the year.

Specimens examined: 5 males, 6 females.

FLORIDA: 1 male, no date (Robinson). 1 female, no date (MCZ). 1 male, 2 females, Gainesville, Apr. 6 and Oct. 5, 1935, Young (UnMich). 1 female, Kissimmee (Cartwright). 1 male, Lakeland, Sept. 11, 1919 (Robinson). 1 female, St. Augustine, Liebeck Collection (Fall at MCZ). 1 male, Steinhatchee River, April (AMNH).

GEORGIA: 1 male (holotype 1578), Billy's Island, Okefenokee Swamp (CU). 1 female, Chickamauga, June 26, 1898, Viereck (USNM).

Bolbocerosoma lepidissimum Brown

Bolbocerosoma lepidissimum Brown, 1928, p. 193. Type, male, Oklahoma (CC).

Length 8.5 to 11 mm., greatest width 6 to 7.5 mm.

Dorsum pale brownish yellow to light reddish brown, marked with brown to black as follows in male: Eye, vertex, tip of horn, tips of clypeus and eye canthus, lateral portions of transverse pronotal carina, lower half to two-thirds of lateral limiting groove, narrow line on apical pronotal margin, between lateral carinae, band on pronotal base extending laterally no farther than elytral margin, scutellum, sutural intervals, extreme base of elytron except humerus, elytral margins and posterior half to two-thirds of elytron from sutural interval to elytral margin but not including the subapical umbone. Small spot at apex of elytron usually not blackish. Punctures in elytral striae often noticeably blackish in color. Female similarly marked. In both sexes ventral portion of head and thorax yellow to reddish yellow, abdomen brownish yellow to brown. Outer margin of at least foretibia edged with black. Vertex of male finely, sparsely punctured; punctures of clypeus rather coarse and close, but not well defined. Coarse medial punctures of pronotum very sparse, becoming slightly smaller and more dense laterally; posterior black area impunctate. Minute, indistinct secondary punctures evenly distributed over pronotum. Declivity of pronotal modification sparsely, coarsely punctured only in lower third or half. Scutellum with minute secondary punctures. Punctures of female (from Brown): Head densely, rather coarsely punctate; a space on the vertex smoother; pronotum at middle very sparsely, irregularly punctate; the punctation of the sides finer and dense; the declivity with moderately close, coarse punctures on apical half, the basal half very finely punctate. Second elytral striae entirely lacking, fifth and eighth striae not impressed, represented by only a few small punctures. Pronounced punctures in elytral striae separated by slightly more than their diameter, without setae. Epipleuron and elytral margin each bear a row of long setae. Foretibia armed with eight teeth on outer margin. Mesosternal prominence in front of middle coxae acute, elevated slightly above metasternum. Hair of underside fairly long and moderately dense.

In male, the tubercles of clypeus and eye canthi similar to those of *B. farctum*, slightly thinner dorsoventrally. Horn in center of vertex pronounced, noticeably smaller in width than *B. farctum*, usually slightly bifid at tip (when not worn). Female lacking horn and tubercles, but with carina similar to female of *B. farctum*. Pronotal modification of male with transverse carina feebly emarginate. Lateral limiting grooves very shallow, lateral carina only vaguely indicated. Brown states that the pronotal modification of female is of usual type, not strongly developed, the limiting concavities and tubercles obsolete.

Genital capsule of male (figured by Brown) blunt, lateral lobe 1.5 times as long as wide, tipped with a number of very long setae, a few being almost as long as the capsule.

Variation of color was quite pronounced in the few specimens examined, one specimen with light yellowish tan markings, and another with the markings almost black. Generally all of the specimens have a faded appearance.

The complete lack of second elytral stria, the sparse punctures, the male genitalia, and usually the color will distinguish this species.

Brown (1928, p. 192) mentions finding *lepidissimum* with *bruneri* and *biplagiatum*, presumably with the same nocturnal and burrowing habits as the other species. Nocturnal activity is also indicated by one of the few specimens examined bearing the label "at light." Specimens, to date, have only been collected in June and July but probably have a longer period of adult activity.

Specimens examined: 3 males, 1 female.

ARKANSAS: 1 male, Washington County, July 18, 1928 (INHS).
ILLINOIS: 1 male, Anna, June 27, 1909, at light (Howden).
LOUISIANA: 1 male, Vernon Park (AMNH).
OKLAHOMA: (Type and allotype, from literature, Payne County, October, Brown (CC).)
TEXAS: 1 female, Marathon (Brewster County) (Robinson).

Bolbocerosoma biplagiatum Dawson and McColloch

Bolbocerosoma biplagiatum Dawson and McColloch, 1924, p. 12 (type, male, Nebraska (UnNeb)).—Dawson, 1922, p. 194.—Brown, 1928, p. 193.

Length 8.5 to 13.5 mm., greatest width 6.5 to 9 mm.

Dorsum orange-brown to red-brown, marked with black as follows in male: Vertex, most of clypeus, eyes, eye canthi, apical pronotal margin between lateral carinae, lateral limiting grooves, lateral portions of transverse carina, lateral portions of pronotal declivity, band on pronotal base extending sharply forward at midline (dentiform point), and extending laterally no farther than elytral margin, scutellum, extreme base of elytra, sutural intervals, and a small almost circular postmedian spot. This spot is usually scarcely longer than wide and is separated from both the sutural interval and elytral margin by about its own width. Female marked as male except the black of the lateral limiting grooves may be lacking. In both sexes the ventral portions of thorax and abdomen dull yellowish brown, some of thoracic sternites may be black; femora dark brown to black. Vertex coarsely, sparsely punctate, less so in females; punctures of clypeus slightly irregular, dense, generally not confluent. Pronotum coarsely, moderately, irregularly punctate medially, punctures becoming fine, close laterally. Minute secondary punctures evenly distributed over pronotum. Lower half of pronotal declivity of male coarsely, sparsely punctured, more heavily and completely punctate in female. Scutellum usually with only minute secondary punctures. The second, fifth, and eighth elytral striae obsolete, indicated by a shallow indentation or a few punctures or both. Second stria indicated by four to eight punctures, fifth and eighth striae slightly more pronounced. Punctures in striae moderate, usually separated by slightly more than their own diameter; without setae. Elytral margin and epipleuron each with a row of moderately long setae and numerous short setae. Metasternal prominence in front of middle coxae small and only slightly elevated above plane of mesosternum. Hair of underside long and moderately dense.

Head of male with tubercles on eye canthi and clypeus moderate to well developed. Horn of vertex long, not bifid at tip. Head of female lacks tubercles and horn, but has carina similar to females of *B. farctum.* Pronotal modification of male moderately to strongly emarginate. Lateral limiting grooves and carinae moderate. In female the transverse carina is less developed and evenly arcuate. The lateral carinae and limiting grooves only barely indicated.

Genital capsule of male short and blunt, about 1.5 times as long as wide, tipped with long setae. Genital capsule is very different from that of *B. confusum*, which is much more elongate.

Variation in the specimens examined is slight. The species can be easily distinguished by the almost circular postmedian elytral spot, the median dentiform point of the black border of posterior pronotal margin, the male genital capsule, and pronounced horn and tubercles of well developed individuals.

B. biplagiatum was mentioned by Brown (1927, p. 27) as occurring with other species in pastures and old sandy roads. He reiterates later (1928, p. 192) that the species is colonial, occurring in mixed colonies with other species.

Adults have been collected occasionally at light and are active from May until October. At no time are they common, but appear to be more numerous in the fall.

Specimens examined: 25 males, 26 females.

KANSAS: 14 males, 14 females. Clark County, Douglas County, Larned, Medora, Norton County, Rush County; (2) May, (2) June, (1) July, (2) August.

NEBRASKA: 1 female. Cambridge; (1) August.

OKLAHOMA: 10 males, 8 females. Payne County, Noble County; (1) May, (1) June, (6) September, (10) October.

TEXAS: 1 male, 3 females. Dallas.

WISCONSIN [Paratype, male, from literature, Trout Lake (Vilas County).]

***Bolbocerosoma pusillum* Dawson and McColloch**

Bolbocerosoma pusillum Dawson and McColloch, 1924, p. 11 (type, male, Kansas (KanStU)).—Dawson, 1922, p. 194.—Brown, 1928, p. 193.

Length 6 to 10 mm., greatest width 4 to 7 mm.

Dorsum reddish brown marked with black as follows in male: Vertex, most of clypeus, eyes, eye canthi, apical pronotal margin between lateral carina, lateral limiting grooves and inner portions of adjacent tubercles of transverse and lateral carinae, band on pronotal base very narrow at midline and extending no farther than elytral margin, scutellum, extreme base of elytra, sutural intervals, and entire apical two-fifths of elytra extending from sutural interval to margin. The black area barely reaches margin, and then usually only in apical fourth. Females marked as male except at pronotal modification where there is only a trace of black along the transverse carina and in lateral limiting grooves. Ventral surface of both sexes reddish brown. Tibia of males edged with trace of black, females with tibia usually entirely brown. Vertex coarsely, moderately punctured, usually more so in female, punctures of clypeus generally regular and dense. Pronotum coarsely, irregularly punctate, lateral portions more finely, closely punctured, more so anteriorly. Minute secondary punctures evenly distributed over pronotum. Declivity of pronotal modification in male coarsely punctured only in lower half, female in some cases with some punctures over entire declivity. Scutellum usually with faint groove running its length, with moderate number of secondary punctures. Second elytral stria obsolete, represented by shallow groove or two or three minute punctures. Fifth and eighth striae indicated by a line of small punctures. Punctures in striae usually not well delimited, generally separated by about their own diameter. Many of elytral punctures and other scattered punctures of elytra and pronotum bearing long erect yellow hairs. Long setae also present on epipleura and elytral margins. Foretibia usually armed with seven teeth on outer margin, but sometimes with eight, rarely six. Mesosternal prominence only slightly developed in front of middle coxae, not elevated above plane of metasternum. Hair of underside long and moderately sparse.

Head of male with tubercles of eye canthi and clypeus pronounced, sharply upturned. Horn in center of vertex long, somewhat conical, tip not bifid. Head of female with suggestion of a tubercle on eye canthus, but none on clypeus. Horn of vertex replaced by a transverse carina which has four small but noticeable tubercles, one at each end of the carina and two slightly more than halfway toward the median line. Pronotal modification of male with the pronounced transverse carina deeply emarginate. Lateral limiting grooves deep, lateral carinae large and elongate. In the female the transverse carina is slightly developed, evenly arcuate. Lateral limiting grooves and lateral carinae barely indicated.

Genital capsule of male blunt (pl. 3, fig. 6), lateral lobe about 1.3 times as long as wide, tipped with a dozen or so long setae.

A moderate amount of variation is present in the extent of the subapical black spot, but it is always confluent with sutural interval, and this coupled with the long erect yellow setae will distinguish the species. The number of setae on the pronotum and elytra vary considerably and sometimes are overlooked on hasty examination.

Nothing has been published on the biology of *pusillum*. Specimens examined were collected from April through November, except during August, indicating a long period of adult activity.

Specimens examined: 25 males, 25 females.

COLORADO: Paratype (from literature), 1 female. No data.
ILLINOIS: 1 male. Chicago (?).
KANSAS: 6 males, 3 females. Manhattan, Onaga, Riley County, Wallace; (2) June, (1) July.
OKLAHOMA: 1 male. Wichita National Forest.
TEXAS: 17 males, 22 females. Abilene, Amarillo, Brownsville, Comfort, Coryell County, Dallas County, Fedor, Liberty Hill, New Braunfels, Val Verde County, Wichita Falls; (2) April, (5) May, (3) June, (1) July, (1) September, (1) November.

Bolbocerosoma pusillum townesi, new subspecies

HOLOTYPE: Male, length 10.5 mm., greatest width 7.2 mm.

Dorsum reddish brown marked with black as follows: Vertex, most of clypeus, eyes, eye canthi, apical pronotal margin between lateral carinae, lateral limiting grooves and inner portions of adjacent tubercles of transverse and lateral carinae, band on pronotal base very narrow at midline, broader laterally and extending no farther than elytral margin, scutellum, extreme base of elytra, sutural intervals, and entire apical two-fifths of elytra extending from sutural interval almost to margin. The black area barely reaches margin of elytra and then only in apical fourth. Ventral surface brownish black. Tibiae brownish black. Vertex coarsely, moderately punctured, punctures of clypeus generally regular and dense. Pronotum coarsely, irregularly punctate, slightly less so than in majority of specimens of *B. pusillum* examined, lateral portions more finely, closely punctured, more so anteriorly. Minute secondary punctures evenly distributed over pronotum. Declivity of pronotal modification coarsely punctured only in lower two-thirds. Scutellum with shallow groove running its length, with moderate number of secondary punctures. Second elytral stria entirely lacking. Fifth and eighth striae indicated only by a line of very small punctures. Punctures in striae not sharply delimited, generally separated by slightly less than their own diameter, and entirely without setae. Epipleuron and elytral margin each bear a row of long setae. Along elytral margin and extending inward no more than 0.5 mm. are a number of small setae; otherwise, elytra and entire dorsal surface of thorax are bare. Mesosternal prominence only slightly developed in front of middle coxae, not elevated above plane of metasternum. Hair of underside moderately long and sparse.

Head with tubercles of eye canthi and clypeus pronounced, sharply upturned. Horn in center of vertex long, scarcely wider near base than at tip, which is not bifid. Pronotal modification with pronounced transverse carina deeply emarginate. Lateral limiting grooves deep, lateral carinae large and elongate.

Genital capsule blunt, lateral lobe about 1.3 times as long as wide. Almost identical to that of *B. pusillum* except that the setae at the tips of the lateral lobes are fewer and shorter than those of *B. pusillum.*

Allotype: female, length 8.5 mm., greatest width 6.1 mm.

Markings similar to holotype except at pronotal modification where there is only a trace of black along the transverse carina and in the lateral limiting grooves. Tibiae brown edged with trace of black. Coarse punctures of pronotum irregular and more numerous than holotype, secondary punctures also more pronounced. Elytral striae and punctures not showing significant variation. Foretibia armed with seven teeth on outer margin.

Head of allotype with suggestion of tubercle on eye canthus, but none on clypeus. Horn of vertex replaced by a transverse carina which has four small but noticeable tubercles, one at each end of the carina and two slightly more than halfway toward the median line. Pronotal modification with the transverse carina slightly developed, evenly arcuate. Lateral limiting grooves and lateral carinae barely indicated.

Holotype, male, St. Johns, Apache County, Ariz., May 28, 1931, (from Barr collection) (USNM 61680). Allotype, female, Brewster County, Tex., August 24, Greene (USNM 61680). Paratypes, male, Clovis, N. Mex., Wickham, August (also paratype of *pusillum* Dawson and McColloch); female, Mesa de la Eucnotada(?), 7,000 ft., Sierra del Carmen, Coahuila, México, July 28, 1938, Baker; female, Valle de Olivos, Chihuahua, México, 5,500 ft., July 20, 1947, D. Rockefeller Expedition, Cazier; female, 5 miles east of Marathon, Brewster County, Tex., 4,100 ft., Sept. 27, 1950, Gertsch and Cazier. Paratypes in the collections of the American Museum of Natural History, O. L. Cartwright, and the writer.

Variation in the six specimens at hand is very slight. Size ranges from 8.5 to 11 mm. in length, 6 to 7.2 mm. in greatest width. Pattern is quite constant. Tibiae of the males are black, those of the females brown. The punctures of the head and thorax are more pronounced in the females than in the males. The obsolete second striae on some of the specimens are represented by two or three very small punctures. Teeth on outer margin of foretibia are either seven or eight in number. Other differences are slight.

This subspecies has almost the identical markings of *pusillum* but can be separated from it by the lack of the long erect yellow hairs on the dorsal surfaces of pronotum and elytra. It may be separated from other species by the blunt genital capsule of the male and by the distal black area which is confluent with the sutural stripe, but which laterally and anteriorly does not extend to the elytral margin.

No biological information other than that contained on the labels is available for this subspecies.

Bolbocerosoma quadricornum Robinson

Bolbocerosoma quadricornum Robinson 1941, p. 132. Type, male, New Braunfels, Comal County, Tex., August, Schaeffer (Robinson).

Length 8.8 to 9 mm., greatest width 6.2 to 6.4 mm.

Dorsum reddish brown marked with black as follows in holotype (male): Vertex, tip of horn, and tubercles, apical pronotal margin between lateral carinae, lateral limiting grooves, and inner portions and tips of adjacent tubercles of transverse and lateral carinae, band on pronotal base very narrow at midline and extending no farther than elytral margin, edges of scutellum, sutural intervals, and a postmedian spot with its forward edge beginning halfway between the base and apex of the elytron and from the fourth stria almost to the margin. Foretibia edged with black. Ventral surface dark orange to almost black. Vertex coarsely, heavily punctured with the punctures of the clypeus regular and dense. Pronotum coarsely, heavily, irregularly punctate, punctures becoming smaller and very dense laterally. Minute secondary punctures scattered evenly over entire pronotum. The declivity of pronotal modification coarsely punctured only on lower (apical) half. Scutellum with a few irregularly placed coarse punctures and numerous fine secondary punctures. Second elytral stria obsolete, represented by only two or three shallow punctures. Fifth and eighth striae indicated by only a few small punctures. Punctures in elytral striae moderately pronounced, usually separated by slightly more than their own diameter. A few of the elytral punctures and other punctures of the elytra and pronotum bearing long erect yellow hairs which are very sparse. Long setae also present on epipleura and elytral margin. Foretibia armed with eight teeth on outer margin. Mesosternal prongs only slightly developed in front of middle coxae, not elevated above plane of metasternum. Hair of underside long and sparse.

Head of holotype with tubercles of eye canthi and clypeus pronounced, sharply upturned; horn in center of vertex long, somewhat conical, tip not bifid. Pronotal modification with the pronounced transverse carina deeply emarginate, lateral limiting grooves deep, lateral carinae large and elongate.

The female of this species is not known.

Genital capsule of male blunt, almost identical to *pusillum*, lateral lobe about 1.3 times as long as wide, tipped with a few long setae.

Variation in this species appears slight in the two specimens seen. Markings are almost identical, but in one specimen the postmedian spot in the elytron begins at the third stria. The carinae of the head and pronotum are slightly less pronounced than in the type.

The species can be distinguished from other species—particularly from *pusillum* to which it is closely allied—by the pronotum heavily punctured, by the rather vague circular elytral spot, separated from the sutural stripe, and by the scutellum with only a black margin, not entirely black as in other species. The presence of long erect hairs on the elytra and pronotum and the shape of the lateral lobes of the genital capsule show extremely close relationship with *pusillum*.

Specimens examined: 2 males.

TEXAS: 2 males. New Braunfels (Comal County), (1) type, August, Schaeffer (Robinson); Comal County (1) (AMNH).

Bolbocerosoma ritcheri, new species

HOLOTYPE: Male, length 8.5 mm., greatest width 6.1 mm.

Dorsum yellow-brown to light red-brown, marked with black as follows: Eyes, eye canthi, tubercles, vertex, horn, clypeus except tubercle, apical pronotal margin between lateral carinae, tips of lateral carinae, lateral portions of transverse carina almost to midline, spot on either side of base of pronotum between outer edge of scutellum and elytral margins, scutellum, extreme base of elytra to humeri and completely around elytral margins, sutural intervals, elytral punctures, and postmedian oblong spot extending from third to ninth striae. The elytral spot is quite similar to that of *B. confusum*. Ventral thoracic sclerites dark brown to black, ventral portions of head and abdomen yellow-brown. Tibia fringed with dark brown, almost no black. Vertex coarsely, moderately, fairly evenly punctured, punctures becoming coarser and slightly more numerous on the clypeus. Pronotum coarsely, irregularly punctate medially, lateral portion more finely, closely punctate, more so anteriorly. Minute secondary punctures evenly distributed over pronotum. Lower half of pronotal declivity heavily punctate. Scutellum is unusual in having on it 10 or more coarse, irregularly placed punctures with no or few minute secondary punctures. Second elytral striae absent, fifth obsolete, represented by 3 to 12 very small punctures, eighth stria represented by a line of 8 to 15 small punctures. A number of punctures on prothorax, scutellum, and elytra bear small erect yellow setae similar to, but about one-third as long as those of *B. pusillum*. The setae are irregularly placed and easily overlooked. They are slightly longer and more dense on elytral margin and epipleuron. The elytral punctures are sharp, well defined, and rather irregularly spaced, being separated by slightly more than their diameter in many places, but in some cases, in the same stria, they may be almost confluent. Foretibia armed with eight teeth on outer margin. Mesosternal prominence in front of middle coxae small, rounded at tip, only slightly elevated above metasternal plane. Hair of underside moderately long and sparse.

Head with tubercles moderate, those of eye canthi sharply upturned. Horn of vertex rather short when viewed from posterior, broadly conical, tip rather pointed, not bifid. Pronotal modification of male with rather narrow, feebly emarginate transverse carina; lateral carinae, and limiting grooves moderate.

Genital capsule of male with lateral lobes blunt, very similar to *B. pusillum*, 1.3 times as long as wide and tipped with 10 long setae (pl. 3, fig. 2).

ALLOTYPE: Female, length 9.5 mm., greatest width 6.8 mm.

Marked as the holotype except that the transverse carina of the pronotum is black for its entire length, while the black is lacking on the other portions of the pronotal modification. Also, the elytral spot extends almost to the second stria, making the spot somewhat wider than in the male. Vertex, clypeus, and pronotum heavily punctured. The pronotal declivity is heavily punctured over its entire surface.

Head without tubercles or horn, but with a pronounced transverse carina similar to that of females of *B. farctum*. Pronotal modification with a small, evenly arcuate transverse carina, obsolete lateral carinae and limiting grooves.

Holotype, male, Brownsville, Tex., Sept. 8, 1947, Alexander (USNM 61681). Allotype, female, Brownsville, Tex., July 23, Barber (USNM 61681). Paratype, male, Brownsville, Tex., Sept. 8, 1947, Alexander (Howden).

The three specimens examined vary in length from 7.7 to 9.5 mm., and in width from 5.5 to 6.8 mm. Also, variation is evident in the divided spots on the posterior pronotal margin. In the type the spots are well separated, but in the other male the spots are joined at midline at their forward margin, leaving a small brown spot at the pronotal margin. The elytral spots are quite constant, slightly larger in the female than in the males.

This species can be separated from other *Bolbocerosoma* by the following characteristics: Sparse short erect yellow hairs scattered over pronotum and elytra, elytral margins black for their entire length, elongate postmedian elytral spot well separated from both black sutural stripe and margin, and punctures of elytral striae very deep, sharply delimited, with their edges rimmed with black.

It gives me a great deal of pleasure to name this colorful species in honor of Dr. P. O. Ritcher, who has given me invaluable aid, both in the field and in the numerous problems encountered in the preparation of this paper.

Bolbocerosoma cartwrighti, new species

Holotype: Male, length 7.5 mm., greatest width 4.6 mm.

Dorsum red-brown marked with black as follows: Eyes, eye canthi, tubercles, vertex, horn, most of clypeus, apical pronotal margin between lateral carinae, inner portions of lateral carinae, lateral portions of transverse carina, lower portion of lateral limiting grooves, lateral margins of the pronotum, band on pronotal base extending sharply forward at midline (dentiform point) and extending laterally no farther than elytral margin, scutellum, extreme base of elytra almost to humeri, posterior half to two-thirds of elytral margin, sutural intervals and postmedian oblong spot extending from third to ninth striae. The elytral spot is quite similar to that of *B. confusum*. Entire undersurface and legs very dark brown to black. Vertex coarsely, somewhat sparsely punctured, punctures becoming coarser and more numerous on the clypeus. Pronotum heavily, coarsely punctate medially, lateral portion more finely, closely punctate, more so anteriorly. Minute secondary punctures evenly distributed over pronotum. Lower two-thirds of pronotal declivity coarsely punctured. Scutellum is unusual by having 15 to 20 coarse, irregularly placed punctures and a few minute secondary punctures. Second elytral stria obsolete, represented by a vague depression without punctures, fifth and eighth striae represented by a few small punctures. Numerous long erect yellow setae are present near most of the coarse punctures on the prothorax, scutellum, elytra, elytral margins, and epipleura. Elytral punctures are well defined and usually separated by slightly more than their own diameter, but this varies. There is an accessory row of moderately coarse, seta-bearing punctures running the length of the elytra next to the suture. In no other species was this noticeable row of accessory punctures present. A few similar punctures are present in a few specimens of *B. pusillum*, but a uniform row was not noted in any of the specimens examined. Foretibia armed with seven teeth. Mesosternal prominence in front of middle coxae small, barely elevated above metasternal plane. Hair of underside long and moderately sparse.

Head with tubercles moderate, those of eye canthi upturned, horn of vertex not long, rather slenderly conical when viewed from posterior, tip not bifid. Pronotal modification of holotype with moderately developed transverse carina broadly, shallowly emarginate; lateral limiting grooves small; lateral carinae well developed, rather elongate.

Genital capsule (pl. 3, fig. 4) with blunt lateral lobes, similar to *B. pusillum*. Lateral lobes 1.2 times as long as wide and tipped with a few long setae.

ALLOTYPE: Female, length 9.2 mm., greatest width 6.5 mm.

Markings similar to holotype except that the unusual lateral black band on the pronotum is much more pronounced; also the transverse carina, lateral carinae, and lateral limiting grooves are black. Vertex, clypeus, and pronotum more heavily punctured in allotype than in holotype. Pronotal modification with entire declivity heavily punctured. Foretibia armed with eight external teeth.

Head of allotype without tubercles or horn, but with small transverse carina, sharply delimited and evenly arcuate. Lateral limiting grooves and lateral carinae small, but noticeable.

Holotype, male, El Paso, Tex. (USNM 61682). Allotype, female, Texas (Howden).

Variation in the two specimens seen is mainly evident in the larger and more pronounced black areas on the pronotum of the female.

Bolbocerosoma cartwrighti can be easily distinguished by the blackish or black lateral portions of the pronotal margin which are not to be noted on any other species. In the male the area is only brownish black, but in the female the area is entirely black and extends from the anterior to posterior angles and inward over 1 mm.

Other distinguishing characteristics are: The accessory punctures along elytral suture, the large number of long erect yellow setae on dorsal surface, the median dentiform point formed by black band on posterior margin of pronotum, and the oblong postmedian elytral spots which are similar in shape to those of *B. confusum*.

This interesting species is named in honor of O. L. Cartwright, who has been of tremendous aid by furnishing many specimens, checking identifications, answering numerous questions, and checking the manuscript.

Bolbocerosoma elongatum, new species

HOLOTYPE: Male, length 10.5 mm., greatest width 6.5 mm.

Dorsum reddish orange marked with black as follows: Vertex, eyes, eye canthi, tubercles, margins of clypeus, apical pronotal margin between lateral carinae, tips of tubercles of lateral and transverse carinae, thin line on the extreme posterior margin of pronotum extending no farther than elytral margins, extreme base of elytra, scutellum, sutural intervals, posterior portion of adjacent intervals, and vague circular postmedian spot. Spot is entirely in posterior third of elytra and is separated from lateral margin and vaguely separated at the third elytral interval from the expanded sutural stripe. The spot is separated by five or six striae from the lateral elytral margins, which are without black markings. Ventral surfaces yellowish brown. Outer margins of foretibia edged with brownish black. Vertex coarsely, sparsely punctured; punctures of clypeus generally regular and dense. Pronotum, coarsely, moderately, irregularly punctate; lateral portions more finely, closely punctured, more so anteriorly. Minute secondary punctures evenly distributed over pronotum. Declivity of pronotal modification with small coarse punctures only in lower half. Pronotum with numerous, very small secondary punctures. Secondary punctures on scutellum about twice the diameter of those on the pronotum. Second elytral striae entirely lacking. Fifth and eighth striae indicated only by a line of very small punctures. Punctures in striae not sharply delimited, generally scattered over the elytra are a few long erect yellow hairs. Epipleuron and elytral margin each bear a row of long setae. Sides of the elytra are almost parallel for approximately half their length, making this species in proportion appear more elongate than other species of *Bolbocerosoma*. Foretibia armed with eight teeth on outer margin. Mesosternal prominence poorly developed in front of middle coxae, only slightly elevated above plane of metasternum. Hair of underside long and moderately dense.

Head with tubercles of eye canthi and clypeus pronounced, sharply upturned. Horn in center of vertex long, slimly conical, not bifid at tip. Pronotal modification with pronounced transverse carina deeply emarginate. Lateral limiting grooves deep, lateral carinae large and elongate.

Genital capsule of male blunt, falling into the same general group as *pusillum, lepidissimum,* etc., but much more elongate. The lateral lobes of the capsule are about 1.8 times as long as wide (pl. 3, fig. 5).

Female is unknown.

Holotype, male, Chisos Mountains, Big Bend, Tex., July 8, 1946, Van Dyke Collection (CAS).

This species can be distinguished by its slightly elongate form, by the rather elongate blunt genital capsule of the male (pl. 3, fig. 5), by the scattered long erect yellow hairs on the elytra, by the thin vague black band on the posterior pronotal margin, and by the vague circular brownish black spot confined to the posterior third of the elytron and separated from the sutural stripe.

Additional material will probably indicate that the holotype is rather poorly marked, as the black circular spot may in other specimens be confluent with the sutural stripe.

Genus *Bradycinetulus* Cockerell

Bradycinetulus Cockerell, 1906, p. 242.—Cartwright, 1953, p. 101.
Bolboceras Kirby (in part), 1818, p. 459.
Amechanus Horn, 1870, p. 48.
Bradycinetus Horn, 1871, p. 334.
Bradycellus Schaeffer, 1906, p. 249.

GENOTYPE: *Bradycinetulus ferrugineus* (Palisot de Beauvois), designation by Cartwright (1953, p. 101).

GENERIC LIMITATIONS: Given by Horn (1870, p. 48; Cockerell merely gave *Bradycinetulus* as a new name for Horn's *Bradycinetus*) under the name *Amechanus:*

> . . . the scutellum being broad, triangular with the sides rounded, and not depressed below the level of the elytra. The very narrow linear and depressed scutellum is seen only in *Athyreus* and *Stenaspidius* in the group Geotrupinae, while the form of the scutellum of our species is very similar to that seen in the *Geotrupes* or *Bolboceras.*

Additional characteristics given by Cartwright (1953, p. 101) are:

> . . . the mandibles are evenly arcuate externally, the median prominence of the pronotum is developed into a pair of horns in the male, the scutellum is wider than long and distinctly punctate with fine to moderate punctures, and the posterior vertical face of the prosternal intercoxal piece is wide and flat with the ventral edge evenly arcuate or slightly angulate at middle. The three species placed here are all of large size, 17 to 21 mm. in length by 10 to 12 mm. in width.

Because of Cartwright's recent and very adequate revision of the genus, no comments on synonymy or adult morphology are needed here. A brief review of the pertinent literature is given, along with any available information on the biology of the species. For keys to the species and locality records the reader should consult Cartwright's revision. Also included in Cartwright's paper were distributional data that the present writer had accumulated.

Bradycinetulus fossatus (Haldeman)

Bolboceras fossatus Haldeman, 1853, p. 362 (type, Texas, LeConte collection at MCZ).—Boucomont, 1911, p. 241.
Amechanus fossatus (Haldeman) Horn, 1870, p. 48.
Bradycinetus fossatus (Haldeman) Schaeffer, 1906, p. 250.
Bradycinetulus fossator (Haldeman) Cockerell, 1906, p. 242.—Cartwright, 1953, p. 103.

The midwestern species *fossatus* appears to have habits similar to its eastern counterpart, *ferrugineus. Bradycinetulus fossatus* has been recorded from sandy localities from Nebraska to Texas. Specimens have been collected in every month from May through August, most commonly in June.

In Noble and Payne Counties, Okla., Brown (1927, p. 27) found it commonly from May to July in vertical burrows from 6 to 14 inches in depth. Similarly, in the sandy areas of Kansas, Knaus (1926, p. 264) found occasional specimens in perpendicular, 8- to 12-inch burrows.

Two miles from Sylvia, Kans., Warren (1917, p. 413) made the following observations on *fossatus:*

> The first impression at sight of the burrow of this species is as though a carpenter had used a half inch auger and left the chips around the hole. . . . The use of a spade a number of times failing in results, a dry weed stalk was pushed down the pit and the sand dug away on one side within two inches of the stem or hole and the rest carefully removed with the fingers, when the beetle would be found at the bottom, sometimes both sexes being present, at other times either singly. The well would be perfectly straight and about 14 inches deep. The species is not scattered but usually restricted to small areas in apparent colonies. A strong light placed on the sand near the burrows yielded from three to five specimens per evening.

Bradycinetulus fossatus has been collected in Arkansas, Kansas, Nebraska, Oklahoma, and Texas.

Bradycinetulus ferrugineus (Palisot de Beauvois)

Scarabaeus ferrugineus Palisot de Beauvois, 1809, p. 90.
Athyreus ferrugineus (Palisot de Beauvois) Klug, 1845, p. 22.—Boucomont, 1902, p. 8.
Bolboceras ferrugineus (Palisot de Beauvois) Lacordaire, 1856, p. 143.—Boucomont, 1911, p. 241.
Amechanus ferrugineus (Palisot de Beauvois) Horn, 1870, p. 48.
Bradycinetus ferrugineus (Palisot de Beauvois) Horn, 1885, p. 89.—Schaeffer, 1906, p. 250.
Bradycinetulus ferrugineus (Palisot de Beauvois) Cockerell, 1906, p. 242.—Cartwright, 1953, p. 102.
Bolboceras lecontei Dejean, 1833, p. 149.

Bradycinetulus ferrugineus, the only East Coast representative of this genus, is found in the inland sandy areas from Florida to North Carolina. Because of its seeming rarity, there is a paucity of knowledge concerning the biology of this insect. The reason for this lack became evident after I spent many weekends over a period of three years attempting unsuccessfully to learn something of the biology of the immature stages of this species. The only data obtained from this work were the times and places where the larvae were *not* found. It is hoped that the present meager information may possibly be of some aid or stimulation to some investigator in the future.

For me, the most easily accessible area where *ferrugineus* was known to occur was in the sand hills around Southern Pines, N. C. There Manee (1908b, pp. 459–460) had recorded finding the beetle from June through August. He mentioned that when he found a pair at work the burrow was closed, and when they were burrowing singly the burrow was open. In his notes he stated that the beetles went to a depth of from 4 to 9 inches (in one case) very rapidly. He further mentioned that he never saw two specimens of the same sex in the same burrow. Males occasionally were collected at light by Manee.

I agree with Manee that the beetles are strong diggers, occasionally come to light, and that they dig vertical burrows, but in other respects my observations differ considerably.

Originally, an attempt was made to locate the exact area in which Manee had made his notes. This failing, considerable time was spent trying to find an area having a large population of these beetles.

During the first summer only occasional burrows were found in August and September. These were usually located in the ruts of seldom-used, sandy roads. The beetles made vertical burrows 2 to 3 feet deep, marked by ropey push-ups of sand 3 to 4 inches in diameter (pl. 10, fig. 2). These burrows were traced by shoving long straws into their openings and then digging down beside the straws. Usually the depth necessitated making a rather large hole with a shovel or trowel. On one occasion it was rather embarrassing trying to explain to the curious owner the reason for the excavation in his road. The occasional need to rapidly remove a beetle from its burrow, plus the difficulty of digging out the beetles with a trowel or spade, led to the use of a posthole digger and a sifter. Due to the beetles' habits of digging a perfectly vertical burrow the digger could be centered over the entrance and the sand sifted as it was brought out. In this manner a beetle could be brought up from a depth of 3 or 4 feet in about 10 minutes. If one wanted to study the burrow, the hole was dug beside the burrow and a trowel was used to carefully expose the shaft of the burrow.

During the second summer, beside a small airport 2 miles north of Southern Pines on U. S. Highway 1, a moderate colony of *ferrugineus* was found. The land across the road from the airport had several seldom-used roads and open patches of bare sand. The area, which was near the top of a high sand ridge, was largely grassy with a few scattered turkey oaks and longleaf pines. It was in this area that both *ferrugineus* and *Eucanthus* (pl. 17, fig. 1) were found.

The burrows of *ferrugineus* were invariably in the open spots of bare sand or in the sandy roads. Burrows were marked and a number of adults were put in rearing cages in the same area. It was noticed that sometimes the entrance of a burrow was plugged with sand at its opening, sometimes it was not. Closer observation showed that usually it was the burrow of a male which had a plug of sand at its entrance. Often the burrow of the female was open 10 to 12 inches before a sand plug was encountered. At no time during the three years, in which time over 70 burrows were dug, were two specimens, pairs or not, ever found in the same burrow. No beetle was ever found feeding or associated with any possible food.

Just before the conclusion of this work, beside the Carthage-Southern Pines airport on the Carthage road, a large number of *ferrugineus* were taken by digging in early September in the wasteland between the airport and the road. There was no sign of feeding or mating, mention being made of the area merely because of the number of *ferrugineus* found there.

Despite the lack of success in procuring any larvae, a few interesting facts were obtained during the three years. The adult beetles lived for almost a year. A number of burrows were marked in September and later dug during the winter. The quiescent adult beetles were found singly at the bottom of their vertical burrows in November and again in March. There they remained until early June, at which time fresh burrows were found. One interesting fact was noted—the older the beetle, the darker brown it was. Specimens taken in June in some instances were almost black. Later in July of 1951 only lightly colored males were found in fresh burrows.

Some of the fresh June burrows were marked and left undisturbed. By mid-July the cages containing adults collected the previous fall were dug up. One female, out of four that were active on June 28, was still alive in one cage, but there was no sign of any brood activity. In another cage, which was merely an enclosure with no bottom, none of the adults or fragments could be found. Every shovelful of sand under the cage was sifted to a depth of 7 feet with no results.

The burrows which were marked in June were then dug. In the latter part of July, three different holes were made following burrows to a depth of as much as 11 feet with no results.

The investigator finally had to conclude that the beetles either went to great depths or changed their burrowing habits and went sideways for a number of feet. The latter supposition would seem to be the probable one.

No fresh burrows were seen in July 1952. On Sept. 12, 1952, the colony at the Carthage airport was found and, out of 48 beetles collected, there were 8 males and 12 females that were fairly dark and 16 males and 12 females that were quite teneral, appearing to be freshly emerged. All of the burrows, as usual, were from 14 inches to 3½ feet deep, with an average depth of 28 inches.

If I were asked to hazard a guess as to the time that the larvae could be found, I would say that, according to the above information, the larvae of *ferrugineus* should occur during June, July, and perhaps August. The problem still remains to find them.

Specimens of *ferrugineus* have been collected in Florida, Georgia, Mississippi, North Carolina, and South Carolina.

***Bradycinetulus rex* Cartwright**

Bradycinetulus rex Cartwright, 1953, p. 103. Type, male, Sarita, Tex., collected on bare sand Nov. 30, 1911 (USNM).

Only three specimens of this species are known, the type and two male paratypes. All were collected in Texas, the two paratypes coming from Corpus Christi, June 28, 1942, and Kingsville.

Genus *Bolborhombus* Cartwright

Bolborhombus Cartwright, 1953, p. 116.

Genotype: *Bradycinetus carinatus* Schaeffer (*Bolboceras schaefferi* Boucomont), designated by Cartwright (1953, p. 117).

Generic Limitations: Given by Cartwright (1953, pp. 116–117):

Mandibles arcuate externally. Head, male and female, without median frontal horn. Pronotum serrate laterally; apex with a carina paralleling anterior margin, the interspace interrupted behind each eye by a distinct rather deep foveola; base margined. Scutellum triangular with base straight, sides arcuate. Elytra not margined at base; seven discal striae, the first two interrupted by the scutellum, the second sometimes indistinctly forked opposite the apex of scutellum. Two prosternal spines in tandem behind anterior coxae, the posterior more or less hastate. Metasternal plate rhomboid in shape, the posterior angle acute with adjacent edges cariniform, the lateral angles with adjacent edges rounded; the intercoxal lobe deeply concave with strong cariniform lateral edges.

For adult descriptions, keys, and locality records the reader should consult Cartwright's revision. None of the species in this genus have been collected in numbers and nothing has been written concerning their biology.

***Bolborhombus carinatus* (Schaeffer), new combination**

Bradycinetus carinatus Schaeffer, 1906, p. 251. Type, male, Palmerlee, Cochise County, Ariz. (USNM).
Bolboceras schaefferi Boucomont, 1911, p. 347.
Bolborhombus schaefferi (Boucomont) Cartwright, 1953, p. 119.

This species was originally described in the genus *Bradycinetus* by Schaeffer (1906, p. 251). The same year Cockerell (1906, p. 242) stated that the name *Bradycinetus* was preoccupied and changed it to *Bradycinetulus*. Then Boucomont (1911, p. 347) decided that *Bradycinetus* (or *Bradycinetulus*) was merely a synonym of *Bolboceras*. As the name *carinatus* had previously been used by Blackburn in 1904 to describe an Australian species of *Bolboceras*, Boucomont stated that *carinatus* Schaeffer was a homonym and proposed the name *schaefferi* to replace it.

Since then Cartwright (1953, p. 101) and I have concluded that Boucomont's application of the name *Bolboceras* was in error (*Bolboceras* being the correct name for the genus sometimes known as *Odontaeus* for reasons given in the section on *Bolboceras*). Because of this, *carinatus* Schaeffer should not have been synonymized, and, as the Australian species *carinatus* Blackburn certainly cannot be referred to the present genus *Bolborhombus* established by Cartwright, the name *carinatus* Schaeffer is restored here.

The species *Bolborhombus carinatus* (Schaeffer) has been sparingly found in Arizona, New Mexico, Texas, and México from June through October with one record in December. The majority of specimens were collected during July and August, some of these bearing the label "light."

Bolborhombus angulus (Robinson)

Bolboceras angulus Robinson, 1947, p. 170. Type, male, Dog Canyon, Brewster County, Tex. (Robinson).
Bolborhombus angulus (Robinson) Cartwright, 1953, p. 117.

Originally described from a unique specimen, three others have since been found. Three of the specimens, including the type, were collected in Brewster County, Tex., while the fourth specimen came from Miller Canyon, Huachuca Mountains, Ariz. All of them were collected in July.

Bolborhombus parvulus Cartwright

Bolborhombus parvulus Cartwright, 1953, p. 118. Type, male, Triunfo, Baja California, México, Aug. 7, 1938, Michelbacher and Ross (CAS).

This species was described from four specimens, all from Baja California. They were collected at Triunfo, San Venancio, and Santa Rosa in August and October.

Genus *Bolbocerastes* Cartwright

Bolbocerastes Cartwright, 1953, p. 105.

Genotype: *Bolbocerastes regalis* Cartwright, designated by Cartwright (1953, p. 105).

Generic limitations: Given by Cartwright (1953, p. 105):

> This genus is closely allied to *Bradycinetulus* but differs in that the apex of the tibia of the middle and hind legs is obliquely truncate, the scutellum is smooth or minutely punctate, the mandibles are parallel, nearly straight sided and bent sharply inward anteriorly, the sides and anterior edges forming a rectangle, the median prominence of the pronotum is without horns, two elevated carinae are present on each side of the pronotum, the prosternal spine behind the anterior coxae is transverse, doubly pointed and remote from the acutely angled intercoxal piece, and the aedeagus of the male is of a characteristic form . . .

Descriptions, keys, references, and distributions of the species are given by Cartwright.

All of the known North American species are quite similar in form. They have frequently been recorded coming to light, while an occasional specimen examined by me bore the label "in burrow." Other than this, nothing has been recorded about the habits of these species.

Bolbocerastes regalis Cartwright

Bolbocerastes regalis Cartwright, 1953, p. 106. Type, male, "3206. Colo. R. bottom. Monument 204, Mex. Bd. line, Mar. 20–31, '94 U. S. N. M. Acc. No. 28133, Dr. E. A. Mearns." (USNM.) The above locality, according to Cartwright, is about 20 miles south of Yuma, Ariz.

This rather striking species was described by Cartwright from 97 specimens from Arizona, California, Nevada, and México. The species has been collected in every month from March through September, being more frequently seen in the spring.

Previously, the species had been confused with *serratus* (LeConte) and many records of *serratus* from California and Arizona probably refer to this species or to *imperialis* Cartwright.

Bolbocerastes imperialis Cartwright

Bolbocerastes imperialis Cartwright, 1953, p. 109. Type, male, Imperial County, Calif., on the experiment farm, June 1912, Bridwell (USNM).

This species, which is very similar to *Bolbocerastes serratus* (LeConte), was described from 212 specimens collected in Arizona, California, New Mexico, western Texas, and México. They were found in every month from May through November, but have been most commonly collected in the summer and fall.

Bolbocerastes imperialis kansanus Cartwright

Bolbocerastes imperialis kansanus Cartwright, 1953, p. 112. Type, male, Rush County, Kans. (CC).

Only seven specimens of this species are known. They were all collected in Rush and Ness Counties, Kans., during July and August.

Bolbocerastes serratus (LeConte)

Athyreus serratus LeConte, 1854, p. 80 (type, LeConte collection, MCZ).—Boucomont, 1902, p. 8.
Amechanus serratus (LeConte) Horn, 1870, p. 48.
Bradycinetus serratus (LeConte) Horn, 1894, p. 334.—Schaeffer, 1906, p. 251.
Bradycinetulus serratus (LeConte) Cockerell, 1906, p. 242.
Bolboceras serratus (LeConte) Boucomont, 1911, p. 341.
Bolbocerastes serratus (LeConte) Cartwright, 1953, p. 113.

This species ranges from Kansas through Oklahoma and Texas to México. It has been frequently taken in Texas from April through September. Specimens have been collected at light, but other than that nothing has been written concerning its habits.

Bolbocerastes peninsularis **(Schaeffer)**

Bradycinetus serratus var. *peninsularis* Schaeffer, 1906, p. 252. Type, male, Santa Rosa, Baja California, México (USNM).
Bolboceras serratus var. *peninsularis* (Schaeffer) Boucomont, 1912, p. 13.
Bolbocerastes peninsularis (Schaeffer) Cartwright, 1953, p. 116.

This rare species has been collected only in Baja California, México. Specimens were taken at Santa Rosa, San Felipe, La Paz, and San Ignacio from July to October.

Genus *Bolbelasmus* Boucomont

Bolbelasmus Boucomont, 1911, p. 335.—Cartwright, 1953, p. 97.
Kolbeus Boucomont, 1911, p. 335.—Chapin, 1946, p. 79.

Genotype: *Scarabaeus gallicus* Mulsant, designated by Cartwright (1953, p. 97).

Generic limitations: Given by Boucomont (1911, p. 335).

Clypeo subrotundato, inermi, tenui, carinula a fronte separato, tuberculo frontali subconico; antennarum clavae primo articulo cum circumscripta area denudata; posterni fovearum oris declivibus absque carinis; coxis intermediis subcontiguis, mesosterno inter illas tenuissimo seu lineari, a genere Bolbocerate tantum differt.

The genus *Kolbeus* was synonymized under *Bolbelasmus* by Cartwright (1953, p. 97) because he believed that there were insufficient morphological differences to warrant generic separation. While *Kolbeus arcuatus* Bates lacked the posterior marginal line on the pronotum, Cartwright found it otherwise essentially similar to the genus *Bolbelasmus*. For full particulars on distributional data, keys, descriptions, and synonymy the reader should consult Cartwright's revision (1953, p. 97).

Bobelasmus arcuatus **(Bates)**

Bolboceras arcuatus Bates, 1887, p. 111. Type, probably in British Museum.
Kolbeus arcuatus (Bates) Boucomont, 1911, p. 336.—Chapin, 1946, p. 79.
Bolbelasmus arcuatus (Bates) Cartwright, 1953, p. 98.

This species has been collected in México and Costa Rica from May through July. One specimen in the Carnegie Museum bears the label "Los Angeles, California," but I would prefer to see other specimens collected in the United States before considering *arcuatus* a North American species.

Bolbelasmus minor **(Linell)**

Bradycinetus minor Linell, 1895, p. 723. Type, female, San Diego, Tex. (USNM).
Bolboceras minor (Linell) Schaeffer, 1906, p. 253.
Kolbeus minor (Linell) Chapin, 1946, p. 79.
Bolbelasmus minor (Linell) Cartwright, 1953, p. 100.

This rare little species has been collected from May through June only in the southern tip of Texas from Duval County southward to Brownsville. Nothing is known of its habits.

Bolbelasmus hornii (Rivers)

Bradycinetus hornii Rivers, 1886, p. 61. Type, Sonora, Tuolumne County, Calif. (present location of type unknown).
Bolboceras hornii (Rivers) Schaeffer, 1906, p. 253.
Bradycinetulus hornii (Rivers) Cockerell, 1906, p. 242.
Kolbeus hornii (Rivers) Chapin, 1946, p. 79.
Bolbelasmus hornii (Rivers) Cartwright, 1953, p. 100.

I have examined specimens labeled "dug from burrow" and seen others with "at light" labels. Presumably this rather common California species has much the same burrowing habits as the species in closely related genera. Of the 130 specimens examined, 6 were collected in January, 6 in February, 7 in March, 38 in April, 61 in May, and 7 in June. To my knowledge, the immature stages of *hornii* have never been collected or described.

Genus *Eucanthus* Westwood

Eucanthus Westwood, 1848, p. 387; 1852, p. 26.—Schaeffer, 1906, p. 253 (as *Bolboceras* in part).—Manee, 1908b, p. 459.—Blatchley, 1910, p. 937 (as Bolboceras); 1928, p. 30.—Boucomont, 1911, p. 336.—Dawson, 1922, p. 195.—Cartwright, 1944, p. 30.—Ritcher, 1947, p. 10.—Robinson, 1948, p. 30.

Genotype: *Scarabaeus lazarus* (=*meliboeus*) Fabricius, by monotype *in* Westwood (1848).

Generic limitations: Given by Westwood (1848, p. 387): "Corpus minus depressum quam in reliquis; pronoto antice haud retuso. Tibiae anticae dentibus duobus apicalibus magnis aliisque minutus externus versus basin armato. Elytra punctato-striata; singulo striis 5 tantum inter humeros et suturam, punctis, profundis."

Other useful characteristics are: Coarse lateral punctures of pronotum with about half of their rims elevated, giving tuberculate appearance; transverse hornlike carinae, one on clypeus, one on vertex, present in both sexes; humeral angle of elytron not broadly rounded, usually with tubercle.

Male genitalia: Both the genitalia and genital capsule are rather simple and poorly sclerotized with no usable characters noted. However, careful study of the genitalia may be helpful in some cases for setting specific limits.

In the genus sexual and size variation is very pronounced. In both sexes the size of horns (carinae) and tubercles may vary, and this size to some extent appears coupled with body size and degree of coarse punctation.

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Descriptions have been based where possible on specimens believed to be normally well developed.

LARVAE: Known larvae may be distinguished by the following characteristics: Body slightly bent without enlarged abdomen; legs 3-segmented with claws, metathoracic legs not reduced; paired ventral anal lobes; galea not emarginate; penultimate segment of antenna with more than two (usually four) conical sense organs.

The genus is represented by three species and one subspecies in North America, one known species in South America, and one in Australia.

Key to the North American species of Eucanthus

1. Surface of head, pronotum, and elytron smooth, not granulate, giving shining brown or black color 2
   Surface of head, pronotum, and elytron finely granulate, giving an oily dark brown color (Gulf Coast States) . . . . **alutaceus** Cartwright
2. Pronotum noticeably explanate; transverse pronotal carina pronounced; tubercle at humeral angle present, usually quite pronounced (subspecies of *lazarus*) 3
   Pronotum only slightly explanate; transverse pronotal carina not pronounced; tubercle at humeral angles of elytra absent or vaguely indicated (Southwestern States) . . . . **greeni** Robinson
3. Color brown to dark brown, antennal club large, at least slightly longer than eye (pl. 2, fig. 7); 2nd and 4th elytral intervals slightly wider than adjacent ones and usually with a medial row of very fine punctures (pl. 2, fig. 9); punctures of elytral striae shallow . . . . . . **lazarus lazarus** (Fabricius)
   Color dark brown to black, antennal club small, slightly shorter than eye (pl. 2, fig. 6); 1st, 2nd, 3rd, and 4th elytral intervals approximately the same width and lacking any supplementary row of small punctures (pl. 2, fig. 8), strial punctures deep, those of third stria (and others) almost confluent (Florida, Alabama, north to North Carolina).
   lazarus subtropicus, new subspecies.

Key to the known larvae of North American species of Eucanthus

Glossa not constricted behind base of palpi, setae limited to lateral portions near the base of the palpi . . . . **lazarus lazarus**

Glossa (pl. 6, fig. 6) constricted behind base of palpi, setae extending entirely across anterior . . . . **lazarus subtropicus**

Eucanthus lazarus (Fabricius)

Scarabaeus lazarus Fabricius, 1775, p. 11; 1781, p. 11, No. 34; 1787, p. 5, No. 25; 1801, p. 23, No. 5.—Jablonsky, 1785, p. 276, No. 38.—Olivier, 1789, genus 3, p. 63.—Panzer, 1794, p. 2, No. 4.

Bolboceras lazarus (Fabricius) Castlenau, 1840, p. 105, No. 11.—Klug, 1845, pp. 51–52.—Horn, 1870, p. 49.—Schaeffer, 1906, p. 253.—Blatchley, 1910, p. 937.

Eucanthus lazarus (Fabricius) Westwood, 1852b, p. 26.—Manee, 1908b, p. 459.—Boucomont, 1911, p. 336.—Dawson, 1922, p. 195.—Blatchley, 1928, p. 30.—Ritcher, 1947, p. 10.

Scarabaeus meliboeus Fabricius, 1775, p. 20.

Eucanthus meliboeus (Fabricius) Westwood, 1848, p. 387; 1852, p. 26.

Length 6.5 to 14 mm., greatest width 4 to 8 mm.

Color of dorsum shining orange-brown to dark red-brown, with eyes, tips of horn, edge of eye canthus, posterior edge of pronotum, and sutural intervals darker brown to black. Antennal club light yellowish brown in color. Ventral portions of thorax and abdomen the same or slightly darker in color than dorsally. Tibiae darker brown to black. In male, punctures of vertex moderately numerous and rather fine, punctures usually more numerous and pronounced in females. Punctures coarse and numerous on the eye canthi and on the base of the clypeal horn of both sexes. Anterior and lateral margins of pronotum heavily and coarsely punctured, as is a narrow band running from the transverse carina to the posterior pronotal margin. On either side of this is a transverse band of coarse punctures, parallel to the posterior pronotal margin, and midway between the margin and the transverse carina, extending almost to the pointed lateral carina. Very minute secondary punctures are scattered over the entire pronotum. Punctures in elytral striae shallow to moderate, separated by a distance usually greater than their own diameter. Elytral punctures without setae except those on the margins and epipleura, where a few of the punctures bear long reddish setae. Five well developed striae between sutural interval and umbone. The second and fourth intervals, which are wider than the adjacent ones, each have a row of minute punctures (pl. 2, fig. 9) (similar to the obsolete second and fifth striae in some *Bolbocerosoma*). Humerus of elytron bearing a small sharp tubercle at edge. Foremargin of eye canthus scarcely produced forward at outer angle and broadly rounded in both sexes. The lamellae of the antennal club noticeably longer than the eye (pl. 2, fig. 7). Male with pronounced clypeal horn, usually longer than wide, bifid at tip. Poorly developed transverse carina on vertex. Pronotal modification with well developed transverse carina, deep lateral limiting grooves and pointed lateral carinae, which are almost the height of the transverse carina. In the female the clypeal horn is small, short, and slightly bifid. The transverse carina of the vertex is better developed than in the male, longer than the clypeal horn, and somewhat bifid. The pronotal modifications of the female are similar to those of the male but smaller and less pronounced.

Genitalia and genital capsule of male poorly sclerotized, no useful constant characters noted.

The above description of the male was based mainly upon a specimen from Oxford, N. C.

Variation in this species is extreme, eastern specimens usually being smaller, with more pronounced punctures, and darker than western ones. However, a specimen in my collection from Alpine, Calif., is very similar to small eastern specimens collected in North Carolina; many examples of this sort were noted and made limitation of the species difficult. Individual colonies of *Eucanthus lazarus* appeared to exhibit remarkable uniformity, but considerably more material with exact data is needed to determine if the variation is intraspecific or interspecific.

I was unable to locate the Fabrician type of *lazarus*, which apparently has been lost. However, specimens were compared with the Fabrician specimens bearing the name *meliboeus* in the collection of the Hope Department, Oxford University Museum, by Dr. F. I. van Emden. The Fabrician specimen, a female in the Hope Collection, bears a label "Lee's Cabinet" and a label affixed by Dr. Taylor stating, "This may be the type, but I cannot be certain." In case other specimens of *meliboeus* were in Lee's collection and should be discovered, and in order to avoid possible confusion, the female specimen bearing the above-mentioned labels in the Hope Department, Oxford University Museum, is here designated as the type of *Eucanthus meliboeus*.

Several of my specimens were compared with the type by Dr. van Emden, and a female from Havana, Ill., was picked by him as very similar to the type, differing mainly by being slightly larger and lighter in color. The type, while being rather dark, has the large antennal club of the northern and midwestern *lazarus*. Because of Dr. van Emden's careful notes I am fairly certain that *meliboeus* Fabricius is identical with *lazarus* as described above.

While *Eucanthus lazarus* is the most common and wide-ranging species of the Bolboceratini, little has been published on its biology. Brown (1927, p. 27) mentioned that the species was often collected in the same pasture or old roads where he would find *Bolbocerosoma*. Wallis (1928, p. 112) mentioned that Sim found the species burrowing in the same areas, old roads and golf courses, where he took *Bolboceras*.

All available biological information was summarized and the larva of *Eucanthus* described for the first time by Ritcher (1947, pp. 10, 11). He stated that the larvae he described were collected in the soil of a vineyard near Fayetteville, Ark., by M. W. Sanderson in the summer of 1942. Unfortunately, there was no additional information.

Since Ritcher's work, nothing has been added to increase the information on the habits of *lazarus lazarus*. The species occurs rather sparingly in the mountain and piedmont regions of North Carolina, but in more northern and western states it is locally common and appears frequently in some of the collections from midwestern states.

The species has often been recorded as attracted to light. I collected a number of specimens in a light trap at Oxford, N. C., on Aug. 2, 1951, and again on August 10. A few specimens were found at Raleigh, N. C., digging vertical burrows 6 to 10 inches deep in the hard clay soil of an old pasture during August. No data was obtained on adult or larval food and no larvae were collected.

The larva of *E. lazarus lazarus* has been described by Ritcher (1947, pp. 10, 11) from one third-stage larva and two third instar exuviae associated with the adults, all collected near Fayetteville, Ark.

Characteristics given by Ritcher (1947, p. 10) which may be useful in separating *lazarus lazarus* from the subsequent form are: "Frons on each side with a pair of posterior frontal setae, a single exterior frontal seta . . . Hypopharynx with 2 symmetrical bulbous oncyli covered with cilia."

The following additional structural characteristics may prove useful: Glossa not constricted behind the base of the palpi; glossal setae limited to the lateral portions near the base of the palpi.

Specimens examined: 265 males, 282 females.

CANADA

MANITOBA: 6 males, 4 females. Aweme; (4) July.

UNITED STATES

ALABAMA: 1 female. Elamville; (1) August.

ARIZONA: 7 males, 8 females. Cavecreek, Chiricahua Mountains, Cochise County, Dewey, Elgin, Flagstaff, Nogales, Paradise(?), Patagonia, Thatcher; (1) July, (3) August, (7) September, (1) October.

ARKANSAS: 13 males, 12 females. Benton County, Hope, Russellville, Springdale, Washington County; (1) April, (4) May, (1) June, (1) July, (4) August, (2) September.

CALIFORNIA: 1 male, 1 female. Alpine, St. Elmo(?); (1) June, (1) July.

COLORADO: 5 males, 7 females. Akron, Carr, Cheyenne Wells, Denver, Watkins (Adams County); (2) July, (3) August.

DISTRICT OF COLUMBIA: 3 males, 4 females. No data.

FLORIDA: 7 males, 8 females. Buena Vista, Captiva Island, Enterprise, Gunntown, Homestead, Indian River, Miami, Sanford, Winter Park; (1) January, (2) March, (2) April, (1) May, (1) November.

GEORGIA: 3 males, 7 females. Atlanta, Roswell, Tifton; (1) April, (1) May, (1) August.

ILLINOIS: 27 males, 33 females. Algonquin, Chicago, Cook County, Elizabethtown, Evanston, Havana, Hazel Crest (Cook County), Homer Park, Le Roy, Putnam County, Urbana; (2) January, (3) May, (11) June, (10) July, (1) August, (7) September, (2) October.

INDIANA: 1 male, 6 females. Hessville, Lafayette; (4) June.

IOWA: 42 males, 37 females. Ames, Denison (Crawford County), Elma, Herrold (?), Lineville, Polk City, Shenandoah, Storm Lake; (1) March, (1) May (64) June, (6) July, (6) August.

KANSAS: 15 males, 15 females. Atchison, Douglas County, Goodland, Larned, Lawrence, Reno County, Sedgwick County, Thomas County; (2) May, (1) June, (1) July, (1) September.

KENTUCKY: 4 males, 5 females. Natural Bridge State Park, Sanborn(?), Sandgap; (1) April, (1) June.

LOUISIANA: 1 female. (1) March.

MASSACHUSETTS: 1 female. Chicopee.
MARYLAND: 1 male, 3 females. Chesapeake Beach, College Park; (1) June, (1) July.
MICHIGAN: 3 males, 1 female. Albion, Allegan, East Lansing, Olivet; (1) June, (1) July, (1) August.
MINNESOTA: 2 males, 6 females. Fairfax, Granite Falls, Rapidan, St. Paul; (1) June, (1) July, (1) August.
MISSISSIPPI: 1 female. Crystal Springs, (1) April.
MISSOURI: 3 males, 4 females. Columbia, Pevely (Jefferson County), St. Charles; (2) May, (2) June, (1) August.
MONTANA: 1 male, 1 female. Poplar; (2) July.
NEBRASKA: 15 males, 14 females. Bennet, Brownville, Dodge County, Friend, Imperial, Malcolm, Mitchell, Niobrara, North Platte, Ponca, West Point; (5) April, (3) June, (15) July, (1) August.
NEW JERSEY: 5 males, 9 females. Atsion, Burlington, Chester, Newark, Newfoundland, Ocean City, *Old Dominion* boat off New Jersey, Riverton, Surf City, Woodbury; (5) June, (2) July, (2) August, (1) September.
NEW MEXICO: 4 males, 1 female. Embudo, Jemez Springs, Mesilla; (1) May, (1) July, (1) September.
NEW YORK: 1 male, 3 females. Greene County, Wading River (L. I.).
NORTH CAROLINA: 23 males, 15 females. Chimney Rock, Edenton, Franklin, Hendersonville, Laurel Hill, Marion, Base of Mount Pisgah, New River (Onslow County), Oxford, Raleigh, Rocky Mount, Smokemont (Swain County), Winston-Salem; (2) April, (5) May, (1) June, (10) July, (15) August, (1) September, (1) November.
OKLAHOMA: 4 males, 4 females. Norman, Sulphur, Wichita National Forest, Woodward; (1) May, (4) June, (1) September.
PENNSYLVANIA: 13 males, 9 females. Allegheny County, Easton, Jeannette, Pipers Gap, Pittsburgh; (5) May, (6) July, (6) August.
SOUTH CAROLINA: 5 males, 4 females. Clemson College, Sassafras Mountain; (1) May, (1) June, (2) July, (2) September.
SOUTH DAKOTA: 1 male, 1 female. Blunt, Volga; (1) July.
TENNESSEE: 1 male, 1 female. Manchester; (1) June.
TEXAS: 35 males, 41 females. Abilene, Alpine, Austin, Dallas County, Fedor, Fort Davis, Hallettsville, Kingsville, Lee County, Sarita, Wills Point; (7) April, (8) May, (3) June, (19) September, (5) October, (1) December.
VIRGINIA: 4 males, 3 females. Bedford Springs, Falls Church, Haywood; (1) March, (1) June, (1) September.
WEST VIRGINIA: 1 female. Talcott; (1) July.
WISCONSIN: 10 males, 10 females. Dane County, Dodgeville, Lancaster, Madison, Port Edwards, Ripon, Winnebago County, Griffith State Nursery (Wood County); (7) June, (6) July, (2) August, (2) September

Eucanthus lazarus subtropicus, new subspecies

HOLOTYPE: Male, length 8.5 mm., greatest width 5.3 mm.

Color shining dark brownish black, darker sutural markings not evident. Antennal club reddish brown. Ventral portions of thorax and abdomen dark red-brown to black. Tibiae almost entirely black. Coarse punctures of vertex almost absent, entirely so medially. Punctures coarse and close on the inner part of the eye canthi (pl. 2, fig. 6) and the base of the clypeal horn. Anterior margin of pronotum with a few coarse punctures, heavily punctate laterally. Coarse punctures are present in a narrow median band running from the transverse carina of pronotum to the posterior margin. Another band of punctures is present at the posterior of the lateral limiting grooves. A second one runs halfway between and parallel to the first band and the posterior margin of pronotum, extending almost to lateral carina. This second band of punctures is in a wide groove, only vaguely indicated in most specimens of *E. lazarus lazarus*. Minute secondary punctures are extremly small and vague, rather sparsely but evenly scattered over pronotum. Punctures in elytral striae deep, sharply delimited, generally separated by less than their own diameter (pl. 2, fig. 8). Elytral punctures without setae except those on the margins of the elytra and epipleura, where some of the punctures bear long yellowish red setae. Five well developed striae between sutural interval and umbone. All of the intervals between these five striae (pl. 2, fig. 8) with no noticeable difference in their widths. Rows of punctures noted in *E. lazarus lazarus* in the wider second and fourth intervals are entirely absent in *E. lazarus subtropicus*. Humerus of elytron bearing a small sharp tubercle at edge. Foremargin of eye canthus noticeably produced forward at outer angle, where it is sharply rounded (pl. 2, fig. 6). The lamellae of the antennal club no longer than eye (pl. 2, fig. 6), noticeably smaller than in *E. lazarus lazarus*. Also, eye size is slightly smaller than in the usual *E. lazarus lazarus*. Holotype with clypeal horn about as long as wide, bifid at tip. Poorly developed transverse carina on vertex. Pronotal modification poorly developed, carinae small with lateral limiting grooves shallow.

ALLOTYPE: Female, length 9.3 mm., greatest width 5.8 mm. Differs from the male holotype mainly in the following respects. Clypeal horn reduced, smaller than the one on the vertex which is larger than on males. Other than the differences in the horns and a slight difference in size, the female is similar to the male. Shape of eye canthus, antennal size, pronotal modifications, and elytral striae are all similar.

Holotype, male, Emory University Field Station, Newton, Baker County, Ga., light, Aug. 12, 1952. (USNM 61683). Allotype, female, Tarpon Springs, Fla., Mar. 20, 1951, H. and A. Howden (USNM 61683). Paratypes: 95 males, 106 females. *Alabama:* Florala; Grand Bay, Aug. 16, Loding; Pineapple, Aug. 25, 1933; Salt Mountain, 6 mi. south Jackson, Clarke County, May 14–16, 1935, Archer; Selma, October 1880, "W. H. I." *Florida:* No data (USNM 1072J); Archbold Biological Station, Lake Placid, April 1947, Needham; Crescent City, June 1938, Brues; Daytona Beach, July 15, 1945, Robinson; Dunnellon, Marion County, Aug. 3, 1938, Hubbell, Friauf; Fort Lauderdale, Apr. 10–25, Mar. 9, 26, May 22, June 1, 1928, Bates; Gainesville, Alachua County, Sept. 26–Oct. 2, 1914; July 7, 1927, Rogers; Mar. 26, 1922, Mar. 22, 1923, Apr. 7, 8, 1923, Apr. 23, 1925, May 20, 1916, May 1946, Sept. 7, 1945, Oct. 5, 1925, Oct. 5, 1929, Oct. 20, 1934, Nov. 15, 1935, Bigelow, Alexander-Walker, Hubbell, Young; Greenville, Madison County, Sept. 2–6, 1932, Gloyd; Hillsborough County, Little Manatee River and U. S. Highway 41, Aug. 15, 1938, Hubbell, Friauf; Jacksonville, Aug. 9, 1898, Bowditch; La Belle, July 16, 1939, Oman; Liberty County, T. 2 N., R. 7 W., Apr. 24, 1924, Hubbell; Miami, Feb. 25, 1934, Aug. 12, 1934, Young; Monticello, Jefferson County, July 21, 1933, Walker; Orlando, van Dauber; Port Sewall, Dec. 11, 1938 (AMNH 36406), Watson, Sanford; Sanford, June 1, 28, 29, July 1, 29, 1929, Gehring; Tarpon Springs, Mar. 20, 21, 1950, H. and A. Howden; Welaka, Putnam County, Oct. 12, 1939, Friauf; Winter Park, Jan. 29, 1929, Feb. 15, 1928, Gehring. *Georgia:* No data; Americus, Aug. 1, 1950, Cartwright; Bainbridge, Sept. 17–Oct. 19, 1910, Bradley; Cordele, Aug. 1, 1950, Cartwright; Emory University Field Station, Newton, Baker County (all specimens from this locality were procured through the help of S. Breeland), June 27, 28, July 1–2, July 31–Aug. 1, Sept. 28–October 1, 1951, July 13, 17, 25, Aug. 13, 18, 20, 21, 28, 1952, light trap; Macon, Bibb County, June 8, 1923, Walker; Rabun County, June 25, 1927, July 10, 1928 (AMNH 30831), Richards; Sparks, Cook County, June 11, 1923, Walker. *Mississippi:* Camp Shelby, near Hattiesburg, Apr. 25, Aug. 10, 18, 26, 30, Sept. 21, 1944, Michener; Lucedale, Apr. 22, May 27, 1932, June 20, 1931, June 20, 1932, Aug. 22, 1931, Oct. 7, 1930, Dietrich; *North Carolina:* Rocky Mount, Aug. 1, 1951, Ritcher; Southern Pines, June 1907, May 12, June 19, 1909, Manee; Mar. 20, May 3, 16, June 14, 21, 1952, July 24, 1951, Aug. 18, 1951 (with Ritcher), May 17, 20, 1953, Sept. 5, 1952, Nov. 9, 1951, H. and A. Howden. *South Carolina:* No data; Aiken; CCC Camp F2, Oconee County, Aug. 12, 1936, Cartwright; Clemson College, Apr. 29, 1935, May 3, 1938, May 18, 1948, May 30, 1934, June 24, 1934, Aug. 1, 1950, Sept. 16, 1934, Cartwright, Dunavan; Edisto Exp. Sta., Blackville, June 8, 1938, Cartwright; Florence, July 14, 1930, Cartwright; Jocassee, July 17, 1932, Cartwright; Rocky Bottom, June 3, 1932, Cartwright; Walhalla, July 2, 1934, July 20, 1936; White Pond, Sept. 6, 7, 1951, Ritcher and H. Howden; Windsor, May 8, 1948, Cartwright. *Tennessee:* Deer Lodge, July 15–30, 1939, Benesh.

Paratypes are in the collections of American Museum of Natural History, British Museum (Natural History), California Academy of Sciences, Canada Department of Agriculture, Carnegie Museum, Cornell University, Illinois Natural History Survey, Iowa State College, Museum of Comparative Zoology, North Carolina State College, Ohio State University, Oregon State College, U. S. National Museum, University of Arizona, University of Kansas, University of Michigan, and in the private collections of O. L. Cartwright, B. K. Dozier, C. A. Frost, A. Martinez, G. H. Nelson, M. Robinson, and the writer.

Variation in specimens of the type series is moderate. Length varies from 6.5 to 10 mm., width from 4.3 to 6 mm. Color ranges from an even reddish brown to black. The area of intergradation with *lazarus lazarus* is not too clear, but in general specimens from areas not bordering the Gulf of Mexico are intermediate in many of their characteristics. Specimens from localities bordering the East Coast tend more toward *lazarus lazarus*. Surprisingly, some specimens from Miami, Fla., exhibit many of the characters of *lazarus lazarus*. *E. lazarus subtropicus* appears to be more a Gulf and inland sandhill form, ranging northward in inland sandy areas to Southern Pines, N. C. Occasional northern specimens appear to exhibit most of the characters of *subtropicus*.

Generally, specimens of *subtropicus* can be easily distinguished by the very small antennal club, shape of eye canthus (pl. 2, fig. 6), evenly spaced elytral intervals between sutural interval and umbone, short clypeal horn in the male, blackish color, few punctures on vertex of head, and deep punctures of elytral striae. Some of these characters can occasionally be found either singly or in some combination in specimens of *lazarus lazarus* scattered throughout the country, particularly on the East Coast. However, further study may prove *subtropicus* to be a distinct species, for in a few cases both *lazarus* and *subtropicus* have been recorded from the same locality, while the specimens themselves show little intergradation. I have never collected both forms or seen them from any one small area—a colony seeming to represent only one subspecies and never both. If it were not for the fact that occasionally a few characteristics of *subtropicus* appear in the varied population of *lazarus lazarus*, I would consider it a separate species.

Eucanthus lazarus subtropicus is generally found in sandy, rather open habitats. Adults were collected in their burrow in every month of the year, but were less frequently found in June than in other months. Specimens were often attracted to light, but were never collected by baits or chemical attractants. No adults were ever seen to feed nor were they collected near any material they seemingly might use for food.

Most of my observations on this subspecies were made at Southern Pines, N. C. It was here that Manee's (1908b, p. 459) observations on *Eucanthus* were made. He mentioned that they (presumably *subtropicus*) dug verticle burrows in the sand and he included a diagram of the push-up and burrow containing the adults. However, the larvae eluded him.

Two miles north of Southern Pines I found *subtropicus* in moderate numbers burrowing in an old sandy road (pl. 17, fig. 1). The road ran along near the top of a high sand ridge which was largely covered with grasses and weeds. The *Eucanthus* did not utilize the shade afforded by the few scattered turkey oaks and longleaf pines present in the area, but burrowed in the exposed bare sandy areas. Here the burrows could be easily located by the characteristic push-ups of "ropey" piles of sand almost 1 inch high and about 2 inches in diameter.

This locality at Southern Pines was visited rather frequently during 1951 and 1952. In July 1952 pairs of *Eucanthus* were found in 3 of 12 burrows dug. The vertical burrows averaged about 20 inches deep, the deepest one measured being 30 inches. On July 24, 1951, three burrows, separated by only a few inches, were excavated by using a posthole digger and sifting the sand as it was brought to the surface. A female was sifted out of the sand, brought up from a depth of 20 inches. In the sand from a depth of 24 inches, a larva was found during the sifting. Because of the manner in which it was collected little could be ascertained concerning the food of the larva or the type of cell that it occupied. A quantity of black humus, similar to that used by *Bolbocerosoma* and *Bolboceras*, was present in the sand brought up. Some of this material was placed in a metal salve box with the live larva for several days, but it could not be determined whether the larva used the humus for food. The larva, a third instar, was preserved on July 29.

After the discovery of the larva on July 24, a number of other burrows were dug the same day, but with rather unsatisfactory results. One burrow, 22 inches deep, yielded a very callow female, but no cell or food material was found. Further digging produced only adults.

During August 1951 considerable adult activity was noted, but no additional larvae were found. Two burrows dug at Southern Pines on August 18 were shallow, being only 12 and 14 inches deep. Numerous other fresh burrows were seen the same day. During the remainder of August and in early September all the burrows dug were shallow. After Sept. 8 a number of these burrows were marked with stakes and left undisturbed.

When the area was next visited, on Nov. 9, 1951, there was no sign of fresh surface activity. Two of the marked burrows were carefully investigated. The burrows, 12 and 14 inches deep, each contained a pair of *subtropicus*, the male slightly above the female in the burrow. The burrow formed a perfectly straight vertical tube ending without any indication of a food supply.

In April 1952 a marked burrow yielded a pair in a 15-inch burrow without any sign of brood activity. In early May two burrows yielded solitary females, but nothing else. On May 16 there were signs of surface activity and a female was collected at light. One burrow, 15 inches deep, yielded a pair of *subtropicus*, but again there was no indication that they were provisioning a cell.

On June 8 fresh burrows were in evidence, but were not as numerous as they had been previously. On June 14 one 18-inch burrow yielded a solitary female, while investigation of a 20-inch burrow produced a pair at the end of a vertical shaft. On the same day one of the burrows that had been marked all winter was examined. After digging to a depth of 30 inches a very callow male was found. Again no definite brood cell could be found in the loose sand, but a quantity of the black humus was nearby.

The following week, on June 21, a burrow was examined that had been newly made four weeks previously. A solitary female was found at a depth of 14 inches. The burrow extended beyond, and digging was continued to a depth of 22 inches, at which point a large, third-stage larva was found. A quantity of poorly compacted, fine, black humus mixed with sand and containing some fungus mycelia was within 1 inch of the spot where the larva was found. While it was not possible to definitely conclude that this was the material used for food, it seemed likely that it was so used. The larva of the closely related *Bolboceras darlingtoni* (Wallis) left the compacted food mass of humus and formed a pupal cell in the sand one-half to 1 inch from the food material. The larval *Eucanthus* may have moved from its food supply to pupate. The burrow push-ups of *Eucanthus* are almost identical to that depicted for *darlingtoni* (pl. 10, fig. 1) and it seemed probable that the larval habits were similar.

Further digging during June and July 1952 yielded only adults, and no further information was obtained concerning the larval habits.

The adults of *subtropicus* apparently have a long period of adult activity and a moderately long period of oviposition. This conclusion tends to be supported by the third-stage larvae being collected in June and July and callow adults being found in mid-June and late July.

Two larvae of *Eucanthus lazarus subtropicus* collected bear the following data: One third-stage larva found at a depth of 24 inches at Southern Pines, N. C., on July 24, 1951, by H. Howden and Ritcher; one third-stage larva found at a depth of 22 inches with female at Southern Pines, N. C., on June 21, 1951, by H. and A. Howden.

Adult specimens from Southern Pines differ considerably from western (Arkansas) *Eucanthus*, exhibiting the characteristics of *sub-*

tropicus. Several differences are also quite evident between the larvae from the two localities. Not enough larvae have been found to establish any limits of variation and it is possible that the larvae are generally as variable as the adult.

The Southern Pines larvae of *subtropicus* differ from the larvae of *lazarus* described by Ritcher in the following respects: Maximum width of head capsule 2.0 mm., frons on each side with two or three posterior frontal setae. Otherwise, head capsule and antenna (pl. 6, fig. 1) appear similar.

Mandibles similar to the Arkansas specimens but with the anterior portion of the scissorial area produced into a tooth, which may have been worn away in the Arkansas specimens. Maxillary stridulating area with a patch of 12 to 18 small, sharp, conical teeth on each side. Hypopharynx with two slightly asymmetrical oncyli covered with fine setae. Glossa with small setae extending entirely across anterior portion (pl. 6, fig. 6). These setae appear to be lacking in the Arkansas specimens (Ritcher, 1947, p. 25, fig. 30). Haptolachus with apparently two sensilla on each side, mesally with a dense, well defined phoba (pl. 6, fig. 6), which differs somewhat in outline from the Arkansas specimens.

Body (pl. 12, fig. 2) not humped or conspicuously swollen. Segments as described by Ritcher. Anal opening (pl. 6, fig. 7) more Y-shaped than V-shaped. Otherwise structures appear similar.

The most noticeable difference between these larvae and other ones described by Ritcher are in the shape of the glossa and in the fact that the setae extend completely across anterior portion of the glossa in *subtropicus*.

Eucanthus alutaceus Cartwright

Eucanthus lazarus var. *alutaceus* Cartwright, 1944, p. 30. Type, male, Mississippi (USNM).

Length 11 to 14 mm., greatest width 6.5 to 7.5 mm.

Color of dorsum oily dark red-brown; head, thorax, and sutural intervals slightly darker than elytra. The oily appearance is due to the fine alutaceus appearance of the dorsum. Color of antennal club reddish brown. Ventral portions of thorax and abdomen the same or slightly darker in color than dorsally. Tibia darker brown to black. Punctures of vertex very few and sparse in both sexes. Coarse punctures of clypeus, eye canthi, and pronotum identical to those of *E. lazarus lazarus*. Secondary punctures of pronotum very fine, much less noticeable than in most specimens of *lazarus lazarus*. Punctures of elytral striae moderate, separated by a distance usually slightly more than their diameter. Elytral punctures without setae except those on the margins of the elytra and epipleura, where a few of the punctures bear long reddish setae. Width of elytral striae similar to *lazarus lazarus*, second and fourth intervals slightly wider than others, and usually with a line of fine punctures. Humerus of elytron bearing a small sharp tubercle at edge. Foremargin of eye canthus scarcely produced forward at outer angle, slightly more sharply rounded than in typical *lazarus*. The lamellae of the antennal club noticeably longer than the eye (as in *lazarus lazarus*). Male with very pronounced clypeal horn, almost twice as long as wide. Clypeal horn of female small and thin, slightly bifid. Horn of vertex more pronounced, noticeably bifid. Pronotal modifications of male identical to well developed males of *lazarus lazarus*, females similar to females of *lazarus lazarus*.

No useful characteristics were noted in male genitalia or genital capsule.

Variation in size, color, or other noticeable characters is very slight. Cartwright described this species as a variety of *lazarus*, but none of the specimens known have been collected in areas with *lazarus lazarus*. Specimens of *alutaceus* occur along the Gulf of Mexico, within the range of *subtropicus*. As it is very distinct from *subtropicus* it is my opinion that it is a separate species. It is easily distinguished by its dorsal alutaceus appearance.

Most of the known specimens were collected at light and there is no information available concerning either the adult or larval biology.

Specimens examined: 14 males, 9 females.

ALABAMA: 1 male (paratype), Grand Bay, August 1906, Loding (Cartwright).
FLORIDA: 1 female, Gainesville, Feb. 13, 1935 (UnMich).
GEORGIA: 12 males, 8 females. Emory University Field Station, Baker County, Sept. 28 to Oct. 1, 1951, Dec. 29 to Jan. 3, Jan. 17, 18, 21, 22, Aug. 12, 19, 20, Sept. 9, 1952, light trap (Howden). Thomasville, paratype, Apr. 1, 1939, Thames (Cartwright).
MISSISSIPPI: 1 male (paratype), Lucedale, Apr. 7, 1932, Dietrich (Cartwright).

Eucanthus greeni Robinson

Eucanthus greeni Robinson, 1948, pp. 30–31. Type, male, New Mexico (Robinson).

Some of the following discussion has been taken from Robinson's original description and has been added to and rewritten merely for the sake of uniformity.

Length 8.3 to 11 mm., greatest width 4.9 to 6.8 mm.

Color of dorsum shining reddish brown with eyes, tips of horn, edge of eye canthus, anterior and posterior edges of pronotum, and sutural intervals darker brown to black. Antennal club light reddish brown in color. Ventral portions of thorax and abdomen the same or slightly darker in color than dorsally. Tibia dark brown to black. In male, coarse punctures of vertex absent, which is also usually true in the female. Moderately coarse pronotal punctures are present on the anterior margin, on the slightly explanate side margins, on the area behind the tubercles, and on a thin median strip from the carina to the basal margin. The punctures near the lateral margins have about half the rim elevated as in the other species, giving them a tuberculate appearance. Very minute secondary punctures are scattered over the entire pronotum. Crenate punctures of elytral striae shallow, usually separated by about twice their diameter. Elytral punctures without setae except those on the margins and epipleura, where a few of the punctures bear long reddish setae. Five well developed striae between sutural interval and umbone. The second and fourth intervals, which are slightly wider than the adjacent ones, each sometimes having a row of very small punctures. Side margins of pronotum less explanate than in the other species of *Eucanthus*. Humerus of elytron with tubercle at edge lacking or only vaguely indicated. Foremargin of eye canthus (gena) at right angle to side, with angle evenly rounded. The lamellae of the antennal club noticeably longer than the eye (similar to *lazarus lazarus*). Male with pronounced clypeal horn, noticeably longer than wide, bifid at tip. Poorly developed transverse carina on vertex. Pronotal modification with transverse carina only barely indicated, lateral limiting grooves shallow, but lateral pointed carinae well developed. In the female the transverse carina of the vertex is a bifurcate tubercle of equal height with the clypeal horn or sometimes even higher. The pronotal carinae are less developed than in the males and the coarse pronotal punctures are larger and denser.

Robinson differentiates the species from *lazarus lazarus* by the following characters: Eye canthus (gena) more angular, lateral margins of the thorax less explanate, sinuation of hind angle less pronounced, coarse punctures of pronotum slightly less pronounced than those of other species, small punctures of elytral striae, transverse pronotal grooves absent or barely indicated and transverse carina poorly defined. It might be added that the tubercle of the elytral humerus absent or barely indicated appears to be an additional character not mentioned by Robinson. Many of the characters mentioned above intergrade with *lazarus lazarus*; some specimens from Manitoba, Canada, and Thomas County, Nebr., show most of the characterists given for *greeni*. Upon further study *greeni* may prove to have subspecific rather than specific rank.

Specimens examined: 6 males, 9 females (1 male, New Mexico or Arizona (CAS)).

UNITED STATES

ARIZONA: 1 male, Granito Mountain, Yavapai County, Sept. 19, 1929, Kusche (CAS).

NEW MEXICO: 2 females (paratypes), Jemez Mountains, July 24, Aug. 1, Woodgate (CAS). 1 male, Santa Fe, August (CAS).
UTAH: 1 female, Moab, Grand County, Aug. 18, 1929, Gloyd (UnMich).

MÉXICO

CHIHUAHUA: 3 males, 6 females. Samalayuca, Aug. 7, 1950, Smith (AMNH).

Genus *Bolboceras* Kirby

Bolboceras Kirby, 1818, p. 459.—Stephens, 1828, p. 178.—Curtis, 1829, description opposite pl. 259.—Melsheimer, 1845, p. 138.—Cartwright, 1953, p. 101.
Odontaeus Megerle, *in* Dejean, 1821, p. 56, nomen nudum and therefore not valid.
Odantaeus Klug, 1845, p. 37.—Westwood, 1852a, p. 11.—Lacordaire, 1856, p. 144.—Horn, 1870, p. 42.—Blatchley, 1910, p. 938; 1928, p. 29.—Dawson, 1922, p. 193.—Wallis, 1928, pp. 119–128, 151–156, 168–176; 1929, pp. 239–241.
Scarabaeus Fabricius, 1775, p. 11.—Olivier, 1789, p. 63.—Marsham, 1802, p. 8.
Geotrupes Latreille, 1804, p. 145.

GENOTYPE: *Bolboceras mobilicornis* Fabricius, designated by Curtis (1829, page opposite pl. 259).

GENERIC LIMITATIONS: Given by Kirby (1818, p. 459):

Labrum transversum.

Labium bipartitum; laciniis oblongo-quadratis.

Mandibulae corneae, supra concava, altera apice bidentata; dente interiori longiori acuto.

Maxillae apice bilobae; lobis ciliatis; interiori minuto, exteriori subcuneiformi; angulo apicis intus producto acutissimo.

Palpi filiformes.

Mentum subquadratum, integrum.

Antennae undecim-articulatae; articulo primo sublcavato extus minutissimo, secundo cylindrico, proximis sex transversis, ultimis tribus clavam maximan compressam suborbiculatam, pilosam, articulo intermedio saepius penitus tecto et abdito, formantibus.

For a detailed account of additional generic characteristics, consult Wallis (1928, pp. 124–126).

Cartwright (1953) has stated that if one accepts the designation by Curtis (1829, page opposite pl. 259) of *mobilicornis* Fabricius (*armiger* Scopoli) as the type of the genus *Bolboceras*, then *Odontaeus* should be placed in synonymy. As no alternative to this has been found, the name *Bolboceras*, as it is used here, includes all the North American species formerly placed in the genus *Odontaeus* by Wallis (1928, 1929).

Since the species in the genus were carefully described by Wallis (1928, 1929), it is unnecessary to redescribe them here. A few notes on adult morphology have been added, but for keys to the species and descriptions of the adults the reader is referred to the previously mentioned papers by Wallis. In the present discussion, only the known biology and larval morphology of the species are considered.

While the species of *Bolboceras* are, as adults, remarkably alike, the known larvae (three species) are remarkably unlike. The larva of

Bolboceras simi (Wallis) was carefully described by Ritcher (1947, pp. 13, 14). The larvae of *Bolboceras darlingtoni* and *liebecki* are subsequently briefly described for the first time by listing only the structures which differ from Ritcher's description of *B. simi*.

Generic larval characteristics exhibited are: Antennae (pl. 6, fig. 3) with one conical sense organ on penultimate segment; first segment longer than second, which is longer than the third; body not humped (pl. 12, fig. 1); anal opening transverse (pl. 6, fig. 10) with lower anal lobe unpaired; prothoracic legs smaller than others, which are similar in size. Legs 2-segmented, lacking claws.

Members of this genus are found largely in the eastern United States and in southeastern Canada, with the exceptions of one species occurring in the western United States and one in Europe.

Biological information on the genus is rather sparse, almost all of the information previously available having been accumulated by Sim (1930). In addition to this published work, Wallis (1928) quotes a number of statements on biology made by Sim in personal correspondence.

Key to the known larvae of the North American species of Bolboceras

1. Anterior frontal setae absent; glossa not emarginate; hypopharynx symmetrical, pternotorma absent . . . . **simi**
   Anterior frontal setae present; glossa vaguely emarginate; hypopharynx (pl. 6, figs. 8, 11) somewhat asymmetrical, epipharyngeal pternotorma indicated . 2
2. Epipharynx (pl. 6, fig. 12) with a small posterior epitorma; small pternotorma elongate. . . . . **liebecki**
   Epipharynx (pl. 6, fig. 9) with a large posterior epitorma; small pternotorma bulblike . . . . **darlingtoni**

Bolboceras obesus (LeConte)

Odontaeus obesus LeConte, 1859, pp. 282–283 (type, male, LeConte collection, MCZ).—Horn, 1870, p. 47.—Wallis, 1928, p. 127.

Bolboceras obesus (LeConte) is the only species of this genus occurring in the western United States where, from the number of specimens examined, in many places it seems to be rather common.

Specimens have been collected in almost every month of the year, but adult activity appeared from the data to approach its peak in spring and early summer. While the adult habits appeared similar to the eastern species, little biological information has been amassed. Adults have been occasionally noted coming to light. Linsley and Michener (1943, p. 79) made the following observations on *obesus* in the vicinity of Mount Lassen, Calif.: "Several hundred pupae and a few larvae of this species were excavated from the sandy soil of an old road bed in the midst of a manzanita chute on June 16 [1941]. One adult female was found at this time. The pupal cells averaged $8 \times 7 \times 15$ mm., and were found at a depth of from 3 to 6 inches below the surface." No mention was made of larval food, nor was there any description of the larvae or pupae.

Rivers (1886, pp. 69–70) gave an extremely vague description of a larva referred to as *Odontaeus obesus*. He stated that the larva was chestnut in color with tufts of setae around each spiracle and had prominent legs. He found the larva feeding on the rootlets of *Umbellularia californica* Nuttall. The above characteristics from his vague description differ in most respects from the described characters of the larvae of other species. That fact, coupled with the statement "feeding on rootlets," which would seem to be a radical departure from the known larval habits of any *Bolboceras*, makes me feel fairly certain that Rivers was mistaken in his identification of the larva before him.

Careful and accurate descriptions of the biology and of the larva are still needed.

Specimens examined: 67 males, 82 females.

CANADA

BRITISH COLUMBIA: 12 males, 16 females. Agassiz, Creston, courtenay, Duncan, Salmon Arm, Victoria; (2) April, (4) May, (6) June, (2) July, (3) August, (1) September.

UNITED STATES

ARIZONA: 1 male, 2 females. McNary, White Mountains (Gila County); (1) August, (1) September.

CALIFORNIA: 29 males, 34 females. Berkeley, Brownsville, Dutch Flat (Placer County), Kaweah, Lassen National Park, Lelands [Stanford?] University, Nevada County, Piedmont (Oakland), Pollock Pines (El Dorado County), Sequoia National Park, Smith River (Del Norte County), Tulare County; (1) February, (1) March, (5) April, (16) May, (27) June, (1) August.

COLORADO: Included by Wallis.

IDAHO: 1 male, 5 females. Moscow, Sandpoint; (1) April, (1) June, (1) August.

NEVADA: 1 male, 1 female. Carson City; (1) June.

NEW MEXICO: 3 males, 3 females. "Mescalero Apache Indian Reservation, Rio Grand (near Taos)," Tajique; (2) June, (1) July, (2) August.

OREGON: 14 males, 13 females. Corvallis, Dilley, Klamath, La Grande, Medford, Portland, Wallowa Lake; (2) April, (6) May, (2) June, (2) July, (1) August.

UTAH: 1 male, 1 female. Salt Lake City, Warner Ranger Station (La Sal Mountains); (1) June.

WASHINGTON: 5 males, 6 females. Pullman, Seattle, Tenino; (9) May, (1) July.

WYOMING: 1 female. Cheyenne; (1) June.

***Bolboceras falli* (Wallis)**

Odontaeus falli Wallis, 1928, p. 151. Type, male, Foxwarren, Manitoba, June 14, 1927, Wallis (Wallis).

Bolboceras falli is a northern species, closely related to *obesus* (LeConte). It is found during June, July, and August.

The only biological observations were made by Wallis (1929, pp. 123–124), and following are excerpts from his discussion:

> . . . *falli* inhabits somewhat richer land than those [species] taken by Mr. Sim. Mr. Criddle finds them near his home at Aweme, Manitoba, along a road through the aspen poplars, where the soil is a rich dark sandy loam. They appear never to occur on the more sandy uplands a few yards away or on the bare sand which, too, is quite close * * * burrows seem never to be more than a few inches deep.
>
> *Falli* occasionally comes to light at Winnipeg, or rather flies around light, rarely if ever coming directly to it, but circling it and falling to the ground some feet away. On one occasion when sugaring for moths in a rich wood, I noticed a small area of the leaf humus undulating in a most vigorous and extraordinary manner. On rolling the pieces of mould off like a blanket a seething mass of *Odontaeus* was found beneath, rolling, crawling, clinging . . . . They . . . appeared to have gathered for mating purposes, as many of the males had the genitalia partly exposed.

No other new facts on the biology of *B. falli* have been mentioned since Wallis' interesting account.

Specimens examined: 27 males, 22 females.

CANADA

MANITOBA: 11 males, 13 females. Aweme, Foxwarren, Shell River, Winnipeg; (2) June, (18) July, (3) August.
ONTARIO: 2 males. Ottawa.
QUEBEC: Quinze Lake, listed by Wallis.
SASKATCHEWAN: Regina, listed by Wallis.

UNITED STATES

MICHIGAN: 11 males, 9 females. Cheboygan County, Douglas Lake, "Hrn. Mt. [=Huron Mountain?] Club," Houghton County, Marquette, Onota (Alger County); (4) June, (12) July, (4) August.
SOUTH DAKOTA: 1 male. Volga.
WISCONSIN: 2 males. Vilas County, Wisconsin Trout Lake Nursery; (1) July.

Bolboceras thoracicornis (Wallis)

Odontaeus thoracicornis Wallis, 1928, p. 153. Type, male, Cincinnati, Ohio, Dury (Wallis).
Odontaeus cornigerus Blatchley (not Melsheimer), 1910, p. 938.

Only one note was found concerning the biology of this species and this was by Blatchley (1910, p. 938) under the name *cornigerus*. His statement was: "One male from Vigo County, Sept. 28. Taken from beneath a partly burned log in upland, sandy woods."

From the information accumulated by dates of capture, the species seems to be adult in the fall, winter, and spring.

Specimens examined: 18 males, 7 females.

ARKANSAS: 1 male. Camp Chaffee; (1) June.
GEORGIA: 2 males. Atlanta, Clarke County; (1) March, (1) May.

ILLINOIS: 5 males, 3 females. Putnam County, Urbana; (1) May, (3) June (1) October.
INDIANA: 1 female. Hessville; (1) June.
IOWA: 4 males. Ames, Burlington; (2) March, (1) November.
KENTUCKY: 1 male, paratype. No data.
MICHIGAN: 1 male. No data.
MISSISSIPPI: 1 male. Lucedale; (1) September.
NORTH CAROLINA: 1 male. Raleigh; (1) May.
OHIO (Type, Cincinnati; from literature.)
OKLAHOMA: Listed by Wallis.
PENNSYLVANIA: 1 male. Allegheny County; (1) October.
SOUTH CAROLINA: 1 male, 1 female. Clemson College; (2) November.
TENNESSEE: Listed by Wallis.
VIRGINIA: 2 females. No data.
TEXAS: Listed by Wallis.

Bolboceras cornigerus Melsheimer

Bolboceras cornigerus Melsheimer, 1845, p. 138. Type, male, Melsheimer collection (MCZ).
Odontaeus cornigerus (Melsheimer) Horn, 1870, p. 47.—Wallis, 1928, p. 172.

Nothing is known about the biology of this species, for while it has a wide range it appears to be very uncommon. During the course of his work Wallis (1928, p. 173) saw only 10 specimens and I have seen only 19, many of them the same specimens seen by Wallis.

The species is apparently a summer form, having been collected from June to August. Because of the rarity of the species, complete data on the labels and the location of collections housing the specimens are given below.

Specimens examined: 8 males, 11 females (1 male, no data).

GEORGIA: 1 female, Clayton, 2,000–3,000 ft., July, 1910, Davis (AMNH).
MASSACHUSETTS: 1 male, Tyngsboro (Blanchard, at MCZ).
MARYLAND: Listed by Wallis.
MISSOURI: 1 female, no data (Ulke at CM).
NEW JERSEY: 1 male, Paterson, October 27 (AMNH).
NEW YORK: 1 female, Fort Montgomery, July 16, 1920, Schott (Robinson).
NORTH CAROLINA: 1 male, 1 female, Black Mountains, June 20, 1937, in burrows, Cartwright (Cartwright). 1 female, Raleigh, June 20, 1939, Wray (NCSM).
PENNSYLVANIA: 1 female, Allegheny County, June 17, 1888, Klages (CU). 1 male, Guys Mills, July 12, 1937, Casselbury (Robinson). 1 male, Pittsburgh, July 15 (Howden). 1 female, Sumneytown, Aug. 1, 1939, Peters (Robinson).
TENNESSEE: 1 female, no data (Howden). 1 male, north Tennessee, summer 1921, Gill (CU).
VERMONT: 1 female, Bennington County (AMNH).
VIRGINIA: 1 male, 1 female, no data (INHS). 1 female, Nelson County, July 13, 1910. Robinson (AMNH).

Bolboceras liebecki (Wallis)

Odontaeus liebecki Wallis, 1928, p. 173. Type, male, Cornwall, Conn., May 30, 1921, taken under wash-up by Chamberlain (Wallis).

Bolboceras liebecki (Wallis) is a rather common, wide-ranging species found in most of the Northeastern States, and in the mountainous portions of the Southern States. Sim (1930, p. 145) stated that:

> This species is more distinctly characteristic of higher elevations. Unlike the preceding beetle [*simi*] which frequently works in open sunny places, *liebecki* is most likely to be found burrowing on the upper levels of well-shaded hills and mountains. While the beetles, of course, frequently have their homes under the leaf carpet of the forest floor, their diggings are much more easily found along some old wood road in which the little used wheel tracks are bare. For N. J. records I mention the Jersey Jump Mountains, August 17, 1929, and Arney's Mount, August 30, 1927.

Robinson (1938, p. 103) found specimens in a somewhat similar locality under leaves near West Chester, Pa.

I have found *liebecki* in this same type of habitat in North Carolina. At the Mills River recreation area in the Pisgah National Forest two males and a female were dug from shallow burrows, 1 or 2 inches deep, on Aug. 16, 1951. The beetles were found in a small, partially shaded clearing formed by an old road and parking spot at the top of a ridge. There were some sand and numerous pebbles, but for the most part just below the surface there were well-packed clay and stones. In the same area, in mid-August, several other specimens of *liebecki* were taken in sunken cans containing fermenting malt. This would seem to indicate that the adults may feed on decaying plant material (probably with food habits similar to those given for *darlingtoni*).

While all previous records of *liebecki* in North Carolina have been from the mountains, I was extremely fortunate in finding a few specimens on a well-wooded hillside 5 miles northwest of Raleigh. The first specimen, a female tentatively identified as *liebecki*, was taken in a trap baited with ethyl sulfide. As this material did not attract other specimens over a period of several months, its attractiveness, if any, was slight.

In the same area, I had a rearing cage, 6 feet long by 3 feet wide, containing *Geotrupes splendidus splendidus* (Fabricius) in the spring and early summer of 1951. At various times an assortment of fungi and rotten bananas were put in the cage to feed the adult *splendidus*, along with a large quantity of dead leaves, humus, and some cow dung to be used as larval food. Through natural decay, the activities of the beetles, and the subsequent digging of the author the top 2 or 3 inches of soil became well mixed with finely divided humus.

By August 1951 all of the *splendidus* had been removed and the screen top was left partially off of the cage. In April 1952 the cage was again placed in use, this time for *Geotrupes hornii.* After the specimens were put in the cage a quantity of dead leaves and cow dung was added and the screen top was securely fastened. During the time that the cage had not been in use the soil (red clay) had become firmly compacted and, except for a rich layer of finely divided surface humus, had approximately the same profile as the neighboring undisturbed ground.

On June 19, 1952, I was digging in the cage for the *hornii* when an unarmed male *liebecki* was unearthed at a depth of 6 inches. The specimen was in a straight vertical burrow that continued downward into the subsoil, which began at a depth of 6 or 7 inches. The burrow was followed downward with difficulty. The rather dry, compact, red clay soil had to be chipped away, after a time bending the tip of one trowel so badly that a second one had to be used. Sim previously had also noted the propensity of *liebecki* to dig in firmly compacted soils in New Jersey. Wallis (1928, p. 123) quotes from correspondence with Sim as follows:

> Now in the *liebecki* localities the soil is pretty purely clay with numerous pebbles and rock fragments . . . [at] Jenny Jump Mountains in North Jersey the stones are so numerous that a burrow may be very irregular in its downward course. Too, the clay is more firm and difficult to dig [through]. So as I recall them the beetles were found from one inch to six or eight inches down.

While the Raleigh clay lacked the numerous pebbles, it was certainly difficult to dig through.

The *liebecki* burrow continued without turns to a depth of 11 inches. There it turned slightly and, behind a half-inch plug of red clay, it was packed with a mixture of some sand grains and rich, very fine surface humus. In the center of the cell of humus was a second-stage larva, about 12 inches below ground level. The larva, with its cell, was placed alive in a metal salve box. At least one other *Bolboceras* burrow was noted in the cage, but digging was temporarily postponed because of the difficulties that the excavation of the burrow entailed.

The larva in the salve box increased rather rapidly in size, sifting through the sand for the humus. Often a grain of sand, coated with humus, was grasped and rotated between the mandibles and maxillae, and then discarded minus its coating. On June 26, 1952, the larva was noted to be a third instar. On June 28, 1952, the larva died, probably killed by unaccustomed high temperatures (over 90° F. in the room in which the salve box was kept). The larva was immediately preserved and the remaining unconsumed portion of its food supply carefully saved.

Later, this material was taken to the North Carolina Department of Agriculture Soil Testing Laboratory. There, through the kindness of Dr. J. W. Fitts, both the food cell and the surrounding red clay were analyzed for the amount of readily oxidizable organic matter contained. A modified Walkley Black procedure was used (the major chemical components being sulphuric acid and sodium dichromate). This method oxidizes about 90 percent (by weight of soil) of the organic matter. The surrounding red clay contained 0.64 percent organic matter, while the larval food cell contained 7.60 percent. This, according to Dr. Fitts, was very high, the usual surface soil in the immediate area containing only 1 to 1.5 percent oxidizable humus. From this it would appear that, if the adult beetle did not concentrate the surface humus, it at least burrowed in spots with an extremely high surface concentration.

On July 1, 1952, the cage northwest of Raleigh was revisited. On this occasion a quantity of water was taken along and the ground in the cage kept thoroughly soaked. This made the digging of the one located *Bolboceras* burrow considerably easier. At a depth of 7 to 8 inches a female *liebecki* was taken in the burrow. Seven inches farther, at a depth of 14 inches, a fully grown third-stage larva was taken at the bottom of the burrow, which for 1½ inches was packed with humus and sand. Above this was a plug of red clay. The burrow was a single tube, much like that diagrammed for *Bolboceras darlingtoni* (Wallis) (pl. 10, fig. 1). The larva, slightly injured by the trowel, was immediately preserved. No other adults or larvae of *liebecki* were taken in the cage.

It was interesting and fortunate for purposes of identification that both adults remained in the burrows containing the larval cells. Whether the presence of the adults in the burrows indicated any brood care was not ascertained. This and many other questions concerning the life history of *liebecki* still are unanswered.

The subsequent description of the larva of *Bolboceras liebecki* was based on the following material: One second-stage larva collected at Raleigh, N. C., on June 19, 1952, by H. Howden, reared to third instar; and one third-stage larva collected at Raleigh, N. C., July 1, 1952, by H. and A. Howden.

Larvae of *liebecki* differed from Ritcher's (1947, p. 13) description of *simi* in the following respects: Maximum width of head capsule 2.2 to 2.5 mm.; frons on each side with 2 or 3 posterior frontal setae, 2 setae in each anterior angle, 1 or 2 exterior frontal setae and 4 or 5 anterior frontal setae; labrum, antennae (pl. 6, fig. 3), and mandibles similar to *simi;* maxilla differing only by having 4 or 5 setae, absent in *simi*, on the base of the galea; hypopharynx slightly asymmetrical with oncyli separated by triangular structure (pl. 6, fig. 11); glossa emarginate; tormae of epipharynx (pl. 6, fig. 12) united medially, asymmetrical, with a small posterior and anterior epitorma; pternotormae small; slightly spiculate pedium with semicircle of phobae.

Structure of body, anal lobes, and legs differ in no respects from Ritcher's description of *simi*.

Specimens examined: 74 males, 67 females.

CANADA

ONTARIO; Listed by Wallis.

QUEBEC; 3 males, 2 females. Knowlton, Lake Memphremagog; (3) June, (2) July.

UNITED STATES

CONNECTICUT; 1 female. Cornwall; (1) May.

DELAWARE; Listed by Wallis.

ILLINOIS; 1 male, 1 female. No data.

INDIANA; Listed by Wallis.

MAINE; 3 males, 11 females. Bethel, Brunswick, Christmas Cove, Paris; (8) June, (4) July.

MARYLAND; 4 males, 1 female. College Park, Relay; (1) May, (1) June.

MASSACHUSETTS; 10 males, 10 females. Billerica, Cotting(?), Dorchester, Humarock, Malden, Marion, Natick, Pembroke, Petersham, Springfield, Tyngsboro, Wellesley, Woburn; (1) April, (4) June, (5) July, (1) August.

MICHIGAN; 1 male, 1 female. Macatawa Beach, Pentwater; (1) June, (1) July.

MISSOURI; Listed by Wallis.

NEW HAMPSHIRE; 7 males, 5 females. Durham, Franconia, Hampton, Manchester, Rumney, Tamworth, Three Mile Island; (1) May, (2) June, (1) July, (1) August, (1) September.

NEW JERSEY; 2 males. Burlington County, Ramsey; (1) June, (1) August.

NEW YORK; 6 males, 7 females. Bemus Point, Buffalo, Fair Haven, Hancock, Ithaca, Leon, Pike, West Farms; (1) May, (1) June, (1) July.

NORTH CAROLINA; 12 males, 16 females. Black Mountains, Highlands, Mills River, Pisgah Forest, Raleigh, Sunburst; (8) June, (8) July, (8) August.

PENNSYLVANIA; 20 males, 7 females. Allegheny County, Bucks County, Delaware County, Downingtown, Glen Olden, Indian Creek, Jeannette, Mont Alto, Pittsburgh, Sharpsville, Westtown; (8) June, (8) July, (1) August, (1) September.

SOUTH CAROLINA; 1 male, 3 females. Sassafras Mountain; (2) July, (2) September.

TENNESSEE; 1 male. Green Brier; (1) June.

VERMONT; 2 males, 2 females. Stowe; (3) June, (1) July.

VIRGINIA; Listed by Wallis.

WISCONSIN; 1 male. No data.

Bolboceras filicornis (Say)

Geotrupes filicornis Say, 1823, p. 211. Type lost.

Odontaeus filicornis (Say) Horn, 1870, p. 47.—Wallis, 1928, p. 168. Neoholotype, male, Medora, Kans., July 14, 1923, W. Knaus (Wallis).

Because of the confusion in the use of the name *filicornis* until Wallis' work, some of the references using the name "*filicornis*" have been referred to different species and others have been omitted due to the difficulty of assigning them to a species.

It was also difficult, owing to the nomenclatorial confusion, to guess whether some of the early biological notes referred to this species or some other. However, the two references cited below appear pertinent for this species. Knaus (1927, p. 126) mentioned that at Medora, Kans., a few specimens of *filicornis* were collected at light in early July; they were not collected otherwise. Later, he stated (1928, p. 98) that he had taken only two specimens at light that season and had never seen them in burrows in the area. Other references by Knaus (and others) add nothing to this information.

Specimens examined: 19 males, 15 females.

ARKANSAS; 1 male, 1 female. Hope; (1) June.
ILLINOIS; 1 male, 1 female. St. Clair County.
INDIANA; 3 males, 2 females. Hessville, Pine; (1) May, (1) June, (3) July.
KANSAS; 2 females. Medora; (1) May, (1) June.
MICHIGAN; 1 male. Douglas Lake; (1) June.
MINNESOTA; Listed by Wallis.
MISSISSIPPI; 4 males. Camp Shelby; (2) September, (1) October, (1) December.
NEBRASKA; 2 males, 2 females. Antioch (Sheridan County), Halsey, Meadville; (4) July.
NORTH DAKOTA; 1 male. Sully's Hill National Park; (1) July.
OHIO; 1 male. Ashtabula (Whitman Beach); (1) June.
SOUTH DAKOTA; 2 males. Brookings; (2) August.
WISCONSIN; 3 males, 7 females. Douglas County (Gordon State Nursery); (1) May, (2) June, (4) July, (3) August.

Bolboceras floridensis (Wallis)

Odontaeus floridensis Wallis, 1928, p. 155. Type, male, Lake Worth, Fla., collection of Mrs. A. T. Slosson (AMNH).

(?) *Odontaeus filicornis* Blatchley (not Say), 1928, p. 29. (Probably referable to *floridensis*.)

The type of this species, the only male available to Wallis, was unarmed. However, Wallis (1928, p. 156) states that "horned specimens are almost certain to occur and if so, judging from the shape of the male genitalia, the horns will probably be movable." This assumption has proven well founded, as I have examined several well-armed males, all with the "movable" horn.

Almost nothing is known about this seemingly rare species. I collected two specimens; one, a well-armed male, was taken at light, and the second, a female, was collected in a can of fermenting malt. From the collecting dates on the specimens seen, I would assume that this is a winter species, perhaps comparable to *darlingtoni* in habits, but further information is badly needed.

Specimens examined: 4 males, 2 females.

FLORIDA: 1 male, Gainesville (Cartwright). 1 female, Interlachen, Nov. 18, 1951, H. Howden (Howden). 1 female, Lake Placid, Archbold Biological Station, Feb. 5, 1943 (AMNH). 1 male, Miami, Feb. 25, 1934 (Robinson). 1 male, St. Augustine, Mar. 4, 1940, Van Dyke Collection (CAS). 1 male, Tarpon Springs, Mar. 20, 1950, light, H. and A. Howden (Howden).

Bolboceras simi (Wallis)

Odontaeus simi Wallis, 1928, p. 170. Type, male, Merchantville, N. J., July 27, 1926, Sim (Wallis).
Odontaeus filicornis Blatchley (not Say), 1910, p. 938.

The following excerpt from Sim (1930, p. 145) presents all the biological information available on the species:

> The type locality for the present species is the golf course at Merchantville, N. J. This seems to be a characteristic habitat. Throughout July and August the little beetles give evidence of their presence on green and fairway by pushing up small but conspicuous piles of sand . . . *Simi* has been found, also, associated with *darlingtoni* at Rancocas Park, in a pine-oak bush lot near Riverside and associated with *liebecki* on Arney's Mount.

Wallis (1928, p. 122) mentioned, quoting from correspondence with Sim, that the species was found in the open and was not present in fall, winter, or spring. Sim concluded that the beetles' actions were apparently the same as *darlingtoni* in burrowing habits and biology.

Sim collected two third-stage larvae with associated adults in September 1927 at Riverside, N. J. One larva pupated on Nov. 10, 1927. Subsequently, the larva was carefully described by Ritcher (1947, p. 13). Included here for purpose of identification are a few of the characteristics of *simi* mentioned by Ritcher.

Anterior frontal setae absent. Hypopharynx symmetrical; glossa not emarginate. Tormae of epipharynx united mesally; almost symmetrical, having a large posterior epitorma and a smaller anterior one. Pternotorma absent. Pedium surrounded by a fairly uniform arc of phobae and covered with spicules.

Specimens examined: 27 males, 19 females.

CONNECTICUT: Listed by Wallis.
INDIANA: 1 female. Hessville.
MASSACHUSETTS: 2 males, 1 female. Sherborn, Tyngsboro; (1) June.
MICHIGAN: 1 female. Paw Paw Lake; (1) July.
MINNESOTA: 1 male. Erskine; (1) August.
NEW HAMPSHIRE: 1 female. Manchester.
NEW JERSEY: 23 males, 14 females. Burlington County, Merchantville, Pine Valley, Riverton, Vineland (Maurice River); (5) June, (26) July, (3) August.
NEW YORK: 1 male. Southampton.
PENNSYLVANIA: 1 female. Allegheny; (1) August.

Bolboceras darlingtoni (Wallis)

Odontaeus darlingtoni Wallis, 1928, p. 175. Type, male, Rancocas Park, N. J., Oct. 27, 1926, Sim (Wallis).

Bolboceras darlingtoni (Wallis) has been recorded as frequenting sandy areas in the pine and deciduous forests of the East Coast States from Georgia northward to Massachusetts. It was usually found on the coastal plain, but occasional specimens have been collected in mountainous areas. To cite an example of this odd distribution, several specimens of *darlingtoni* were taken along with a number of *liebecki* in the mountains at the Mills River recreation area in the Pisgah National Forest, N. C. The burrows of both species were found 2 to 4 inches deep in an old dirt road at the top of a small hill where the soil consisted of packed clay with numerous small rocks.

In sandy areas *darlingtoni* makes an almost vertical burrow from 8 to 18 inches deep. Sim (*in* Wallis, 1928, p. 123) mentioned finding the species working in pairs, but I rarely found a pair in the same burrow.

In North Carolina, adults were active in fall, winter, and spring. Specimens were occasionally found coming to light on warm nights in October, November, December, and January. Most of the fresh burrowing activity was noted in April, May, and June, and again in October.

On Oct. 18, 1952, in a sandy pine woods near Raleigh, N. C., I found two male and four female beetles in shallow burrows under what appeared to be "atypical puff balls." The beetles were feeding on decaying pieces of these puff balls which gave off an odor similar to fermenting apple cider. Several of them were later identified by Dr. A. Kelman, North Carolina State College, and Dr. Couch, University of North Carolina, as *Rhizopogon nigrescens* Coker and Couch (Hymenogastraceae, Gastromycetes). Previously, Sim (1930, p. 144) had noted that *darlingtoni* fed on *Rhizopogon pachyphloes* Zeller and Dodge. The *Rhizopogon* mentioned by Sim was entirely subterranean, the beetles burrowing down to it. Bedel (1911, p. 99) stated that he believes that the adult European *Bolboceras* "*armiger*" Scopoli had feeding habits similar to those of *Bolbelasmus gallicus* Mulsant, which has been recorded as feeding on a species of *Rhizopogon* and other types of fungi. No further references to the adult food habits were seen. Adults of several species were occasionally attracted to fermenting malt, which might indicate more generalized feeding habits than have been indicated by the data available.

While Sim (1930, pp. 139–147) recorded his observations about the habits of the adults, the larval biology of *darlingtoni* eluded him.

Dr. P. O. Ritcher and I were able to work out, at least partially, the biology and life history of these elusive beetles.

On Apr. 19, 1951, in the center of a burned-over area in a sandy pine, deciduous woods at Faison, N. C., two small push-ups of yellow sand were noted. One of these yielded a well-armed male at a depth of 5 inches. Under the second push-up a pair of *darlingtoni* was found in a small cell at a depth of 11 inches. A few inches away, apparently not connected to either of the two burrows containing adults, another small cavity was found at a depth of 11½ inches. In the cavity was a single elliptical egg, 2.4 mm. long by 1.5 mm. wide. Just above the cavity containing the egg (pl. 14, fig. 1) was the food supply. This consisted of very finely divided surface humus mixed with sand packed into the slightly sinuate burrow.

Through the kindness of Dr. J. W. Fitts, Soil Testing Laboratory, North Carolina Department of Agriculture, a portion of this black humus used for larval food by *darlingtoni* was analyzed. The analysis was made using a modified Walkley Black procedure to show the amount of readily oxidizable organic matter that the material contained. The larval food cell was found to have 3.44 percent organic matter compared to 0.16 percent found in the surrounding subsoil. Normally, the surface soil in the area contained only about 1 percent readily oxidizable organic matter. It would appear that, if the adult beetles actually did not concentrate the humus in the burrows, they at least chose areas that have a very high surface concentration of organic matter in which to burrow.

The egg collected at Faison was carefully transferred to a metal salve box along with the food material provided and was taken into the laboratory. Eleven days later, on Apr. 30, 1951, the larva emerged from the egg and the following day began feeding on the humus. Growth was quite rapid, the larva becoming a second instar on May 18 and a third instar on June 14. Several days after this the larva was preserved.

On June 19, 1951, the same area in the Faison woods where the egg had been collected was revisited. A fresh burrow was noted only a foot away from the previous excavation. The burrow yielded a single female *darlingtoni* and nothing else. No other activity was indicated by the surface push-ups, but the area of excavation was extended. At a depth of 10 inches in a rather winding burrow five-sixteenths of an inch in diameter, packed with the finely divided black humus, a third-stage larva was found.

Further digging yielded seven additional larvae in the same type of slightly sinuous burrows packed with surface humus. The food cell varied from 6.5 to 8 mm. in diameter and from 2 to 3 inches in length. The larvae were found at depths of 8¼, 8½, 9, 9¼, 10½, 11½, and 12 inches. All the larvae were third-stage. Two specimens had moved below the food material in the burrow and made a pupal cell one-half to 1 inch to the side and below the burrow. One of the specimens in the cells, a prepupa, pupated on June 25. The position of the pupal cell in relation to the burrow is diagrammed in plate 10, figure 1.

Further excavation on June 26, 1951, yielded a male *darlingtoni* in an old burrow 7 inches deep, and a male pupa in a cell 12 inches deep, 1 inch from the humus-packed burrow. A second pupa was taken in a cell one-half inch from the burrow at a depth of 10½ inches. No additional specimens were found then or on later visits.

The life cycle of *Bolboceras darlingtoni*, in North Carolina, can be sketchily summarized as follows: Egg laying occurred in mid-April with the incubation period lasting approximately 11 or 12 days. The first instar (one example) occurred in early May, remaining as a first instar for 18 days. From May 18 to June 14, a period of 30 days, the larva was in second-stage. The exact length of time spent as a third instar was not obtained, but appeared to be from 2 to 3 weeks, with a prepupal stage of about 3 or 4 days. Length of pupation in one case was 24 days, the adult appearing on July 14 and taking a week or more to loose its callow appearance. At Raleigh, some adult feeding on *Rhizopogon nigrescens* Coker and Couch was noted in October. *B. darlingtoni* overwinters in the adult stage and becomes active on warm winter evenings. The period of oviposition was in the spring.

The time of mating was not ascertained, nor could it be definitely decided whether the burrows containing the larvae were single tubes or whether they were branched. If asked to hazard a guess on the latter, I would say that the burrows were branched, basing the guess on the following observation: On the surface of the 6 square feet dug up, there were only 4 push-ups, while there were 11 larvae found in the burrows under these push-ups.

Description of the immature stages of *Bolboceras darlingtoni* is based on the following material, all of which was collected at Faison, N. C., by P. O. Ritcher and H. Howden: One egg collected Apr. 19, 1951, reared to third instar; nine third-stage larvae collected June19, 1951; three being allowed to pupate, one emerging as adult male Aug. 26, 1951, before other pupae were preserved; two pupae collected June 26, 1951.

Third-stage larvae of *darlingtoni* differed from Ritcher's (1947, p. 13) description of *simi* in the following respects: Maximum width of head capsule 2.1 to 2.4mm. Frons on each side with 2 or 3 posterior frontal setae, 2 setae in each anterior angle, 3 exterior frontal setae, and 1 or 2 anterior frontal setae. Antennae similar to those of *simi* and *liebecki* (pl. 6, fig. 3), as are the mandibles and maxillae. Hypopharynx (pl. 6, fig. 8) slightly asymmetrical, with oncyli rather widely separated anteriorly. Glossa slightly emarginate. Tormae of epipharynx (pl. 6, fig. 9) united mesally, with a large posterior epitorma and a very small, asymmetrically placed anterior epitorma. Tormae on each side forming a bulblike suggestion of a pternotorma. Pedium anteriorly with structure appearing to be an unattached, circular portion of the epitorma, and surrounded with irregularly placed phobae (pl. 6, fig. 9). Pedium generally finely spiculate.

Structure of body (pl. 12, fig. 1), anal lobes (pl. 6, fig. 10), and legs differed in no respect from Ritcher's description of *simi*.

Egg oval (pl. 14, fig. 1), yellowish white, 2.4 mm. in length, 1.5 mm. in greatest width.

First-stage larva with greatest width of head capsule about 1.5 mm. Body shape same as third instar.

Head capsule of second-stage larva about 1.9 mm.; skin was lost.

Specimens examined: 31 males, 35 females.

DISTRICT OF COLUMBIA: Listed by Wallis.
GEORGIA: 4 males, 1 female. Atlanta; (2) January, (2) March, (1) November.
MARYLAND: 1 female. College Park; (1) October.
MASSACHUSETTS: 1 female. Tyngsboro; (1) October.
MISSISSIPPI: 1 female. Lucedale; (1) December.
NEW JERSEY: 11 males, 18 females. Rancocas Park; (14) February, (2) March, (1) April, (4) September, (3) October, (2) November.
NEW YORK: Listed by Wallis.
NORTH CAROLINA: 11 males, 11 females. Faison, Mills River, Newton Grove, Raleigh, Southern Pines, Tarboro, Winston-Salem; (1) January, (7) April, (4) May, (2) June, (1) July, (2) August, (1) October, (3) November, (1) December.
SOUTH CAROLINA: 5 males, 2 females. Clemson College, Florence, Windsor; (2) January, (1) April, (4) November.
VIRGINIA: Listed by Wallis.

Bolboceras alabamensis (Wallis)

Odontaeus alabamensis Wallis, pp. 239–241. Type, male, Grand Bay, Ala., March 1908, Loding (Wallis).

So few specimens of this species have been collected that little has been noted concerning its habits. Specimens in my collection from the Emory University Field Station were all taken in light traps.

Further study of other specimens might indicate a complex of forms rather than a single species. I found some differences in male genitalia, but additional specimens are needed to satisfactorily establish the variation within the species and to ascertain its habits.

Specimens examined: 4 males, 5 females (1 female, no data, ANSP).

GEORGIA: 4 males, 4 females: 2 males, 3 females, Emory University Field Station, Baker County, Aug. 17–20, 31, Sept. 3, 1951, Jan. 3–4, 1952, Jan. 4–5, 1951, Feb. 1–6, 1952, light trap (Howden). 1 male, Thomasville, Apr. 6–10, 1940, Field (CNHM). 1 male, 1 female, Thomasville, Mar. 31, 1940, Thames (Cartwright).

Genus *Geotrupes* Latreille

Geotrupes Latreille, 1796, p. 6; 1802, pp. 142–144; 1804, pp. 142–147; 1806, pp. 91–95; 1810, p. 428; 1829, pp. 542–546.—Kirby, 1818, p. 461.—Mulsant, 1842, pp. 353–367.—Jekel, 1865, pp. 513–618.—Horn, 1868, pp. 313–322, 1880, pp. 139–154.—LeConte and Horn, 1883, p. 243.—Blanchard, 1888, pp. 103–110.—Boucomont, 1902, pp. 1–10; 1906, pp. 1–44; 1911, pp. 344–345; 1912, pp. 19–33.—Dawson, 1922, pp. 195–197.—Blatchley, 1910, pp. 938–939; 1928, pp. 44–45.—Bradley, 1944, p. 112.—Ritcher, 1947, pp. 1–27.—Potts, 1948, pp. 23–26; 1951, pp. 49–51.—Townes and Howden, 1952, pp. 207–209.

Geotrupes Fabricius (not Latreille), 1798, pp. 1–7.—Walckenaer, 1802, p. 1.

Scarabaeus Linné, 1758, pp. 345–354.—Fabricius, 1775, p. 17; 1798, pp. 23–34.—Olivier, 1789, pp. 55–69.—Marsham, 1802, p. 8.

GENOTYPE: *Scarabaeus stercorarius* Linné designated by Latreille (1810, p. 428) (see opinion 11 of the International Commission of Zoological Nomenclature). If this designation is not acceptable to some investigators, then Curtis' designation (1829, page opposite pl. 266) of *stercorarius* Linné should be. There has been some doubt concerning the application of the name *Geotrupes*, but I believe the above usage is correct. For a full discussion of the problems involved, consult Potts (1951) and Townes and Howden (1952).

GENERIC LIMITATIONS: Given by Latreille (1796, p. 6):

Antennes de onze articles. Lèvre superieure avancée. Mandibules fortes. Lèvre inférieure a deux divisions alongées.

C. H. chaperon rhomboidal. Écusson. Jambes antérieures dentelées.

Other useful characteristics, besides the 11-segmented antennae, are general oval body shape, antennal club 3-segmented, small, not convex on both sides, eyes divided by canthus, color dark iridescent blue or green to dark brown or black, front femur with conspicuous hairy spot on anterior internal surface, elytra usually striate, thorax similar in both sexes, mid- and hind tibiae with apical transverse carina complete.

In addition to the characters mentioned above, many males of the species of *Geotrupes* exhibit striking external modifications. These sexual differences have caused a number of investigators to propose subgeneric groupings for the various species. Many of these groupings appear justified but others contain a rather unrelated mixture of structurally different species.

It is in this category of unrelated species that many of the North American species seem to fall. The subgenera *Cnemotrupes* Jekel (type *Geotrupes blackburnii* Fabricius) and *Onychotrupes* Jekel (type *Geotrupes splendidus* Fabricius) are separated only on the basis of an enlarged middle tarsal claw in the males of the latter. In other morphological respects *Geotrupes splendidus* is closely related to *G. blackburnii*, while *G. ulkei* Blanchard and *G. egeriei* Germar, both in

TABLE 1.—*Some differences between the North American species of* Geotrupes

Species	Color	Striae and punctures	Sutural striae complete to elytral base	Foretibial modifications of male	Posterior pronotal margin	Tarsal claws of male
hornii	Black	Strong str., moderate punct.	Complete	Carina beneath extreme antepenultimate tooth	Complete	Not modified.
balyi	Black with purple, blue, or green iridescence.	Strong str., moderate punct.	Complete	No modification	Complete	Not modified.
stercorarius	Black dorsally, purple ventrally.	Strong str., vague punct.	Complete	Deflexed antepenultimate tooth.	Complete	Not modified.
opacus	Alutaceous black	Obsolete str., strong punct.	Incomplete	A.e.t.* produced forward.	Complete	Not modified.
semiopacus	Greenish or purplish black.	Strong str., no punct.	Incomplete	A. e. t. produced forward.	Incomplete medially.	Enlarged middle claw.
splendidus splendidus	Brilliant green	Strong str., strong punct.	Incomplete	A. e. t. produced forward.	Complete	Enlarged middle claw.
s. miarophagus	Coppery green to purplish black.	Strong str., strong punct.	Incomplete	Identical to *s. splendidus*.	Complete	Enlarged middle claw.
blackburnii blackburnii and *b. excrementi.*	Black	Strong str., moderate punct.	Incomplete	A. e. t. produced forward.	Complete	Not modified.
ulkei	Dark brown	Obsolete str., strong punct.	Incomplete	A. e. t. produced forward.	Incomplete laterally.	Not modified.
egeriei	Black with traces of blue or green.	Strong str., strong punct.	Incomplete	A. e. t. produced forward.	Complete	Not modified.

*Anterior external tooth.

TABLE 2.—*Summary of biological information on North American* Geotrupes

Species	Oviposition time	Length of immature development	Time of adult emergence	Usual adult food	Usual larval food	Avg. depth of burrow	No. cells per burrow
opacus	(?)	(?)	Fall?	Dung	Dung?	(?)	(?).
ulkei	Spring	1 summer?	Fall	Fungi	Dead leaves	2 or 3 in.	1 or 2.
blackburnii blackburnii, b. excrementi.	Winter, early spring	1 summer	Sept.–Oct.	Dung	Cow dung, some leaves.	4 to 7 in.	1.
egeriei	Aug. to Nov.	2 summers?	Late summer	Fungi, dung	Old cow dung	9 to 30 in.	1 or more?
hornii	Early summer	2 summers	Late summer	Fungi	Old cow dung	15 to 24 in.	3 or 4.
balyi	(?)	(?)	Late summer?	Fungi	(?)	(?)	(?).
stercorarius	Spring	2 summers	Fall	Dung	Cow or horse dung	2 to 10 in.	4 or more.
splendidus splendidus	Spring	1 summer	Sept.–Oct.	Fungi	Dead leaves	5 to 8 in.	1.
s. miarophagus (one case)	Spring	1 summer	Sept.–Oct.	(?)	Dead grass	(?)	Several.
semiopacus	(?)	(?)	Fall?	Fungi	(?)	(?)	(?).

the same subgenus with *blackburnii*, are radically different, particularly in body shape and size. These differences become even more striking when one includes the larval morphology in the comparisons. While it is very difficult to separate the larva of *G. splendidus* from that of *blackburnii*, the separation of *ulkei* is slightly more apparent and the larva of *egeriei* is quite different from any of the above-mentioned species.

However, the larvae of several of the species remain to be discovered and any changes in the subgeneric concepts of *Geotrupes* should be delayed until the unknown larvae can be procured and studied. The present subgeneric groupings as delimited by Jekel (1865) are *Geotrupes*: *stercorarius* (Linné); *Anoplotrupes*: *balyi* Jekel, *hornii* Blanchard; *Cnemotrupes*: *blackburnii* (Fabricius), *blackburnii excrementi* Say, *egeriei* Germar, *opacus* Haldeman, *ulkei* Blanchard; *Onychotrupes*: *semiopacus* Jekel, *splendidus* (Fabricius), *splendidus miarophagus* Say.

The ten native species and subspecies of North American *Geotrupes* are quite diversified and the affinities of our species with European or Asiatic species are not clear. *Geotrupes balyi* and *hornii* appear rather closely related to some of the European species. *G. stercorarius* (Linné), native of Europe and Asia, has recently become established in Canada (Brown, 1940, p. 74). The other species are quite divergent, with little resemblance to foreign species. *G. occidentalis* Horn is synonymous to *laevistriatus* Motschulsky, a Japanese species which has evidentally not become established in this country.

The North American species of the genus are quite variable (table 1) in size, shape, and often in color, and because of this variation considerable confusion has resulted in their nomenclature. Jekel (1865), in his lengthy monograph, named from single specimens a number of North American species, later synonymized by Horn (1868). Because of my inability to examine Jekel's types, the present synonymy may not be correct. However, I was able to personally examine the types of LeConte, Horn, and Blanchard, and had specimens compared with the Fabrician types, so the usage of the majority of names should be reasonably accurate.

The range of the genus *Geotrupes* in North America is limited to the states east of the Rocky Mountains, from southern Canada to México.

Adult and brood habits of the species vary greatly and will be discussed for each species after the adult description.

Key to the North American species of Geotrupes

1. Elytra with strongly impressed striae 3
   Elytra with striae vaguely impressed or obsolete 2
2. Color dull black, dorsal surface finely granulate (Indiana, Illinois, Kansas,

Missouri, Texas, Oklahoma) . . . . **opacus** Haldeman
Color shining dark brown, dorsal surface not finely granulate (Virginia, North Carolina, and Alabama) . . . . **ulkei** Blanchard

3. Anterior tooth of foretibia of males never expanded and produced inwardly; females (and males) with longitudinal row of setigerous punctures next to longitudinal carina on flattened dorsal surface of front tibia interrupted by a strong curved carina extending onto the penultimate tooth on outer margin (pl. 2, fig. 14) 4
Anterior tooth of foretibia of males expanded and produced inwardly; females (and usually males) with longitudinal row of setigerous punctures next to the longitudinal carina on flattened dorsal surface of front tibia not interrupted by a strong curved carina extending onto the penultimate tooth (pl. 2, figs. 12, 13); a weak carina sometimes present in males of *egeriei*. . 6
4. Femora without pronounced iridescent bluish or purple color; hind femur of male without posterior carina produced into a tubercle near the coxa; size generally 15 mm. or smaller. 5
Femora with pronounced iridescent bluish or purple color; hind femur of male with posterior carina produced into a tubercle near the coxa; size generally 20 mm. or over (Canadian Maritime Provinces) . . **stercorarius** (Linné)
5. Pronotum and elytra completely black without any trace of iridescent blue or purple; males with anterior femur bearing a tooth at base of forward margin, female without tooth (southeastern Canada to Georgia, generally east of the Mississippi River) . . . . **hornii** Blanchard
Pronotum and elytra not completely black, with at least some trace of iridescent blue or purple; males without anterior femur bearing a tooth at base of forward margin, not externally different from female (southeastern Canada to Georgia, generally east of Mississippi River) . . . **balyi** Jekel
6. Longitudinal carina on flattened dorsal surface of front tibia not curving towards penultimate tooth of outer margin, generally close to inner margin throughout its length (pl. 2, fig. 13); punctures of elytral striae shallow, usually not having a more pronounced iridescent color than surrounding surfaces 7
Longitudinal carina on flattened dorsal surface of front tibia curving slightly toward or extending to outer margin when opposite penultimate tooth, approximately median in position, particularly apically (pl. 2, fig. 13); punctures of elytral striae deep, usually having a more pronounced iridescent color than surrounding surfaces (southeastern Canada to Florida).
egeriei Haldeman
7. Posterior ventral longitudinal setigerous carina on hind femur not extending two-thirds the length of the femur; elytral striae rough, with at least a trace of punctures 8
Posterior ventral longitudinal setigerous carina on hind femur extending more than two-thirds the length of the femur; elytral striae smooth, lacking any trace of punctures (southeastern Canada to North Carolina).
semiopacus Jekel
8. Row of longitudinal setigerous punctures which is contiguous basally with the longitudinal carina of the foretibia, apically separated from the carina, forming a smooth area usually several millimeters in length between the carina and the punctures (pl. 2, fig. 13); color dorsally usually black or dark bronzy brown; middle tarsus of male similar to that of female, not thickened. Subspecies of *blackburnii* (Fabricius) 10
Row of longitudinal setigerous punctures which is basally contiguous with the longitudinal carina of the foretibia apically contiguous or only slightly

separated from the carina, not forming a smooth area between the carina and the punctures; color dorsally usually green, bronze, or purple; middle tarsus of male not similar to that of female, thickened (southeastern Canada to Florida). Subspecies of *splendidus* (Fabricius) 9

9. Color bright green, size moderate (generally east of Appalachian Mountains). **splendidus splendidus** (Fabricius)

   Color coppery green to purplish black, size large (generally west of the Appalachian Mountains) . . . . **splendidus miarophagus** Say

10. Base of left dorsal paramere of male genitalia not extending posteriorly beyond base of right dorsal paramere (pl. 4, figs. 4, 5); unevenly spaced teeth on underside of foretibia of male largest apically, becoming evenly smaller basally (pl. 2, fig. 10); punctures in elytral striae usually moderately pronounced (Massachusetts and eastern Ohio south to Florida east of the Appalachian Mountains) . . . . . . **blackburnii blackburnii** Fabricius

    Base of left dorsal paramere of male genitalia extending posteriorly beyond base of right dorsal paramere (pl. 4, fig. 6); unevenly spaced teeth on underside of foretibia of male largest in the center, becoming smaller both apically and basally (pl. 2, fig. 11); punctures in elytral striae usually only vaguely defined (Iowa, Indiana south to Texas, generally west of the Appalachian Mountains) . . . . **blackburnii excrementi** Say

Key to the known larvae of the North American species of Geotrupes

1. Sclerotized lines of the endoskeletal figure of the ventral anal lobe almost meeting, forming a triangular area, and below this continuing on to fuse with the sclerotized line defining the ventral edge of the anal lobe (pl. 7, figs. 15, 17) 2

   Sclerotized lines of the endoskeletal figure of the ventral anal lobe meeting and forming a triangular area, without the narrow continuation to the ventral edge of the anal lobe . . . . **stercorarius** (Linné)

2. Tip of tibiotarsus of each leg with tubercle bearing a minute brownish claw . 3

   Tip of tibiotarsus of each leg usually with a small tubercle (pl. 7, figs. 10, 16), but in all cases the minute brownish claw is lacking 5

3. Epipharynx bearing, anterior to the pedium, an irregular transverse row of 10 to 12 very stubby setae (pl. 8, fig. 1); posterior epitorma of epipharynx slightly longer than anterior epitorma (pl. 8, fig. 1). **splendidus splendidus** (Fabricius)

   Epipharynx bearing, anterior to the pedium, an irregular transverse row of 5 to 7 setae, not differing greatly in length from the setae on the chaetoparia; anterior epitorma of epipharynx slightly longer than posterior epitorma . . 4

4. Setae in front of the hypopharyngeal oncyli and behind the anterior transverse row of sensilla with their origins much nearer in position to the midline than are the outermost sensilla (pl. 8, fig. 2). **blackburnii blackburnii** (Fabricius)

   Setae in front of the hypopharyngeal oncyli and behind the anterior transverse row of sensilla with their origins about the same distance from the midline as the outer sensilla (pl. 8, fig. 5) . . . . . . **blackburnii excrementi** Say

5. Maxilla with inner surface of galea (pl. 7, fig. 1) bearing only 6 or 7 setae; epipharynx with row of fine setae extending from tip of posterior dexiopternotorma to tip of posterior epitorma . . . . **ulkei** Blanchard

   Maxilla with inner surface of galea bearing 9 or more setae; epipharynx lacking a continuous row of setae from the tip of the posterior dexiopternotorma to tip of posterior epitorma. 6

6. Dorsal annulets of abdominal segments 6 to 8 with a transverse patch of setae; 7 or 8 stridulatory teeth on the fused trochanter-femur and 1 tooth on the tibiotarsus of the reduced metathoracic legs; epipharynx in front of phoba with a single sensilla well isolated from either setae or row of sensilla at the base of the phoba (pl. 8, fig. 4) . . . . **egerici** Haldeman

   Dorsal annulets of abdominal segments 6 to 8 lacking a transverse patch of setae; 9 to 11 stridulatory teeth on the fused trochanter-femur and 5 to 8 small teeth on the tibiotarsus of the reduced metathoracic legs; epipharynx in front of phoba without a single sensilla isolated from the row of sensilla at the base of the phoba (pl. 8, fig. 7) . . . . **hornii** Blanchard

(The larvae of *G. opacus*, *semiopacus*, *splendidus miarophagus*, and *balyi* are not known to the writer.)

Geotrupes opacus Haldeman

Geotrupes opacus Haldeman, 1853, p. 362 (type, LeConte collection, MCZ).—Jekel, 1865, pp. 533–594.—Horn, 1868, p. 318.—Blanchard, 1888, p. 110.—Blatchley, 1910, p. 939.—Dawson, 1922, p. 196.—Bradley, 1944, p. 112.

Geotrupes haldemani Jekel, 1865, p. 593.—Horn, 1868, p. 318.

Geotrupes chevrolati Jekel, 1865, p. 593.—Horn, 1868, p. 318.

Length 11 to 17.5 mm., greatest width 7 to 11 mm.

Color of dorsum dull brown to black, sometimes with traces of blue or green along margins of pronotum, elytra, and in some coarse punctures. Dull coloration is due to finely alutaceous surface of dorsum. Ventral surface black, sometimes with traces of bluish iridescence. Legs black. Antenna and antennal club usually piceous. Clypeus, eye canthus, and vertex rather finely densely punctured except on the tip of the rather pronounced clypeal tubercle. The tubercles near the eyes vaguely indicated. A distinctly indented narrow line runs from the middle of the vertex forward to the clypeus, where it bifurcates and runs along the posterior edge of the clypeus almost to the outer margins. Clypeus margined, varying greatly in shape, generally evenly rounded, but sometimes sharply arcuate either anteriorly or laterally. No other structural differences appear constantly correlated with these variations. The margined eye canthi are also rather variable in shape, but usually evenly arcuate and form a moderately obtuse angle with the clypeal edge. Pronotum completely margined, quite convex, but with considerable variation in the curvature of the lateral margins. Coarse punctures scattered over most of pronotum, most pronounced laterally. A line of coarse punctures may be present along the pronotal midline, and a small circular punctate depression is usually present laterally. Minute secondary punctures are sometimes present, scattered over entire pronotum. Scutellum usually coarsely punctured, roughly triangular with sides arcuate. Elytral striae obsolete, usually indicated only by somewhat irregular rows of coarse punctures. Elytral margin narrow, slightly wider anteriorly.

Foretibia of male with the anteriormost of the 6 or 7 teeth of the outer margin expanded forward and bifurcate. In both sexes there are small teeth on a ridge on the inner flattened surface of the foretibia. Dorsally there is a raised dorsal longitudinal carina extending along the inner edge, with a small sharp extension inward, almost onto the base of the penultimate tooth. Closely adjacent row of setae only interrupted by the small inward carinal extension. External face of tibia of mesothoracic leg with three complete transverse carinae, tibia of metathoracic leg with three, sometimes four, complete transverse carinae, with two or three partial carinae. Posterior edge of hind femur of male produced into a tubercle near coxa, which also protrudes slightly posteriorly. Tarsal claws similar in both sexes.

Genital capsule and genitalia of male well developed (pl. 5, fig. 2), rather similar to that of *egeriei*, but generally less elongate.

Variation within the species is considerable, but apparently is not due to population differences. Size and shape of clypeus and pronotum are extremely variable.

This species can be easily distinguished by its finely alutaceous dorsal surface, imparting a dull appearance to its brown or black color. Also, the lack of striae, fine dense clypeal punctures, piceous antennal club, and structure of male genitalia (pl. 5, fig. 2) will delimit the species.

Geotrupes opacus Haldeman has been collected in moderate numbers in sandy localities from South Dakota southward to Texas and from Ohio westward to Colorado.

Brown (1927, p. 28) mentioned that *opacus* could be collected from August to May in sandy localities in Payne County, Okla. Knaus (1916, p. 81) recorded taking three specimens on May 7 in the sand hills near Medora, Kans. One of the longer accounts of the species was published by Jones (1886, p. 80), in which he mentions finding in November a number of specimens under some fresh dung along the roadside between Manhattan and Salina, Kans. He observed that, "I have almost always taken it where I have found no other scavengers at work, except *Aphodius*, and a few *Staphylinus* perhaps, and I have always taken it either very early in spring or late in the fall. Generally, I have taken it on low bottom land, or on sand bars in the river, where cattle are wont to drink . . . ."

There are a few other desultory notes concerning the adults, but nothing has been published on the life history of the species.

Specimens examined: 128 males, 111 females.

ARKANSAS: 18 males, 12 females. Hope, Imboden, Marion County; (2) September, (6) November.

COLORADO: 1 female. No data.

ILLINOIS: 10 males, 10 females. Mason City, north Illinois, Topeka; (13) October.

INDIANA: 4 males, 4 females. Michigan City, Miller, Mineral Springs, Ogden Dunes (on Lake Michigan), Pine; (2) April, (2) May, (2) September (1) October.

IOWA: 2 males, 3 females. Columbus Junction, Sergeant Bluff; (2) September.

KANSAS: 20 males, 22 females. Douglas County, Lawrence, Medora, Mount Hope, Roybury (Reno County), Salina, Topeka, Wichita; (1) April, (3) May, (2) June, (15) September, (1) October, (2) November.

LOUISIANA: 7 males, 3 females. Leesville, Natchitoches; (8) September, (1) October.

MICHIGAN: 4 males, 3 females. George Reserve (Livingston County), Portage Lake (Washtenaw County); (1) May, (1) September, (4) October.

MISSOURI: 8 males, 5 females. Columbia, Galloway, Kimmswick (Jefferson County), Malden, New Hartford, St. Louis; (1) March, (1) April, (1) September, (5) October, (1) November.

NEBRASKA: 5 males, 8 females. Bennet, Frenchman River, Hyannis (Grant County), Malcolm, Sand Hills Nebraska National Forest (Thomas County); (1) April, (1) June, (1) July, (4) October.

OHIO: 2 males, 2 females. Williams County; (4) September.

OKLAHOMA: 7 males, 5 females. Caddo County, Cleveland County, Fort Sill Military Reservation, Noble, Payne County, Tulsa; (1) March, (3) April, (2) September, (3) October, (1) December.

SOUTH DAKOTA: 5 males, 2 females. Martin; (1) August, (6) September.

TEXAS: 36 males, 29 females. Abilene, Austin, Brazos County, Comfort, Dallas, Dallas County, Harris County, Kingsville, Mount Hope, Tyler; (1) March, (1) May, (1) June, (1) November.

WISCONSIN: 2 females. No data.

Geotrupes ulkei Blanchard

Geotrupes ulkei Blanchard, 1888, pp. 106–107 (lectotype, here designated, male, Virginia, labeled as type, Ulke collection in CM).—Loding, 1935, p. 108.—Bradley, 1944, p. 112.—Ritcher, 1947, p. 8.

Length 10 to 12 mm., greatest width 7 to 8 mm.

Color of dorsum dark brown with margins of thorax and elytra tinged with blue or purple. Ventral surface and legs brown to black. Antenna and antennal club dark brown, differing little in color from rest of ventral surface. Clypeus coarsely, deeply punctured; vertex and eye canthus with scattered coarse punctures. The three tubercles on the head extremely indistinct. An indistinct indented line runs from the middle of the vertex forward to the clypeus, where it becomes sharply delimited, bifurcates running along the posterior margin of the clypeus. Clypeus margined, more arcuate laterally. Poorly margined eye canthus forms a moderately obtuse angle with the clypeal edge, sides of eye canthi arcuate anteriorly, slightly so posteriorly, almost parallel. Pronotum moderately convex, margined anteriorly and laterally. The posterior margin broadly broken laterally. Poorly defined coarse punctures scattered unevenly over pronotum, slightly more pronounced laterally and in slightly indented median line. Lateral portions of pronotum near margin with a vaguely defined indentation medially. Minute secondary punctures not apparent. Scutellum small, triangular with sides slightly arcuate. Elytra connate, metathoracic wings absent (this fact being called to my attention by Dr. T. H. Hubbell), elytral striae obsolete, indicated by rows of coarse punctures usually separated dorsally by a distance two to three times their own diameter. Elytral margin narrow, approximately the same width throughout.

Foretibia of male with anteriormost of the usually eight external teeth expanded inward and forward, somewhat bifid. The tip of the inward expansion, the tip of the normal portion of the tooth, and the tip of the penultimate tooth forming an almost straight row of tubercles. No other pronounced sexual modifications noticeable in male. Tarsal claws similar in both sexes as are hind femora. In both sexes there is a dorsal longitudinal raised carina extending along the inner edge of the foretibia, similar to the carina in *blackburnii.* A row of deeply indented setae is adjacent to the base of carina. Near the midline of the dorsal surface of the foretibia is a vague raised carina parallel to the carina on the inner edge, seemingly enclosing the previously mentioned row of setae in a wide shallow groove with small cross ridges separating each seta. External face of tibia of meso- and metathoracic legs each with three complete transverse carinae and from two to five vaguely indicated partial carinae.

Genitalia and genital capsule of male well developed, the elongate, rather linear dorsal parameres being quite distinctive (pl. 4, fig. 3).

The specimens examined showed little variation, except in size of the coarse dorsal punctures and curvature of the elytra. No constant geographical variation was noted.

The species can be readily distinguished by its small size, connate elytra, obsolete elytral striae, male genitalia, clypeus more arcuate laterally, and the dark shining brown color with traces of blue or purple on the thoracic and elytral margins. Also the dark brown antennal club seems characteristic.

Geotrupes ulkei Blanchard, while being one of the least frequently collected of the North American *Geotrupes*, was one of the first species to have its larval biology discovered.

The rarity of the species seems to be due in part to the restricted habitat of this insect and its general secretiveness. The type specimens were collected at fungi by Ulke. Subsequently, specimens have been collected in cans of fermenting malt or molasses and in their burrows.

All of the available information on the biology of the species has been published by Loding (1935, p. 108). His information was obtained from a colony of these beetles at Monte Sano, Madison

County, Ala., where in June 1934 he made the following observations (1935, p. 108):

. . . in burrows in the ground, in diameter the size of a lead pencil and about an inch and one-half deep, with some leaf frass at the bottom. . . . [found] 14 specimens all similarly located under leaves on level ground at the side of mountain paths, never more than one specimen in a hole one and a half to 2 inches deep with leaf frass at the bottom, [but] no larvae. In July Dr. Jones again visited the mountain and this time besides several beetles also found three larvae, 2 in one hole and one in another. The food seems to be decomposing leaves.

From the above information it would appear that the formation of the brood cells (and also the time of egg laying) was in June with rapid larval development in late June and July. The larvae collected by Dr. Jones in July and later described by Ritcher (1947, p. 8) and seen by the present writer appear to be small third instars. Adults which have been collected in September and October would seem to represent the newly emerged brood.

The third-stage larva of *Geotrupes ulkei* was described by Ritcher (1947, p. 8) and a caudal view of the last abdominal segment was given (p. 27).

One interesting feature of the third-stage larva is the small size of the head capsule, the maximum width mentioned by Ritcher being 2.45 to 2.52 mm.

In addition to the characters given by Ritcher, the following structures might be mentioned: Galea (pl. 7, fig. 1) of the maxilla with only 6 or 7 setae on its inner surface (other known species have 9 or more setae); epipharynx with a pronounced row of short stubby bristles running from the posterior tip of the dexiopternotorma to the tip of the posterior epitorma, and tips of all the legs with a tubercle, but lacking the small brownish claw.

Specimens examined: 16 males, 28 females.

ALABAMA: 13 males, 19 females. Monte Sano (Madison County); (30) June, (2) July.

NORTH CAROLINA: 5 females. No data.

VIRGINIA: 3 males, 4 females. Bald Knob, Fisher's Gap (Shenandoah National Park, Page County), Hillsboro, Mountain Lake Biological Station (Giles County), Salt Pond Mountain (Giles County); (2) July, (2) August, (1) September.

Geotrupes blackburnii blackburnii (Fabricius)

Scarabaeus blackburnii Fabricius, 1781, p. 20, No. 85. Lectotype, here designated, male; lectotype label placed on specimen by S. L. Tuxen (Fabrician collection at Kiel).

Geotrupes blackburnii (Fabricius) Castelnau, 1840, p. 100.—Jekel, 1865, p. 529.—Horn, 1868, p. 317.—Blanchard, 1888, p. 106.—Blatchley, 1928, p. 44.—Bradley, 1944, p. 112.

Geotrupes conicollis Jekel, 1865, p. 591.—Horn, 1868, p. 317.

Geotrupes jekellii Horn, 1868, p. 317.

Length 10 to 18 mm., greatest width 6.5 to 11 mm.

Color of dorsum dark shining coppery black to black. Occasional specimens dark brown. Ventral surface and legs black. Antenna, except basal segment which is black, dark reddish brown to black, club reddish brown. Eye canthus, clypeus, and anterior portion of vertex coarsely, densely punctured. The three tubercles on the head, one near the median basal margin of the clypeus and one beside each eye, lack punctures. A distinctly indented narrow line runs from the middle of the vertex forward to the clypeus, where it bifurcates and runs along the posterior edge of the clypeus, finally reaching the outer margins at the juncture of the clypeus with the eye canthi. Clypeus margined, more arcuate anteriorly. Poorly margined eye canthi form a very obtuse angle with clypeal edge; sides of eye canthi slightly arcuate, almost parallel. Pronotum completely margined, quite convex laterally, coarsely punctured laterally and usually along midline but both number and size of the punctures are variable, as are the clusters of punctures which usually form a median circular depression on each side. Minute secondary punctures lacking or barely visible near the posterior angles. In many specimens of both sexes the posterior half of the pronotal midline is indented, in others the indentation is completely lacking. Scutellum generally triangular with gradually arcuate sides. Elytra with well developed striae. Punctures in striae moderately developed basally, usually becoming vaguely delimited and uneven beyond top of scutellum. Elytral margin narrow, slightly wider anteriorly.

The foretibia of the male differs in two major respects from that of the female. The anteriormost of the seven or eight teeth of the outer margin is expanded forward in the male and somewhat bifurcate at the tip. Also on the inner flattened surface of the foretibia of the males there is an uneven row of 4 to 7 (usually 5) conical teeth. These teeth gradually become larger distally, the apical one being longest (pl. 2, fig. 10). In both sexes there is a dorsal longitudinal raised carina extending along the inner edge of the foretibia. This carina basally has a row of setae parallel and closely adjacent to it. Distally, opposite the penultimate tooth on the outer margin, the row of setae separates from the carina, leaving a smooth area enclosed by carina and setae. These reunite at the base of the distal tooth (pl. 2, fig. 13). External face of tibia of meso- and metathoracic legs each with three complete transverse carinae and two partial ones. Posterior edge of hind femur of male produced into a tubercle near coxa. Tarsal claws similar in both sexes.

Genitalia and genital capsule of male well developed, the dorsal parameres quite distinctive (pl. 4, figs. 4, 5). The most readily discernible characteristic is the basal portion of the right paramere which is rather elongate, curved toward the midline, and extended beyond the basal tip of the wide left paramere

Variation within the species is considerable. Size, punctures, degree of sexual modification in the males and, to some degree, color show wide differences, even in specimens from the same colony.

The description of the male has been largely made from a homotype from Raleigh, N. C., compared with the Fabrician specimens for me by S. L. Tuxen of the Copenhagen Zoological Museum.

The species may be distinguished by the male genitalia (pl. 4, figs. 4, 5), the shape of the longitudinal carina of the foretibia (pl. 2, fig. 10), the conical teeth on the underside of the foretibia of the males, poorly punctured elytral striae, and shining black color, sometimes with a coppery cast.

Geotrupes blackburnii blackburnii was by far the most common species of *Geotrupes* taken by me in North Carolina. During the fall, winter, and early spring specimens were numerous under cow dung. Addiction to cow dung was not very noticeable however, as specimens were frequently taken at carrion, almost any type of dung, chicken feathers, and decaying fungi. On one occasion several specimens were taken on the bare ground under a willow tree badly infested with aphids, but whether they were attracted by the "honey dew" or not cannot be stated.

One of the easiest and best methods for collecting the adults, as it eliminated digging, was by the use of chemical attractants and fermenting malt. Not only were many adults collected by the use of attractants, but the time and amount of above-ground activity of the adult beetles could easily be traced through their use. These data, with the chemicals that proved useful, are given in table 3.

The greatest feeding activity was in the fall just after the emergence of the adults. The time of mating was not definitely ascertained, but as several pairs were taken in burrows 4 to 8 inches deep under cow dung in October, copulation may have occurred then. The adults were not only active during the spring and fall, but several times were also seen flying in the late afternoons or early evenings of warm winter days. Quite frequently specimens were taken at lights on warm nights, particularly during the winter. About 9 p. m. on Jan. 6, 1953, I found several male *blackburnii* at brightly lighted store windows.

Because of an ample supply of adults, rearing was attempted in several ways. Specimens were put in gallon cans partially filled with dirt and supplied with fresh cow dung. Others were put in an apple box filled with dirt and covered with a wire screen. Outdoors, in a shaded spot, an enclosure 3 feet wide by 8 feet long was made and covered with a wire screen. About 50 males and 50 females were put in this cage, along with cow dung, fungi, carrion, and dead leaves. In this case the conditions approximated those in a moderately wooded area, and the beetles could, because of the absence of a bottom to the cage, burrow to any desired depth.

All rearing cages were kept in partial shade, for seldom was any species of *Geotrupes* collected in an open field. If there was a single tree in a field the beetles always took advantage of its shade.

After several months it was apparent that rearing was best undertaken in the large enclosure. The smaller the container the more difficult it was to induce the beetles to do anything. In addition, moisture and mites both became problems. Several of the beetles in the gallon cans laid eggs in wads of dung, but few of the eggs hatched. Gamassid mites appeared to be the cause of this failure, for when the mites clustered on an egg it never hatched. Fortunately, this problem was relatively minor in the outdoor enclosure, where much of the life history data was obtained.

There was one question that often could not be answered. Was the developmental rate of the immature stages either accelerated or retarded when they were brought indoors, where temperatures were usually higher and certainly fluctuated more rapidly than temperatures 6 or more inches underground? Early in the course of the work it was proved satisfactorily that larval development could be accelerated. One of the female *blackburnii* confined in a gallon can indoors oviposited about March 18. On March 27 the egg hatched. The larva became a second instar on April 16, a third instar on April 30, and a pupa on June 24. Subsequently it was found that in this case the development of the early stages was not particularly rapid, but that the time of development of the third instar to pupa was greatly shortened.

It was later found that acceleration of larval development was possible only under certain circumstances. If the female beetle was brought indoors and it oviposited, and development occurred from the start at a warm temperature, then it was possible to produce more rapid growth than was normal. However, if the egg was laid in a natural habitat and remained there for even a few days, its subsequent development could not be greatly affected even by much higher temperatures. This conclusion was reached by doing a small amount of digging in the cage of *blackburnii* at different times. On each occasion 10 or 15 larvae were collected and kept alive in salve boxes. These then could be compared with larvae subsequently collected from the cage to see if there was any great difference in growth between them. There was not.

It can be argued that conditions in the cage were not natural, the light being dimmed by the screen, the soil frequently dug up, many beetles in a small enclosure, etc. Fortunately, a large natural colony of *blackburnii* was discovered at Faison, N. C., and digging there over the summer showed the development of the larvae in the cage closely approximated that found in the Faison woods (pl. 16, fig. 1).

One *blackburnii* larva was found in a pasture at Mills River, N. C., and the time of its pupation and emergence was the same as many of the larvae taken from Faison.

Before discussing the length of the various stages of development, the burrow and larval food should be mentioned. On the average the burrows of *Geotrupes blackburnii* were the shallowest of any of the species of *Geotrupes* studied. The vertical feeding burrows, which were 4 to 8 inches deep, were often deeper than the burrows having the larval cell at the bottom.

TABLE 3.—*Bait used in traps and number of* Geotrupes blackburnii blackburnii *Fabricius collected at Raleigh, N. C.*

(First column under month refers to first two weeks, second column to last two weeks)

Chemical	*Jan.*		*Feb.*		*Mar.*		*Apr.*		*May*		*June*		*July*		*Aug.*		*Sept.*		*Oct.*		*Nov.*		*Dec.*		*Total*
Propionic acid	6	3	2	6	2	2	0	0	0	0	0	0	0	0	0	0	0	2	2	3	6	11	26	7	78
n-Butyric acid	7	7	1	3	0	9	3	0	0	0	0	0	0	0	0	0	0	0	0	13	3	2	1	3	52
Oleic acid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isoamylamine	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Valeric acid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-Amyl mercaptan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2
Pelargonic acid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethyl mercaptan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	13	10	3	9	2	11	4	0	0	0	0	0	0	0	0	0	0	2	2	18	9	13	27	10	133

The brood burrows found at Faison, where the soil was a sandy loam, were from 3¼ to 6½ inches deep, with an average depth of 4 inches. The one burrow found at Mills River went to a depth of 5 inches into the hard red clay. In the enclosure at Raleigh, where the soil was not well packed, the burrows were slightly deeper, from 4½ to 9 inches, with an average depth of 6 to 7 inches. All the measurements given refer to the vertical distance between the point where the larva was found and the ground surface.

In the matter of larval food, *blackburnii* seemed to show a greater plasticity than did other species. The larval cell at Mills River and all of those at Raleigh were composed of fairly old cow dung, while those at Faison, while they may have contained some dung, also had bits of leaves and grass making up part of the wad. At the time the colony was found the larvae had largely eaten out the center of the wad, which may have been composed of dung. If this were true, it was not cow dung, as no cow had been in the woods for a number of years.

The burrow containing the single brood cell consisted of a short vertical shaft which took a sharp turn, at which point the food cell began. Often a plug of dung or soil was found near the opening of the burrow and in addition there was some soil covering the end of the brood cell. The brood cells were from 2½ to 3½ inches long with a diameter of from three-quarters of an inch to 1 inch. One-half inch from the terminal end was a cavity in which the female layed a single elongately oval egg (pl. 14, fig. 2). Plate 10, figure 6 is a diagram of a typical brood burrow. In no instances were two brood cells found originating from one burrow. When all the food of the cell was consumed, the larva plastered the sides of the cell with its feces, which became hard and made a compact cell about 2 inches long. Ten of these cells were measured just at the time of pupation (pl. 15, fig. 2). The inside length varied from 19 to 28 mm., the greatest inside width from 11 to 14 mm. The outside dimensions were more variable, ranging in length from 29 to 45 mm., and in width from 16 to 20 mm.

The complete life cycle of *blackburnii* takes one year in North Carolina. While exact dates are not mentioned below, as they can easily vary from place to place and from one year to the next, "early" refers to the first 10 days in the month, "mid" to the next 10 days, and "late" to the remaining days in the month. The dates and data given below were accumulated from notes made on 100 larvae.

In mid-September newly emerged adults began appearing. Feeding and perhaps mating occurred in the fall and winter with oviposition occurring from mid-January through early May. Incubation normally lasted at least 10 days, apparently taking considerably longer when the eggs were laid in January and February. First-stage larvae were found from late March until mid-May, the stadium usually lasting between 20 and 30 days. The second stadium took about 20 days. The first third-stage larvae appeared in late April. By the end of May all larvae collected were third instar. Early growth of the third-stage larvae was rapid. In 15 or 20 days the larvae had entirely consumed their available food supply, and then remained quiescent until September.

After the larva had become quiescent, if more food was added it would resume feeding but with no visible increase in size. The quiescent period lasted most of June, July, and August. In early September pupation occurred. On Sept. 4, 1951, several prepupae were found at Faison and pupae were taken on September 11. On Sept. 12, 1951, the remaining portion of the enclosure at Raleigh was dug. In it were found 1 third instar, 4 prepupae, and 19 pupae. The prepupal stage lasted from 4 to 9 days, with the pupal stage lasting from 15 to 20 days. It required 3 to 4 days for the adults to become fully pigmented and hardened. About the fifth day after metamorphosis the adults became active, emerging from their cells in late September and early October.

The adults fed and overwintered in their feeding burrows. The following spring the females dug and provisioned the brood cells, unaided by the males.

Description of the larva of *Geotrupes blackburnii blackburnii* is based on the following material: 20 third instar exuviae with adults, 10 third-stage larvae, and 2 second-stage larvae, all collected during the summer of 1951 at Faison, N. C., by P. O. Ritcher and H. Howden; 23 pupae with third instar exuviae, 24 third-stage, 5 second-stage, 4 first-stage larvae, and 5 eggs, all from adults in cage at Raleigh, N. C., by H. Howden; third instar exuvia with adult collected at Mills River, N. C., by H. Howden.

The larvae of the eastern subspecies of *blackburnii* appear to differ only slightly from Ritcher's description (1947, pp. 6–7) of the larvae of *G. blackburnii*, which I have referred to the western subspecies, *G. blackburnii excrementi*. The only structures not consistent with Ritcher's excellent description were noted in the hypopharynx and glossa (pl. 8, fig. 2). The asymmetrical oncyli differed slightly in shape from the western subspecies *excrementi*. Also, the setae in front of the hypopharyngeal oncyli and behind the transverse row of sensilla have their origin much nearer to the midline than do the outermost sensilla. Other than that, there were no consistent differences noted. Maximum width of head capsule was 3.9 to 4.5 mm.

The egg of *G. blackburnii blackburnii* (pl. 14, fig. 2) is yellowish white, generally oval with one end larger than the other. The egg increases gradually in size until a maximum size of 3.8 to 4.0 mm. in length and 2.3 to 2.5 mm. in width is reached a day or so before hatching.

First instar maximum width of head capsule is 2.4 to 2.6 mm. Structurally, larva differs very little from third instar. The respiratory plates of the first instar are very small and circular, while in the second- and third-stage larvae they are large and crescent-shaped. Also, the antennal segments of the first instar vary slightly in length and the mandibular teeth are more pronounced than in later stages. Posterior portion of abdomen not swollen as in second and third instar.

Second instar maximum width of head capsule is 3.4 to 3.7 mm. Structurally it is very similar in all respects to third instar.

Specimens examined: 259 males, 237 females.

CONNECTICUT: 2 males, 1 female. Hartford, Pomfret, Yalesville; (1) April, (1) October.

GEORGIA: 18 males, 13 females. Armuchee, Atlanta, Clarkston, Head River, Morgan, Newton, Panthersville, Rome, Satolah, Savannah, Spring Creek (Decatur County), Stone Mountain, Summerville, Thomasville; (1) January,

(1) February, (5) March, (5) April, (1) May, (3) October, (14) November. [Intergrade: 7 males, 2 females. Atlanta, Rockmart; (1) October, (8) November.]

FLORIDA: 9 males, 8 females. Alachua County, Gainesville, Jacksonville, Lake City, Levy County, Newmans Lake (Alachua County), Ocala; (4) March, (4) October, (2) November, (6) December.

MARYLAND: 9 males, 16 females. Baltimore, Charles County, College Park, Edgewood, Ivory, Riverdale, Takoma Park; (4) April, (4) May, (1) July, (1) September, (2) October, (1) November.

MASSACHUSETTS: 10 males, 3 females. Milton, Sherborn, Springfield.

NEW HAMPSHIRE: 1 male. No data.

NEW JERSEY: 21 males, 16 females. Almonessung, Elizabeth, Manahawken, Manchester, Rancocas Park, Riverton, Snake Hill, Westville; (3) April, (1) May, (1) June, (1) August, (13) October, (1) December.

NEW YORK: 4 males, 5 females. Astoria, Brooklyn, Long Island, New York, Shelter Island; (4) July.

NORTH CAROLINA: 108 males, 102 females. Apex, Aquone, Asheville, Beaufort, Black Mountains, Boone, Burgaw, Cataloochee, Climax, Creedmoor, Davidson, Durham, Edenton, Elizabeth City, Faison, Lake Raleigh (Wake County), Lake Waccamaw, Lexington, Marion, Mills River, Plymouth, Raleigh, Southern Pines, Sunburst, Tryon, Whiteville, Wilmington, Victoria; (6) January, (6) February, (12) March, (6) April, (8) May, (62) October, (92) November, (3) December.

OHIO: 12 males, 11 females. Athens, Columbus, Delaware County, Hocking County; (2) April, (1) June, (2) September, (17) October. [Possible intergrade? 1 male. Worthington; (1) September.]

PENNSYLVANIA: 32 males, 30 females. Allegheny County, Castle Rock, Darby, Forrest County, Jeannette, Harrisburg, Morton, Philadelphia, Wilmerding; (1) March, (10) April, (3) May, (5) June, (1) July, (2) August, (2) September, (22) October, (4) November, (1) December.

RHODE ISLAND: 1 male, 1 female. No data.

SOUTH CAROLINA: 20 males, 21 females. Charleston, Clemson College, Florence, Kingstree, Marion County, Meredith, Mountain Rest, Oconee, Rocky Bottom, Summerville, Sumter County, White Pond, Windsor; (1) February, (9) October, (10) November, (8) December.

TENNESSEE: 1 male, 2 females. Deer Lodge; (3) May. [Western? 1 male, 1 female. Madison; (2) April.]

VIRGINIA: 6 males, 3 females. Falls Church, Fredericksburg, Newport News, Richmond; (1) May, (1) August, (2) October.

VERMONT: 1 female. No data.

WEST VIRGINIA [Intergrade: 5 males, 4 females. Fairmont; (9) April.]

Geotrupes blackburnii excrementi Say, new combination

Geotrupes excrementi Say, 1823, p. 210 (type lost).—Melsheimer, 1845, p. 139.—Jekel, 1865, p. 532.

Geotrupes blackburnii (Fabricius) Blatchley, 1910, p. 939.—Ritcher, 1947, pp. 6–7.

Length 12 to 19 mm., greatest width 7 to 11 mm.

Color of dorsum dark shining coppery black to black. Occasional specimens may have the elytral margin tinged with green; others in a few instances may be entirely dark brown in color. Antenna with first segment black, others dark reddish brown to black, with club reddish brown. Structure and angle of clypeus, eye canthus, tubercles, and vertex very similar to *blackburnii*. No constant differences were noted. In general there appear to be a few more punctures near the clypeal base in *excrementi* than in *blackburnii*. Pronotum completely margined, but usually not as convex as in specimens of *blackburnii*. Coarse punctures either confined to sides or scattered unevenly over entire pronotum, most numerous laterally and along midline. A cluster of punctures usually forms a median circular depression on each side of the pronotum. Minute secondary punctures almost always evident laterally and in many cases scattered over the entire pronotum. The posterior half of the pronotal midline may or may not be indented. Scutellum and elytra like those of *blackburnii*, except that in *excrementi* the elytra are usually less convex and have slightly more pronounced strial punctures.

Foretibia of male differing from the female by having an expanded apical tooth and a row of conical teeth on the undersurface, both of which are lacking in the female. The conical teeth on the undersurface of the tibia of the males are highest medially, becoming smaller both basally and distally (pl. 2, fig. 11). In other respects the legs are similar in structure to *blackburnii*.

Genitalia and genital capsule of male are well developed, the parameres of the male genitalia being quite distinctive (pl. 4, fig. 6). The most readily discernible characteristic is the basal portion of the right paramere, which is moderately elongate, but shorter and thicker than in *blackburnii*. In none of the examples studied did it extend beyond the basal tip of the widened left paramere. The left paramere is more elongate than it is in specimens of *blackburnii*, and in many examples, particularly from the southwestern portion of the range, the inner portion of the paramere has many small spines.

Neotype: Male, Columbia, Mo., Apr. 2, 1935, Start (USNM).

As Say listed two places in Missouri and the State of Pennsylvania as localities, I have picked Missouri as the type locality.

Variation is the same as that given for *blackburnii*. The subspecies *excrementi* is rather difficult to separate from *blackburnii* by external characteristics. Females are almost impossible to differentiate, but in general the presence of numerous, fairly distinct secondary punctures on the lateral portions of the prothorax will separate female *excrementi* from *blackburnii*. The males may be easily separated on genital characteristics (pl. 4, fig. 6) and by the conical teeth on the inner flattened surface of the foretibia which are longest in the middle in *excrementi*, while in the males of *blackburnii* the distal tooth is longest (p. 2, fig. 11).

To my knowledge, this subspecies has never been differentiated before. It is very probable that Say's description of *excrementi*, which fits *blackburnii* equally well, was actually made from a specimen of this western subspecies, and as Say's name *excrementi* is available it has been used.

It might be mentioned here that the more northern specimens of *excrementi*, which Say probably had, have fewer pronounced secondary punctures than the southern specimens from Louisiana and Texas, but the male genitalia shows little difference.

Intergradation with *blackburnii* appears rather limited (actual intergrades seen were from only a few localities), but additional data will probably show intergradation occurring in a general line from central Ohio southward, west of the Appalachian Mountains to Rockmart, Ga. Specimens believed to be intergrades have been listed under *blackburnii*. The range of *excrementi* extends generally along the Mississippi River basin. Before assigning the name *excrementi* to this subspecies, I called it the "western subspecies" of *blackburnii* and had identified numerous specimens in that manner.

Since *excrementi* has not previously been recognized as distinct from *blackburnii blackburnii*, the biological information published on *blackburnii* from areas west of the Appalachian Mountains should be referred to the subspecies *excrementi*.

The following account, the best one available on this subspecies, is quoted from Ritcher's paper (1947, p. 7), which is mainly concerned with the larval morphology.

> It is fairly common at Lexington, Kentucky, especially in the early spring when it can be collected in numbers from soil beneath fresh cow dung. In March, 1943, the writer dug over 20 adults from burrows beneath one pile of cat dung. The species is also attracted to lights . . . . Adults construct winding vertical burrows in the soil and pack the lower end of each with an elongate wad of dung in which a single larva develops. Winter is passed in the adult stage.

A number of the adult beetles collected by Ritcher at Lexington, Ky., were later personally examined and identified as *excrementi*. Brown noted (1927, p. 28) that *blackburnii* (again subspecies *excrementi*) in Payne and Pawnee Counties, Okla., were common in the woods, hibernating as adults in their burrows. Mohr (1943, p. 296), in his work in Illinois on the succession of forms in cattle droppings, described *blackburnii* (*excrementi*) as an "irregular influent" of fairly fresh droppings.

The larva of *Geotrupes blackburnii excrementi* was originally well described by Ritcher (1947, pp. 6–7).

Only a few of the larvae of *G. blackburnii excrementi* were personally examined, but these seemed to differ slightly from the eastern *blackburnii blackburnii*. The differences were evident only on the hypopharynx and glossa (pl. 8, fig. 5). The asymmetrical oncyli were slightly different in shape from those of the eastern specimens. Also the setae between the hypopharyngeal oncyli and the transverse row of sensilla did not have their origins any nearer to the midline than the outermost sensilla.

Maximum width of head capsule 3.9 to 4.6 mm.

Specimens examined: 173 males, 165 females.

ALABAMA: 11 males, 12 females. Blount Springs, Kushla (?), Lauderdale County, Mobile, Tuscaloosa County; (1) May, (1) June, (1) August, (1) October, (17) November, (1) December.

ARKANSAS: 8 males, 14 females. Fayetteville, Hope, Imboden, Lawrence, Ozark, Washington County; (1) January, (5) April, (7) September, (4) November.

ILLINOIS: 29 males, 21 females. Alton, Blandinsville, Carbondale, Dubois, Golconda, Homer, Martinsville, Muncie, Putnam County, St. Joseph, Topeka, Urbana, White Heath; (1) February, (2) March, (13) April, (3) May, (1) June, (23) October.

INDIANA: 3 males, 4 females. La Porte, Michigan City, Osborn, Terre Haute; (1) April, (1) July, (2) October.

IOWA: 2 males, 1 female. Ames, "County #89," Mount Pleasant; (3) April.

KANSAS: 7 males, 7 females. Douglas County, Elk City, Johnson County, Muncie; (2) April, (1) May, (1) June, (7) September.

KENTUCKY: 15 males, 13 females. Clay's Ferry (?), Frankfort, Fulton, Lexington, near Mammoth Cave, Russellville [east of Lexington areas of intergradation]; (1) January, (1) March, (2) April, (4) May, (2) June, (1) July, (1) August, (1) September, (5) October, (5) November.

LOUISIANA: 9 males, 8 females. Leesville, Mandeville, Pilare (?), Shreveport, Vowells Mill; (1) February, (3) March, (2) April, (5) December.

MICHIGAN: 1 female. Whitefish Point (Chippewa County); (1) July.

MISSISSIPPI: 16 males, 12 females. Cleveland, Hattiesburg, Vicksburg; (1) February, (4) March, (2) April, (1) June, (10) November.

MISSOURI: 17 males, 35 females. Carthage, Columbia, Fulton, Jefferson County, Louisiana, New Hartford, St. Louis, Willard, Williamsville; (2) March, (15) April, (3) May, (1) July, (2) September, (18) October, (1) December.

OKLAHOMA: 13 males, 10 females. Caddo County, McClain (?), Norman, Panama, Payne County, Sapulpa, Sequoyah County, Sulphur, Tulsa; (7) April, (1) May, (7) October, (6) November, (2) December.

TEXAS: 40 males, 27 females. Anderson County, Cherokee County, Dallas County, Houston; (7) January, (5) April.

WEST VIRGINIA: 2 males. Huntington; (2) August.

WISCONSIN: 1 male. No data.

Geotrupes egeriei Germar

Geotrupes egeriei Germar, 1824, p. 114.—Jekel, 1865, pp. 532, 593.—Horn, 1868, p. 318.—Blanchard, 1888, p. 106.—Blatchley, 1928, p. 44.—Bradley, 1944, p. 112.

Geotrupes lecontei Jekel, 1865, p. 592.—Horn, 1868, p. 318.

Length 11.5 to 20 mm., greatest width 7.5 to 13.5 mm.

Color of dorsum shining black tinged with traces of iridescent blue or green which is most pronounced in striae, on thoracic and elytral margins, and on the head. Ventral surface strongly iridescent bluish black with numerous long reddish setae. Antenna dark brown with club light reddish brown. Legs black with traces of bluish iridescence. Eye canthus, clypeus, and most of vertex coarsely, densely punctured. The three tubercles on the head evident, the posterior clypeal horn being quite pronounced. Posterior edge of clypeus indicated by a distinctly indented line, which usually becomes obsolete laterally. Clypeus margined, generally evenly arcuate, but in some cases extended and sharply arcuate anteriorly. Eye canthus margined, forming a very obtuse angle with clypeus. Canthus arcuate, usually slightly more so posteriorly. Pronotum completely margined, convex, more so laterally. Deeply, coarsely punctured laterally, sometimes with punctures anteriorly and along vaguely indented midline. A very shallowly indented cluster of punctures usually present laterally. Extremely fine secondary punctures sometimes closely scattered over pronotum. Scutellum large, sides moderately arcuate. Convex elytra with striae well developed. Pronounced, irregularly shaped elytral punctures usually separated by about their own diameter, sometimes almost confluent. Elytral margin very narrow, not widened anteriorly.

The foretibia of the male differs in two major respects from that of the female. The anteriormost of the six or seven teeth of the outer margin is expanded forward and slightly inward in the male and is bifurcate. Also, there is on the inner flattened surface of the foretibia of the male an uneven row of about three to five conical teeth which are quite variable in size and number. In both sexes there is a dorsal longitudinal raised carina extending along the inner edge of the foretibia. This carina differs from those of *blackburnii*, *splendidus*, *semiopacus*, and *ulkei* by bending slightly inward opposite the penultimate tooth (pl. 2, fig. 12). A row of setae closely approximates the carina throughout its length. On the external face of the tibia of meso- and metathoracic legs there are three complete transverse carinae and one or two partial ones. Posterior edge of hind femur of male produced into a tubercle near coxa. Tarsal claws similar in both sexes.

Genital capsule and genitalia of male well developed and distinctive (pl. 5, fig. 1). The left dorsal paramere is somewhat triangular in outline, widest at base and sinuate near the tip.

The size and shape of clypeus and density of the punctures vary greatly in this species. Color is fairly constant. Specimens north of Maryland tended to be slightly smaller, more elongate, and yellowish green, but none of these differences could definitely be correlated with range.

The species can be distinguished by its oval, very convex form, pronounced punctures in elytral striae, external carina on foretibia curved inward opposite penultimate tooth (pl. 2, fig. 12), black color with traces of blue or green iridescence along elytral striae, margins, and on head, and by the shape of male genitalia (pl. 5, fig. 1).

Geotrupes egeriei, ranging east of the Mississippi River from New Hampshire southward to Florida, appeared to me to be a rather common but elusive species. In three years of intermittent collecting at Southern Pines, N. C., I did not see a single specimen of *egeriei* in this locality except for specimens that were taken in cans of fermenting malt. In dry areas such as Southern Pines, the beetles were seldom taken in any other manner. Occasionally a few specimens came to butyric acid, but malt was by far the best attractant.

In the mountains near Mills River, N. C., specimens were taken in late July, August, and September feeding on the fungi *Clitocybe gigantea* (Fries) Quelet and *Russula emetica* (Fries) Kummer (determined by Dr. H. Fink, North Carolina Experiment Station at Mills River). In the drier nonmountainous localities specimens were seldom taken at fungi. On one occasion in October several specimens were found under rotten watermelon at Faison, N. C. Mance's note (1908a, p. 288) about collecting *balyi* under rotten watermelon at Southern Pines should be referred to *egeriei*, as Mance's specimens (seen by the writer) were incorrectly identified. In addition to finding specimens around decomposing vegetable matter, dung, and fungi, they were occasionally found attracted to light.

A number of adults were taken in burrows under cow dung at Mills River, N. C., and at Interlachen, Fla. The beetles taken at fungi had constructed burrows only 5 or 6 inches deep, but the burrows under dung were noticeably deeper. In the mountains, one burrow went 18 inches into the hard red clay, and at Interlachen, in the loose sand, several of the burrows reached a depth of 3 feet. The burrows, whether in sand or clay, were typically vertical with a small push-up around the opening. Often the burrows were open; at other times a small plug of dirt was found near the entrance.

It was noticed that there was a long period of adult activity, specimens being taken in every month from April to November. The greatest numbers, which seemed to include newly emerged specimens, were seen in August and September. Several deep burrows under old cow dung at Mills River yielded pairs of *egeriei* in July, but there was no indication of either mating or nidification. The burrows typically were under rather old, dried pieces of cow dung. This was different from *Geotrupes blackburnii*, which typically was found under fresh droppings.

At Mills River on July 30, 1951, a burrow was found under an old dried piece of cow dung at the edge of the woods in a well-shaded spot. The ground was extremely hard and rocky, making digging difficult. At a depth of 7½ inches the burrow, which had been open its entire length, took a sharp bend. There, a female *egeriei* was discovered still packing a larval cell with dung. The cell, about 2½ inches long and containing an oval yellowish white egg similar to that pictured for *blackburnii* (pl. 14, fig. 2), was carefully removed, placed in a metal salve box, and taken indoors. The first instar emerged on August 7; by August 18 the larva was second instar, and by September 10 was a third instar. The larva was preserved on September 24. The rapid growth of the larva, while not too unusual for the genus, probably was considerably accelerated by warm room temperatures and should not be considered typical. Under more normal conditions it would seem likely that the larva would have overwintered as a second or early third instar. However, this cannot be substantiated at present.

It should also be mentioned here that other larval cells might have been present at a greater depth, but as there was no indication that this was the case, digging was discontinued. Usually it was always deemed advisable to dig 6 to 12 inches below the visible end of a burrow, as multiple larval cells had sometimes been found at the end of a burrow (this being particularly true of European species).

At Interlachen, Fla., on Nov. 17, 1951, a pair of *egeriei* was taken in a burrow at a depth of 40 inches. The beetles had a small wad of cow dung, about 1 inch in length, packed in the end of the burrow, but no egg was found. A second burrow was noted and upon excavation yielded, at a depth of 20 inches, a female *egeriei* with a completed larval cell of old cow dung about 2½ inches long by 1 inch wide. An egg was found in a small cavity one-half inch from the terminal end of the wad. The egg, with the food supply, was placed in a metal salve box. On this occasion digging was continued to a depth of 3 feet and the hole was considerably enlarged, but no other cells were found, nor was a male present. (The males of European species of *Geotrupes* have often been credited with aiding the females in provisioning the larval cells, but I did not note any similar case of cooperation in North American species.)

The egg was brought indoors, at Raleigh, and it increased from 4.2 to 4.7 mm. in length and from 2.3 to 3.2 mm. in width before hatching occurred on Dec. 2, 1951. As the larva was indoors and not subject to the winter temperatures, development was rapid. The larva became a small third instar by mid-February at which time it died.

From the sketchy information available, it appears that *Geotrupes egeriei* has a 2-year life cycle at least in the North Carolina mountains.

The adults are present much of the year, being most numerous in the fall. Nidification occurs from the end of July (in the mountains) through November (in Florida) depending on the locality. It would seem that the egg or larva overwinters, emerging as an adult in the following summer in July and August. At that time the freshly emerged adults were found at Mills River, N. C., feeding on fungi. In the mountains and in northern states the newly emerged adults probably overwinter and begin egg laying in July of the next year. In the case of the Interlachen, Fla., specimens, they could possibly have either a 1-year or 2-year cycle, as activity certainly was not greatly impaired by any cold weather.

Description of larva of *Geotrupes egeriei* was based on the following material: One third-stage larva and second instar exuvia reared from egg collected with female at Mills River, N. C., July 30, 1951, H. Howden; one third-stage larva reared from egg collected with female at Interlachen, Fla., Nov. 17, 1951, H. Howden and B. Dozier.

Maximum width of head capsule 4.0 to 4.2 mm. Frons (pl. 7, fig. 8) on each side with 1 or 2 posterior frontal setae, 3 or 4 setae on each anterior angle, 1 or 2 exterior frontal setae, and 2 or 3 anterior frontal setae. Antenna 3-segmented, the last segment reduced in diameter and about three-fifths as long as the second segment (pl. 7, fig. 5) which distally bears a small conical sense organ. Mandibles (pl. 7, figs. 11, 12) similar to those of *blackburnii*. Maxilla (pl. 8, fig. 6) with stridulating area bearing a row of 5 to 7 small conical teeth on the stipes and 2 or 3 teeth on the posterior margin of the palpifer. Hypopharynx (pl. 8, fig. 6) with two asymmetrical oncyli. In front of the hypopharyngeal oncyli, on each side, is a row of 12 to 14 small sensilla almost united medially, bending anteriorly with a short line of 3 or 4 sensilla on each side. These two parallel forward extensions of sensilla have several small setae irregularly placed between them. Glossa slightly emarginate. Epipharynx (pl. 8, fig. 4) with thin tormae united mesally. Anterior and posterior epitormae present, their tips obscured by fine dense setae. Setae at tip of posterior epitormae rather V-shaped in outline. Phobae surrounding the pedium, which is mostly spiculate. Medially along the anterior edge of the phobae is a row of from 3 to 6 sensilla, and anteriorly, well separated from either the phobae or the irregular row of 9 to 12 setae, is a single isolated sensillum, slightly left of the midline.

Body shape (pl. 11, fig. 2) similar to that of *blackburnii*, as is the setal pattern. Dorsal annulets of abdominal segments 6 to 8 inclusive each with a transverse patch of long setae, as in *blackburnii*. Anal lobes (pl. 7, fig. 17) with endoskeletal figure slightly different from *blackburnii*. Stridulating organs on the reduced metathoracic legs consisting of a row of 7 or 8 teeth on the inner surface of the fused trochanter-femur and a single small tooth on the tibiotarsus. Tips of all legs (pl. 7, fig. 16) with a circle of setae around a small tubercle which lacks the small brownish claw present in *blackburnii.*

When first collected, one egg measured 4.2 by 2.3 mm., and was oval and slightly wider at one end. Five days later the egg measured 4.6 by 2.7 mm., and in another five days it measured 4.7 by 3.1 mm. It finally attained the size of 4.7 by 3.2 mm. three days before hatching, which occurred on the 15th day.

Maximum width of head capsule of live first-stage larva about 3.1 mm. Exuvia not recovered.

Maximum width of head capsule of live second-stage larva about 3.7 mm. Exuvia recovered but no significant differences were noted between it and the third-stage larva.

Specimens examined: 183 males, 127 females.

ALABAMA: 4 males, 4 females. Augustine (Perry County), Mobile, Monroeville, Monte Sano, The Pocasins (Pike County); (1) July, (5) August, (1) November.

DISTRICT OF COLUMBIA: 1 male. (1) July.

FLORIDA: 49 males, 47 females. Gainesville, Interlachen, Jacksonville, Lakeland, Lutz, Miami, Monticello (Jefferson County), New Smyrna, Ocala, Putnam County, Sanford, Steinhatchee, Valparaiso; (5) January, (10) March, (3) April, (3) June, (1) July, (5) August, (7) September, (2) October, (11) November, (1) December.

GEORGIA: 4 males, 3 females. Head River, Midway (Bryan County), Roberta, Robertstown, Vidalia; (1) May, (1) June, (2) August, (2) September.

ILLINOIS: 1 male, 1 female. Maywood, northern Illinois.

LOUISIANA: 1 female. No data.

MARYLAND: 2 males, 1 female. Beltsville, College Park; (1) April, (1) May, (1) September.

MASSACHUSETTS: 19 males, 12 females. Chicopee, Counb (?), Dover, Duxbury, Framingham, Lowell, Nantucket, Norfolk, Sherborn, South Hadley, Springfield, Tyngsboro, Wayland, Wellesley; (4) April, (1) July, (7) August, (5) September, (3) October.

MICHIGAN: 2 females. Bloomfield (Oakland County), George Reserve (Livingston County); (1) July, (1) August.

MISSISSIPPI: 8 males, 6 females. Camp Shelby, Iuka, Lakesville [Leakesville?], Leakesville, Lucedale, New Augusta; (2) July, (7) September, (5) October.

NEW HAMPSHIRE: 4 males. Exeter; (1) September.

NEW JERSEY: 19 males, 17 females. Browns Mills, Burlington County, Cape May County, Marlton, Ocean View, Palmyra, Point Pleasant, Ramsey, Riverton, Sea Girt, Westwood; (1) May, (2) June, (1) July, (19) August, (2) September, (9) October, (1) November, (1) December.

NEW YORK: 1 male, 3 females. Farmingdale, Montauk; (2) August.

NORTH CAROLINA: 47 males, 13 females. Dunn, Faison, Julian, Mills River, Newton Grove, Oxford, Pine Bluff, Raleigh, Southern Pines, Swannanoa, Tarboro; (8) May, (7) June, (26) July, (7) August, (4) September, (6) October, (1) November.

PENNSYLVANIA: 5 males. Glenolden, Jeannette; (1) July, (1) August, (1) October.

RHODE ISLAND: 1 male, 1 female. Berkeley, Warwick; (1) April, (1) July.

SOUTH CAROLINA: 17 males, 12 females. Clemson College, Columbia, Florence, Govan, Hampton, Jocassee, Longcreek, Meredith, Orangeburg, Palmetto, Rocky Bottom, Sassafras Mountain, Tunnel Walhalla, Williamsburg County; (6) June, (13) July, (6) August, (3) September, (3) October.
TENNESSEE: 1 female. Sparta; (1) August.
VIRGINIA: 1 male, 3 females. Nelson County, Norfolk, Petersburg (Camp Lee); (1) April, (2) August, (1) September.

Geotrupes hornii Blanchard

Geotrupes hornii Blanchard, 1888, pp. 107, 108 (lectotype, male, bearing label "Tewks. (Mass), 4/28," in Blanchard collection, MCZ).—Boucomont, 1911, p. 344.—Bradley, 1944, p. 112.
(?) *Geotrupes miarophagus* Say, *in* Melsheimer, 1846, p. 139.

Length 12 to 18 mm., greatest width 7 to 11 mm.

Color of dorsum and ventral surface black without any trace of other colors. Antennal club rather dull yellow-brown, slightly lighter than remaining segments. Eye canthus, clypeus, and most of vertex coarsely, densely, and sometimes confluently punctured. Three tubercles of head poorly defined, but with indented line at base of clypeus rather pronounced. Clypeus poorly margined, varying considerably in shape, usually rather evenly arcuate or slightly more so anteriorly. Anterior portion of eye canthus poorly margined, sometimes forming an almost straight line with the clypeus or at most forming a very obtuse angle. Sides of canthi slightly arcuate. Pronotum completely margined, rather convex. Posterior margin may be only slightly margined laterally. Coarse punctures scattered irregularly over pronotum, dense laterally. Median lateral indentation very poorly indicated. At least posterior half of pronotal midline slightly indented. Scutellum generally triangular with median line usually slightly indented, sides arcuate, more so anteriorly. Elytra with well developed striae containing coarse, very irregular punctures. Sutural stria extends around scutellum to elytral base. Second stria does not reach the elytral base. Elytral margin narrow, slightly widened anteriorly.

Foretibia of male differing from that of female by having the antepenultimate external tooth deflexed slightly downward and thickened ventrally. Otherwise the foretibiae are similar, with six or seven external teeth and a longitudinal raised carina extending along the inner edge of the dorsal surface. This carina, similar to that of *balyi* (pl. 2, fig. 14), has an extension onto the penultimate tooth. The row of setae at the base of the longitudinal carina has each seta separated by a small transverse carina. Male specimens also have a small raised carina near the anterior base of the front femur; hind femora are unarmed. External faces of tibiae of meso- and metathoracic legs have three complete carinae and one or two partial carinae. Tarsal claws similar in both sexes.

Genital capsule and genitalia of male well developed, the parameres almost concealed by the phallobase (pl. 3, figs. 8, 9), which gives the genitalia a symmetrical appearance. The parameres are tipped with numerous short setae.

Size variation is considerable, specimens from the Appalachian Mountains being generally smaller than ones taken from the piedmont or coastal plain areas of the East Coast. Several large, elongate, heavily punctured specimens collected in Newfoundland appeared to differ slightly from mainland specimens, but additional specimens and further study are needed to fully determine and correlate structural differences with geographical ones.

The species can be distinguished by its entirely black dorsal and ventral color, the sutural stria extending around the scutellum to elytral base, second stria not reaching elytral base, irregularly punctate elytral striae, coarsely rather densely punctured pronotum, shape of the carina of the foretibia, the small carina on the anterior base of the front femur of the males, and the numerous setae on the tips of the parameres almost hidden by the phallobase (pl. 3, figs. 8, 9).

Geotrupes miarophagus Say as described by Melsheimer (1846, p. 139) appears to be synonymous with *G. hornii* Blanchard, if the description was based upon specimens in the Melsheimer collection now housed in the Museum of Comparative Zoology at Cambridge. There are only two specimens labeled *miarophagus* in this collection; the first specimen bears the label "U. S. Melsheimer" with a separate red-margined label "*splendidus* var. *miarophagus* Melsh." This specimen is a large female *hornii* Blanchard (as we now know it). The second specimen, labeled simply "*miarophagus*," is a female *blackburnii* (Fabricius).

Following his description of *Geotrupes hornii*, Blanchard (1888, p. 109) wrote that Ulke, in correspondence, mentioned that *hornii* sometimes came to light while *balyi* did not. While at Hendersonville, N. C., where both species occurred, I noted *hornii* was attracted on several occasions to lights while *balyi* was not. This difference in attraction to light was interesting, for in other respects these two species seemed to have very similar habits, often being collected in adjacent burrows under the same fungi. Frost (1929, p. 111) in Massachusetts stated that *hornii*

> . . . is one of the common species of the genus in this locality occurring, according to my series, from August 8 to September 30. It can be easily distinguished from the other species by its pure black color with nonmetallic reflections. I have found it frequently under a fungus having an acrid milky juice (*Lactarius*, perhaps *piperatus*) and it often bores from the top down through the stem and into the ground to a depth of 5 or 6 inches; I have never noticed this particular mode of attack by *G. balyi* Jek. which at times frequents the same species of fungi.

Although the writer, with P. O. Ritcher, has taken a number of *hornii* at Mills River, N. C., on the fungi *Clitocybe gigantea* (Fries) Quelet and *Russula emetica* (Fries) Kummer, they were not noted boring down through the fungi in the manner described by Frost.

While *hornii* has been found fairly commonly in the northeastern United States, it is generally restricted to the mountains of western North Carolina. An occasional specimen was taken at Raleigh and a single pair was found under fungi at Faison, which is situated in the center of the North Carolina coastal plain.

From July through September adults of *hornii* were taken in shallow, sinuous burrows under fungi and human feces. During that time they were also taken in traps of fermenting malt and propionic or butyric acid. However, I was puzzled to find an occasional adult in April and May which was never near any fungi or other source of food. A possible explanation for this apparent change in habits will be discussed later.

In the fall of 1951, 16 specimens of *hornii* from Mills River were placed with a quantity of fungi and cow dung in a rearing cage at Raleigh. The cage, 5 feet long by 3 feet wide and composed of boards sunk into the ground and covered with a wire screen, was situated on a well drained hillside in a rather open deciduous forest. The particular area was chosen as the conditions there appeared to approximate rather closely those found at Mills River.

The cage was opened for the first time on Oct. 22, 1951. Numerous burrows were found where the fungi had been placed. Some of these burrows were dug up and in every case, at a depth of 8 to 10 inches, a single adult was found at the bottom of its vertical hole with a small wad of decomposing fungi. None of the burrows contained any dung. Again, on Apr. 7, 1952, the cage was partially dug up. The adults were still alive, but there was no activity, and no food in evidence at the bottom of the burrows. Fresh cow dung was added and the screen wire replaced.

In late April and May a few adults were collected in fresh burrows at Raleigh and Mills River, but there was no sign of adult feeding or any indication of any provisioning for larvae. The cage at Raleigh was examined again on June 19, 1952, and, as several of the adults were noted making fresh burrows, the cage was not disturbed.

Finally, on July 1, 1952, a portion of the cage was dug up, even though some of the adults were still active. Digging was extremely difficult in the packed red clay, which at the time was quite dry. The two burrows, which were carefully investigated, were open for 12 and 13 inches, then suddenly came to an end. The clay at the end of the burrow, while having the same consistency and hardness as the surrounding soil, was slightly darker in color. As it seemed that the burrow might possibly have been filled in, digging was continued. At a depth of 17 inches, slightly to one side, a cell parallel to the surface of the ground was found. It was almost 4 inches long and coated on the outside with a few dead leaves, but on the inside it was composed entirely of old cow dung. Near the terminal end of the cell a small second instar was found.

Further digging produced a second cell at a depth of 18 inches, apparently coming from a branch of the burrow which led to the first cell. Two other cells were found, 19 and 24 inches deep, both seemingly attached to the same burrow as the others. A fifth cell containing a dead larva was found near the others. As all the cells contained second-stage larvae, further investigation was postponed. A number of the adult beetles, six females and one male, were still alive and they were removed from the cage.

No further digging was undertaken until Aug. 4, 1952. Then, before attempting to follow any of the burrows, 5 gallons of water was poured into the cage and allowed to settle. This procedure greatly facilitated digging.

Seven larvae, all small third-stage, were found on this occasion. Four cells were grouped at the end of one burrow; two cells were at the end of another, and one burrow apparently had only a single cell at its end. The depth of the cells ranged from 16 to 20 inches. A diagram of the burrow and cell arrangement is given in plate 10, figure 5. All of the cells were composed of old cow dung, some coated with a thin layer of dead leaves, some without the layer. The larvae overwintered as third instar, some being kept alive through January 1953.

Pupation probably occurs in early summer with adult emergence in July and August. It would seem from the data obtained that the general biology of *hornii* is quite similar to that of *G. stercorarius* described by Sano (1915–1916, pp. 25–28).

The life cycle of *Geotrupes hornii* apparently takes two years. Freshly emerged adults feed on fungi from July until October, overwintering in their feeding burrows. Adult activity begins again in April and May. Then, instead of feeding on fungi, the beetles burrow under old dung, with which they provision the larval cells. Oviposition appears to take place in May and June with the larvae becoming third instars by fall. The second winter is passed as a larva, with pupation assumed to occur in early summer. The adults emerge in July and August and begin feeding on fungi.

Description of *Geotrupes hornii* larva is based on the following material reared at Raleigh, N. C., from adults collected at Mills River,

N. C.: Three second-stage, one third-stage larvae collected from cage on July 1, 1952; two second-stage larvae collected from cage Aug. 4, 1952; and five third-stage larvae collected in August and preserved on Sept. 15, 1952

Third-stage larvae of *G. hornii* differ from Ritcher's description (1947, pp. 6–7) of *G. blackburnii excrementi* in the following respects.

Maximum width of head capsule 4.0 to 4.5 mm. Frons on each side with 1 posterior frontal seta, 2 or 3 setae in each anterior angle, 1 exterior frontal seta and 1 or 2 anterior frontal setae. Antenna fairly long, the length of the second segment equal to or slightly longer than that of the first segment. Third segment greatly reduced in diameter (pl. 7, fig. 7), only half as long as the second segment. Mandibles and maxillae not differing in any respect from Ritcher's description, except that the 2 or 3 stridulatory teeth on the posterior margin of the palpifer of *blackburnii* are usually lacking in *hornii*. Hypopharynx (pl. 8, fig. 8) with 2 asymmetrical oncyli which are generally narrower than that of *blackburnii*. Before the hypopharynx is a row of 20 or more sensilla on each side united medially. At the midline, anteriorly, is a clump of 6 or 7 sensilla and, posteriorly, 2 setae. Glossa slightly emarginate. Epipharynx (pl. 8, fig. 7) with tormae united mesally, very similar to *blackburnii*. Anterior and posterior epitormae of equal length. Anterior to the pedium is a row of 7 or 8 setae. In *blackburnii* there are about 6 setae in the same area, in an uneven row.

Body less swollen posteriorly than *blackburnii* but otherwise quite similar. Endoskeletal figure (pl. 7, fig. 15) of anal segment not as constricted as that of *blackburnii*, quite similar to that figured for *ulkei* by Ritcher (1947, p. 27, fig. 44). Dorsal annulets of abdominal segments 7 and 8 lacking the transverse patch of long setae present in *blackburnii*, otherwise setal patterns are quite similar.

Legs 3-segmented, prothoracic and mesothoracic legs rather long, metathoracic legs reduced in size. Nine to 11 stridulatory teeth on the inner surface of the fused trochanter-femur of metathoracic legs and 5 to 8 small teeth on the inner surface of the tibiotarsus. Tips of all legs with a circle of setae around a small tubercle (pl. 7, fig. 10) which lacks the small brownish claw present in *blackburnii*.

Second instar maximum width of head capsule 3.2 to 3.5 mm. No other morphological difference noted to distinguish second instar from the third-stage larva.

Specimens examined: 114 males, 131 females, 22 not sexed.

CANADA

NO EXACT LOCALITY: 1 specimen. No data.

NEWFOUNDLAND: 1 male, 3 females. Nicholasville, Romaine Brook; (1) July.

UNITED STATES

CONNECTICUT: 1 male. No data.
DISTRICT OF COLUMBIA: 4 males, 3 females. (1) June.
GEORGIA: 1 female. Clayton; (1) July.
ILLINOIS: 3 males, 2 females. Cook County, Schiller Park, Urbana; (1) April, (1) October.
INDIANA: 1 male. Brown County. (1) July.
IOWA: 1 male, 1 female. Forest City; (2) August.
MAINE: 3 males, 2 females. Katahdin, Monmouth, Paris; (1) July, (1) August, (1) September.
MARYLAND: 1 male, 7 females. College Park, Easton, Glen Echo; (3) July, (1) August, (1) October.
MASSACHUSETTS: 18 males, 21 females. Dorchester, Duxbury, Framingham, Natick, Nantucket, Sherborn, Tewksbury, Tyngsboro, Wilbraham, Wilmington; (1) April, (1) June, (5) July, (5) August, (19) September.
MICHIGAN: 7 males, 6 females. Beaver Island (?), Cheboygan County, Douglas Lake, George Reserve (Livingston County), Naubinway, Pentwater; (4) July, (5) August, (1) September, (2) October.
MISSISSIPPI: (?) 1 female. No data.
NEW HAMPSHIRE: 3 males, 2 females. Belknap County, Exeter, Franconia, Mount Washington; (1) September.
NEW JERSEY: 22 males, 24 females. Burlington, Frieses Mill (?), Lakehurst, Marlton, Maurice River (Vineland), Merchantville, Millville, Mount Laurel (?), Ocean City, Palmyra, Phillipsburg, Rancocas, Riverton, Sea Girt, Shark River, Warren Grove (?), Westville; (2) March, (1) June, (3) July, (28) August, (6) September, (3) October.
NEW YORK: 4 males, 4 females. Ithaca, Jamaica, Long Island, New Windsor, West Point; (1) April, (1) July, (1) August, (1) September.
NORTH CAROLINA: 15 males, 21 females. Black Mountain, Cullasaja River (Macon County), Faison, Hamrick, Highlands, Linville, Mills River, North Wilkesboro, Raleigh; (1) April, (1) May, (1) June, (7) July, (15) August, (1) September, (2) October.
OHIO: 1 male. Ashtabula County; (1) June.
PENNSYLVANIA: 14 males, 10 females. Allegheny County, Forest Park, Germantown, Jeannette, Lancaster County, Mount Alto, Pittsburgh, Poe Paddy (?), Windgap; (13) July, (4) August, (3) September.
SOUTH CAROLINA: 9 males, 20 females. Cashiers Valley Road (Oconee County), Clemson College, Greenville, Mountain Rest, Oconee County, Rocky Bottom, Sassafras Mountain, Table Rock; (1) June, (17) July, (5) August, (2) September, (4) October.
TENNESSEE: 1 male. Deer Lodge; (1) March.
VIRGINIA: 21 specimens. Great Falls, Nelson County, Rosslyn; (21) August.
WEST VIRGINIA: 2 males. White Sulphur; (2) July.
WISCONSIN: 3 males, 4 females. Wood County; (3) July.

Geotrupes balyi Jekel

Geotrupes balyi Jekel, 1865, p. 617 (type, J. Baly, Canada, in Jekel collection).—Horn, 1868, p. 319.—Blanchard, 1888, p. 108.—Boucomont, 1911, p. 344.—Bradley, 1944, p. 112.

Geotrupes similis Jekel, 1865, p. 617.—Horn, 1868, p. 319.

(?) *Geotrupes starkii* Jekel, 1865, p. 609.—Horn, 1868, p. 319.

Length 10 to 16 mm., greatest width 6 to 10 mm.

Color of dorsum black suffused with vague purple, blue, or green iridescence which is obscure at times but noticeable along elytral margins and in lateral striae. Ventral surfaces black. Antennal club light reddish brown with middle lamella not emarginate. Eye canthus, vertex, and clypeus, except for small median area just before tubercle, coarsely, densely, irregularly punctate. Three tubercles on head very vague, as is the indented line at the clypeal base. Clypeus margined, slightly more arcuate anteriorly. Eye canthi vaguely margined, rather sharply bent anteriorly, sides almost parallel; angle with clypeus very obtuse. Pronotum completely margined, moderately convex, with numerous coarse punctures most numerous laterally and along indented posterior portion of midline. Vague median circular depression usually present on the sides of the pronotum. Minute secondary punctures almost always lacking. Scutellum triangular with a longitudinal median depression and sides rather evenly arcuate. Elytra with well developed striae having numerous irregularly spaced and shaped punctures. The sutural stria extends around the scutellum reaching the elytral base. The second stria does not quite reach the elytral base. Elytral margin narrow, wider anteriorly.

There is no distinguishing external sexual modification between male and female. Foretibiae, which are identical in both sexes, have the dorsal longitudinal raised carina extending along the inner edge of the outer flattened surface. The carina has a pronounced extension onto the penultimate external tooth (pl. 2, fig. 14) and a row of adjacent setae basally, which are separated by small transverse carinae. External face of tibia of meso- and metathoracic legs each with two complete transverse carinae and two or three partial carinae. Tarsal claws similar in both sexes.

Genital capsule and genitalia of male well developed with the parameres almost hidden by the large phallobase. Both parameres lacking long setae at tips (pl. 3, figs. 10, 11).

Variation in size, punctures, and color is moderate. There is no evident external difference between male and female specimens; however, female specimens appear to be generally slightly larger than males.

The species may be distinguished by the lack of external sexual differences, dorsal black color slightly suffused with purple, blue, or green iridescence, sutural stria extending around scutellum to elytral base, second stria not reaching base, only two complete external transverse carinae on tibiae of meso- and metathoracic legs, tips of parameres of male genitalia lacking long setae.

Geotrupes balyi Jekel has often been recorded from the wooded Northeastern States and also has been frequently found during July and August in the mountains of North Carolina, South Carolina, and Tennessee.

During August and September I collected a number of specimens at Mills River, N. C. The beetles in most cases had made burrows 2 to 5 inches deep at the base of several species of fungi. Into these burrows they had taken small bits of the fungi on which they were feeding. Dr. Harry Fink, North Carolina Experiment Station at Mills River, later identified the fungi as *Clitocybe gigantea* (Fries) Quelet and *Russula emetica* (Fries) Kummer.

The beetles were taken in wooded areas and not in open pasture land. None were noted at cow dung, but several specimens were taken at what may have been human feces. Other specimens were collected in traps baited with butyric acid or fermenting malt.

Numerous specimens of *Geotrupes balyi* bore the label "fungi." Moennich (1939, p. 156) states that *balyi* was collected at Midvale, N. J., on the fungus *Lactarius piperatus* (Fries) Quelet. Another reference to *balyi*, by Manee (1908a, p. 288), states that specimens from Southern Pines, N. C., were collected not only at animal droppings but on decaying fruit, watermelon, etc. This reference caused me some doubts, as specimens from Southern Pines would not only be considerably out of their range for the species in North Carolina, but the reference to animal droppings itself was unusual. Later, I noted than a number of Manee's Southern Pines specimens in the North Carolina Department of Agriculture collection were identified as *balyi* when, in actuality, they were *egeriei*. It would seem that Manee's note (1908a, p. 288) should be referred to *egeriei*, which is a common species at Southern Pines. Other references to *balyi* are scattered and usually merely mention its capture.

Nothing has been written, to my knowledge, about the larval biology of this species.

Specimens examined: 401.

CANADA

QUEBEC: 5 specimens. Fort Coulonge, Isle of Orleans, Val Morin; (2) June, (3) August.

UNITED STATES

CONNECTICUT: 21 specimens. Cornwall, Eastford, Stamford, Union (Tolland County); (3) July, (13) August (2) October.
DISTRICT OF COLUMBIA: 1 specimen. No data.
GEORGIA: 1 specimen. Tray Mountain; (1) September.
ILLINOIS: 3 specimens. Algonquin.
IOWA: 4 specimens. Forest City; (1) August.
KENTUCKY: 5 specimens. Near Mammoth Cave; (5) April.

MAINE: 13 specimens. Bethel, Isle au Haut, Katahdin, Lincoln County, Monhegan, Monmouth, Paris, Southport; (1) July, (6) August, (3) September, (1) October.

MARYLAND: 3 specimens. Lakeland; (1) August.

MASSACHUSETTS: 47 specimens. Ashland, Chatham, Concord, Cummington, Framingham, Houghton (?), Lenox, Marion, Melrose Highlands, Milton, Monterey, Montgomery (?), Natick, Norfolk County, Sherborn, Springfield, Tyngsboro, Wakefield, Westfield; (1) March, (2) June, (3) July, (13) August, (8) September, (1) October.

MICHIGAN: 37 specimens. Alger County, Charlevoix County, Cheboygan, Crawford Lake, Douglas Lake, East Lansing, Emmet County, "Hrn. Mt." [=Huron Mountain?] Club, Isle Royale (?), Lake County, Makinac County, Naubinway, Oakland County, South Fox Island, Leelanau County; (2) June, (8) July, (10) August, (2) September, (9) October.

NEW HAMPSHIRE: 13 specimens. Belknap County, Chocoura, Farmington, Lyme, Mont Vernon, Percy, Pittsburg, Rumney; (2) May, (3) July, (4) September.

NEW JERSEY: 12 specimens. Bear Swamp, Carmel, Cecil, Greenwood Lake, Hopatcong, Lakehurst, Marlton, Rancocas Park, Split Rock Lake, Stanhope; (1) April, (1) July, (2) August, (6) September.

NEW YORK: 58 specimens. Allegheny State Park, Bear Mountain, Catskill Mountains, Debruce, Delmar, Duane, Fallsburgh, Ithaca, Locke, McLean Bogs (Tompkins County), Montauk, Mount McIntyre (summit), New York City and vicinity, Perrysburg, Scarsdale, Tupper Lake, Washington County, West Point; (3) May, (2) June, (13) July, (20) August, (12) September, (1) October.

NORTH CAROLINA: 51 specimens. Balsam, Black Mountain, Chimney Rock, Crestmont, Deep Gap, Gray Beard Mountain, Highlands, Mills River, Mount Mitchell (5,000–6,700 ft.), Newfound Gap, Pisgah Forest, Satulah Mountain, Sunburst, Whiteside Mountain; (3) June, (11) July, (7) August, (12) September, (3) October.

OHIO: 2 specimens. Jefferson, Sandusky; (1) August, (1) September.

PENNSYLVANIA: 64 specimens. Allegheny, Bellasylva (?), Bonadense (?), Brandtsville (?), Clarks Valley, Coudersport, Dauphin County, Doubling Gap, Forest County, Germantown, Indian Creek, Jeannette, Jefferson County, Lancaster County, Lehigh Gap, Ligonia, Maysville, Mont Alto, Mount Pocono, Pen Mar, Pike County, Pittsburgh, Pocono Mountains, Pocono Pines, Seven Mountains (Centre County), Warren County, Windgap; (2) April, (2) May, (3) June, (14) July, (15) August, (15) September, (3) October.

RHODE ISLAND: 5 specimens. Watch Hill; (4) July, (1) August.

SOUTH CAROLINA: 18 specimens. Cashiers Valley Road, Clemson College, Greenville, Greenwood, Jocassee, Mountain Rest, Oconee County, Rocky Bottom, Sassafras Mountain; (2) July, (12) August, (3) September, (1) October.

TENNESSEE: 1 specimen. Deer Lodge; (1) June.

VERMONT: 1 specimen. Salisbury; (1) July.

VIRGINIA: 19 specimens. Basye, Giles County, Jones Creek (Lee County), Mountain Lake, Nelson County, Pennington Gap; (1) July, (2) August, (2) September.

WEST VIRGINIA: 2 specimens. White Sulphur Springs; (1) July.

WISCONSIN: 15 specimens. Bayfield, Eagle River, Spread Eagle, Stanley, Washington County; (5) July, (2) August.

Geotrupes stercorarius (Linnaeus)

Scarabaeus stercorarius Linné, 1758, p. 349.—Gorham, Walker, and Simpson, 1929, p. 15.—Brown, 1940, p. 74. (For complete synonymy see Boucomont, 1912, pp. 24, 25. Only references pertaining to North American specimens are given here.)

The following description is intended only to separate the introduced *stercorarius* from North American species and is based entirely on New Brunswick specimens furnished me by W. J. Brown, Canadian Department of Agriculture, Division of Insect Identification.

Length 20 to 26 mm., greatest width 11 mm. to 16 mm.

Color of dorsum black with traces of bluish iridescence in striae and along thoracic and elytral margins in some specimens. Ventrally black with strong blue or purple iridescence on thorax, abdomen, and femora. Basal segment of antenna dark brownish black; other segments, including the club, dark reddish brown. The middle lamella of the antennal club is very strongly emarginate on one side. Eye canthus, clypeus, and vertex densely rather finely irregularly punctured. The three tubercles of the head moderately developed, indented line present at base of clypeus extending for a short distance on the vertex at median line. Clypeus margined, sharply arcuate anteriorly. A slight obtuse angle is formed between edge of clypeus and margined eye canthus. Pronotum completely margined, only moderately convex, with a few coarse rather vague punctures present laterally. The median lateral circular indentations are present but shallow. Posterior half of pronotal midline may be slightly indented, but usually lacks coarse punctures. Minute secondary punctures lacking. Scutellum triangular, sides slightly arcuate. Elytra with well developed striae which are vaguely and shallowly punctate. The sutural stria extends completely around the scutellum to elytral base (this also occurs in *balyi* and *hornii*), and the second stria does not quite reach the base. Elytral margin is narrow, slightly wider anteriorly.

The anterior-external tooth of the foretibia of the male is slightly smaller than that of the female. In the male there is a longitudinal carina ending in a tubercle on the ventral flattened surface of the foretibia extending a distance roughly equal to that between the fourth to sixth external teeth. In both sexes there is a dorsal longitudinal raised carina extending along the inner edge of the foretibia. There is an irregular lateral extension of this carina onto the penultimate external tooth somewhat similar to the carinal extension of *balyi* (pl. 2, fig. 14). A row of setae is closely adjacent to the base of the carina, briefly interrupted by the carinal extension into the penultimate external tooth. External face of tibia of meso- and metathoracic legs with three transverse carinae, the upper one small.

One or two incomplete carinae are also present. Tarsal claws similar in both sexes.

Genital capsule and genitalia of male large, most of the elaborately sinuate parameres enclosed dorsally and ventrally by the phallobase (pl. 4, fig. 2), which is somewhat similar in structure to that of *balyi* and *hornii*.

Variation in the specimens examined was not great. Size and number and density of the coarse head and pronotal punctures showed the greatest differences, but the species appears quite uniform. No consistent differences were noted between New Brunswick and European specimens.

This species can be distinguished from other North American species by its generally large size, poorly punctured elytral striae, the sutural stria continued around the scutellum to the elytral base with the second stria not extending to elytral base (differing from other North American species except for *balyi* and *hornii*), the second segment of the antennal club strongly emarginate, the structure of the male genitalia (pl. 4, fig. 2), and the bright purple or blue iridescence of the ventral surface.

While the biology of *Geotrupes stercorarius* has not been studied in North America, there have been numerous observations made on its life history in Europe where it is widely distributed, ranging from Great Britain (Curtis, 1829, page opposite plate 266) to Russia (Lebedeva, 1906, p. 436). However, due to nomenclatorial confusion, any references to this species must be used with caution, as is pointed out by Main (1917, p. 18):

> . . . it is by no means certain that the beetle we now call *G. stercorarius* is the species referred to by Fabre or other earlier writers by that name. Hence, apparent discrepancies in the records of various authors about an insect may be due to the fact that different species are being referred to under the same name. As a case in point, Fabre gives the autumn as the time of oviposition of *G. stercorarius*, while the insect which now goes by this name lays its eggs in the spring, and it is our [British] *G. spiniger*, whose name he does not mention, which lays its eggs in the autumn. . . .
>
> It might also be put on record that the interesting account of the parasitism of *Aphodius porcus*, related by Dr. Chapman in the "E. M. M.," 1869, pp. 273–276, should be referred to *G. spiniger* Marsh, as the host, and not *G. stercorarius* L., the names having certainly been transposed since the date of the published account.

Several good, fairly recent papers dealing entirely or in part with the biology of *Geotrupes stercorarius* are Spaney (1910, pp. 625–634), Sano (1915–1916, pp. 25–28), Main (1917, pp. 18–22), and Schjelderup-Ebbe (1925, pp. 97–98). Some of the information set forth in these papers is briefly summarized here.

Geotrupes stercorarius has been noted as using horse or cow dung for larval and adult food. Egg laying occurs in the spring and early summer. Incubation lasts about 14 to 16 days with the resulting larva growing rather rapidly until fall. Then, as an early third instar, it overwinters, does a small amount of feeding in the spring, and finally pupates in July. The adults emerge from their pupal cells in September, overwinter, and begin egg laying the following spring, completing a 2-year life cycle.

Sano mentioned that the emerging beetles do not necessarily come to the surface by way of the old burrows, but dig new ones. Main (1917, pp. 18–22) brought out several interesting facts. In many cases he found the male aiding the female in making burrows and provisioning the larval cells. The male pushed the excavated dirt from the burrow, rotating the body 90°, and then heaved the small plug of earth upward. This was followed by another turn, another heave, and so on. When the burrow reached the desired depth, the male brought the dung down the burrow to the female, and she in turn packed the larval cell. Main observed that if the male did not return with alacrity (p. 20) "the female then calls him using the stridulatory apparatus situated on the base of the abdomen and the posterior coxae. It is quite audible to an observer. If he still lags she comes up after him and gives him a good dressing down, clawing him vigorously, and he then once more resumes his task." Main mentioned however, that the female may do all of the work unaided. He also stated that three, four, or five brood chambers may be made branching off a single burrow. A diagram of the burrow of *Geotrupes stercorarius* with its brood cells can be found in the paper by Spaney (1910, fig 3).

The larva of this introduced species, *Geotrupes stercorarius* Linné, has not been collected in this country to my knowledge. However, it has been described in European literature a number of times. The original description was by Frisch (1736, pp. 13–15), but the only larval character brought out by him was the reduced metathoracic leg. Later, Schiødte (1874, table 16, pl. 61, figs 1–18; table 19, pl. 64, fig. 13) described the larva more fully, but unfortunately treated some of the structures more artistically than accurately. Schiødte's fanciful drawing of the epipharynx was later perpetuated by Hayes (1929, p. 25, pl. 6, fig. 58). The most adequate descriptions and best illustrations can be found in Spaney (1910, p. 632), Sano (1915–1916, pp. 25–28), Main (1917, pp. 18–22), and van Emden (1941, p. 121).

The larva can easily be separated from the other known North American *Geotrupes* larvae by the following characteristics given by van Emden (1941, p. 121): Greatest width of head capsule of third instar "5.9 to 6.8 mm," and

Sclerotized line of the endoskeletal figure of ventral anal lobe meeting that of the other side and forming with it a subtriangular area, but not extending beyond it towards the sclerotized line that defines the ventral edge of the lobe. Subtriangular part of endoskeletal figure slightly wider than long, the angles broadly truncate and rounded, the sclerotized band dilated at middle of dorsal side and broader at that point than at lateral angles, stalk narrow above, more gradually widening to dorsal angles of subtriangular part.

Specimens examined: 20.

CANADA

NEW BRUNSWICK: 3 males, 1 female, Tabusintac, June 22, 24, 27, 1939, Brown (Howden). 4 specimens, Tabusintac, June 20, 22, 24, 1939, Brown (Frost). 4 specimens, Tabusintac, Apr. 27, 1939, Brown (MCZ). 1 male, 1 female, Tabusintac, May 24, 1939, Brown (CU). 5 specimens, Tabusintac, June 24, 1939, Brown (Robinson). 1 specimen, Fredericton, Aug. 1, 1928, Gorham (Robinson).

Brown (1940, and in correspondence) lists the following additional Canadian localities.

NEW BRUNSWICK: Bathurst, Scotch Lake, Shediac.
PRINCE EDWARD ISLAND: Alma, Bedford, Kinkora.
QUEBEC: St. Hilaire.

Geotrupes splendidus splendidus (Fabricius)

Scarabaeus splendidus Fabricius, 1775, p. 18, No. 63. Lectotype, male, here designated. Lectotype label placed on the specimen by S. L. Tuxen (Fabrician collection at Kiel).

Geotrupes splendidus (Fabricius) Say, 1823, p. 210.—Melsheimer, 1846, p. 139.—Jekel, 1865, p. 529.—Horn, 1868, p. 316.—Blanchard, 1888, p. 106.—Blatchley, 1928, p. 45.—Bradley, 1944, p. 112.

Geotrupes blackburni Palisot de Beauvois (not Fabricius), 1805, p. 75.—Jekel, 1865, p. 530.

Geotrupes starki Jekel, 1865, p. 609.—Boucomont, 1912, p. 28.

Length 13 to 18 mm., greatest width 7.5 to 11 mm.

Color of dorsum usually bright shining green. Occasional specimens may be entirely light blue, others rarely entirely purple black. Ventrally specimens are generally black with slight bluish iridescence, particularly on the femora. Antenna dark reddish brown with antennal club light reddish brown. Eye canthus, clypeus, and anterior two-thirds of vertex coarsely, closely punctured. The tips of the three tubercles on the head, one medially near the basal margin of the clypeus and one beside each eye, lack punctures. A distinctly indented narrow line runs from the middle of the vertex forward to the posterior edge of the clypeus, where it bifurcates and runs along the posterior margin of the clypeus, finally reaching the outer margin at the juncture of the clypeus with the eye canthus. Clypeus margined, almost semicircular. Poorly margined eye canthus forms a very obtuse angle with clypeal edge, with sides of eye canthi slightly arcuate, almost parallel. Pronotum completely margined, moderately convex with the lateral edges evenly arcuate. Width of anterior half of pronotum noticeably less than posterior half, coarsely punctured unevenly over entire pronotum; punctures more numerous laterally and along vaguely indented midline, where they form a narrow line. An uneven indentation, heavily punctured, may be present medially on each side of the pronotum. Minute secondary punctures may be evident over entire pronotum or visible only laterally. Scutellum triangular with sides only slightly arcuate. Elytra with striae well developed, strial punctures irregular in outline and shallow, rather evenly placed in the striae. Elytral margin narrow, slightly wider anteriorly.

Foretibia of the male with apical tooth inwardly expanded, slightly bifid; the mesotarsal claw is greatly enlarged and the hind femur has a small posterior tooth in the males, modifications which are not present in the females. In both sexes there is a dorsal longitudinal uninterrupted carina extending along the inner edge of the foretibia similar to carina of *blackburnii;* a row of setae is contiguous with the carina throughout its length. External face of tibia of meso- and metathoracic legs each with three complete transverse carinae and two partial ones.

Genitalia and genital capsule of male well developed, the shape of dorsal parameres readily separating the species (pl. 4, fig. 1).

The species may be most easily distinguished by the well developed strial punctures, the male genitalia (pl. 4, fig. 1), the shape of the carina and the closely adjacent row of setae on the foretibia, the enlarged tarsal claw of the mesothoracic leg of the males, and usually the shining green color.

Variation, particularly in color, within the species is considerable, with punctures and size varying to a noticeable extent. The description was based on Raleigh, N. C., specimens compared with the Fabrician type for me by S. L. Tuxen. Size limits given in the description refer to southern specimens only, as does the description of color. Specimens collected from North Carolina southward generally are quite uniform in size and color. The constancy diminishes northward and westward. Specimens collected west of the Appalachian Mountains usually show sufficient constant size and color differences to warrant subspecific rank, which they are subsequently given. However, as areas of intergradation are large with clear subspecific separation not always possible, no attempt at separation has been made in the species locality list, both subspecies being listed together.

Although *Geotrupes splendidus splendidus* is one of the most common and most widely distributed species in the genus, there have been relatively few notes published on its biology. The feeding habits, particularly of the newly emerged adults in the fall, appeared to be amazingly varied. While fungi were noted to be the preferred food, beetles were attracted to horse and cow dung, human feces, dead animals, chicken feathers and entrails, fermenting malt, isoamylamine, and butyric and propionic acids. By the use of the last three and other chemicals in traps, adult activity could be easily plotted. The relative abundance and time of surface activity of *splendidus* as it was indicated by the use of chemical baits is shown in table 4.

Spector (1943, p. 229) had previously noted the attraction of *splendidus* to chicken heads and feathers, while Moennich (1939, p. 156) mentioned finding a specimen of *splendidus* at Midvale, N. J., feeding on the fungus *Clavaria aurea* Fries. In North Carolina, *splendidus* did not seem to be limited to one or two species of fungi but merely utilized what was at hand.

Despite the omnivorous habits of the adults, fungi were definitely preferred. In September, the freshly emerged males made burrows 4 to 6 inches deep under partially decayed fungi. They then took portions of the fungi into the burrows, fed, and apparently awaited the approach of a female. From observation, it seemed to me that the female entered the burrows after the males. The males, when considered as a group, emerged a week or so before the females and made their burrows. When the females appeared, single males could be found in a few of the burrows, but never single females.

TABLE 4.—*Bait used in traps and number of* Geotrupes splendidus splendidus *Fabricius collected at Raleigh, N. C.*

(First column under month refers to first two weeks, second column to last two weeks)

Chemicals	*Jan.*		*Feb.*		*Mar.*		*Apr.*		*May*		*June*		*July*		*Aug.*		*Sept.*		*Oct.*		*Nov.*		*Dec.*		*Total*
Propionic acid	1	0	1	0	2	1	1	8	3	0	0	0	0	0	0	0	0	0	0	5	3	2	8	0	35
n-Butyric acid	2	0	0	1	0	3	30	4	4	1	0	0	0	0	0	0	0	1	0	21	4	1	9	0	81
Oleic acid	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Isoamylamine	0	0	0	0	0	0	0	4	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	11
Valeric acid	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
n-Amyl mercaptan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	5
Pelargonic acid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	5
Ethyl mercaptan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Total	3	0	1	1	2	4	31	23	11	3	1	0	0	0	0	0	0	1	0	36	8	3	17	0	145

Sex ratio: 66 males, 79 females.

In an attempt to learn more about the habits of the adults during the fall, several gallon-cans were filled with dirt, sunk into the ground, and fungi placed on top. When the burrows were noted in the dirt the cans were pulled out, rapidly inverted, and dumped out. In this way several pairs of *splendidus* were observed in copulation. The male genitalia, when in the process of retraction, was rotated a full 360° to the right. At no time was the genital capsule seen, apparently never being extruded. On Oct. 23, 1950, a pair of *splendidus* left for several hours in a salve box were found in copulation. The 360° rotation of the male genitalia during retraction was again noted.

In order to ascertain the stage of development of the female ovaries at the time of mating, several females were subjected to histological examination. Only vague suggestions of one or two partially formed eggs were seen in the specimens examined.

During September and October at Raleigh, a number of *splendidus* were kept alive and placed, along with a quantity of cow dung, in a 3-by-6-foot enclosure which was covered with screen wire. On Apr. 17, 1951, the cage was dug up. In most cases the adults were found inactive at the bottom of shallow burrows. In two instances the burrows turned sharply at a depth of about 6 inches and were then packed with an elongate wad of dung. In each dung wad, within one-half inch of the terminal end, was a small cavity about one-fourth inch in diameter containing an elongately oval, yellowish white egg. The eggs, with their accompanying wads of dung, were placed in salve boxes and taken indoors. One egg failed to hatch, probably due to injury by mites. The other egg hatched on April 29. The larva grew rather rapidly, becoming a second instar in May 10, and then died, for no apparent reason, on May 17, 1951.

Because of the rather poor results obtained, it was decided to move the adults to a new enclosure in an area where many *splendidus* had been collected. The area chosen, about 5 miles north of Raleigh, was on a well-wooded, southward-facing hillside. The deciduous trees, predominantly oaks, were by far the largest components of the woods and beneath them was a thick layer of dead leaves.

The adult beetles were placed in a new enclosure, the same size as the old one, along with a quantity of the ground litter, dead leaves, and some fresh cow dung.

The cage was left undisturbed for over a month; then, a portion of the cage was dug up on June 27, 1951, with gratifying results. Each burrow yielded a cell containing an egg or larva. The burrows typically went to a depth of from 3¾ to 6½ inches, where they took a sharp, almost right-angled turn. Half an inch beyond this turn the packed food cell began. These wads, 2 to 3 inches long and slightly under 1 inch in diameter, were composed, surprisingly, of tightly packed pieces of dead leaves in concentric layers. There was no dung or other material used, merely small bits of dead leaves (largely oak) which were so tightly packed into a firm mass that it retained its shape when removed from the burrow. Seemingly none of the burrows led to more than one cell, but because of the difficulty of digging in the hard red clay, and because of the beetles' habits of partially refilling the burrows, the statement cannot be made with certainty. Plate 10, figure 7 is a diagram of what is believed to be a typical burrow and cell.

Five of the cells found on June 27 contained eggs, three cells contained first instars, two cells contained second instars, and one cell contained a small third instar. Several of the larvae were preserved; others were kept alive in salve boxes.

The remainder of the cage was dug up on Aug. 8, 1951. At this time all of the cells found (a total of 14) contained third-stage larvae. These were at depths ranging from 4½ to 7 inches. Again all of the cells were composed of bits of leaves. Cow dung, while available, was not used in a single instance.

Previously, on Apr. 23, 1951, several hundred yards from the cage a burrow was found which yielded a tightly packed wad of leaves at a depth of 3½ inches. An egg contained in the wad was reared, became a third instar on July 5, and a pupa on September 6. The adult which emerged on September 20 proved to be a specimen of *splendidus.*

A second burrow, containing a second instar in a tightly packed cell of leaves, was found in the same area on May 7, 1951. This larva, which also proved to be *splendidus,* became a third instar on May 26, a pupa on August 20, and an adult on August 28.

From information gained from reared larvae, both from the cage and from unknowns, the life history of *splendidus* in North Carolina can be summarized as follows:

Newly emerged adults feed largely on fungi during September and October. Mating occurs at this time in burrows probably made by the males. The adults pass the winter in these burrows, emerging in April. Oviposition lasts from April through June. In late June all stages of the larvae can be found, but, because of the rapid development of the early stages (11 to 17 days for the first instar, and 15 to 25 days for the second), by August all of the larvae are third instar. Pupation occurs from late August until mid-September. The newly transformed adults begin to emerge in early September, completing a life cycle of one year.

Description of the immature stages of *Geotrupes splendidus* was based on the following material collected at Raleigh, N. C.: One egg, Apr. 21, 1951, H. Howden; two first-stage larvae, June 27, 1951, H. Howden; two second-stage larvae, June 29, 1951, H. Howden; 11 third-stage larvae in cage, Aug. 8, 1951, H. Howden and P. O. Ritcher; one prepupa, Sept. 12, 1951, H. Howden and P. O. Ritcher; 7 third-stage larval skins associated with pupae and adults reared from larvae.

Third-stage larvae of *Geotrupes splendidus* differ from Ritcher's (1947, pp. 6, 7) description of *G. blackburnii* (*excrementi*) in the following respects.

Maximum width of head capsule 4.0 to 4.5 mm. Frons (pl. 7, fig. 9) on each side usually with 1 posterior frontal seta, 2 setae in each anterior angle, 1 exterior frontal seta and 1 anterior frontal seta. First two antennal segments approximately equal in length, third segment greatly reduced in diameter (pl. 7, fig. 2) and slightly over half the length of the second segment. Mandibles (pl. 7, figs. 13, 14) and maxillae (pl. 8, fig. 3) similar to those of *blackburnii* except for the maxillary stridulating area which consists of a row of 8 to 10 conical teeth on each stipes and a short row of 3 teeth along the posterior margin of the palpifer. Hypopharynx (pl. 8, fig. 3) with asymmetrical oncyli differing in shape from those of *blackburnii* (pl. 8, fig. 2) and *excrementi* (pl. 8, fig. 5). Before the hypopharynx is a row of about 10 sensillae on each side, separated medially by several setae. The setae are part of a small group of 7 or 8 median setae just anterior to the row of sensillae (pl. 8, fig. 3). Glossa emarginate. Epipharynx (pl. 8, fig. 1) quite similar to that of *blackburnii.* Torma united mesally, posterior epitorma slightly larger than anterior epitorma. Anterior to the pedium are about 12 very irregularly placed stubby setae (much shorter than the irregular row of 6 setae in *blackburnii* or the even row of 7 or 8 setae in *hornii*).

Body shape and setal arrangement similar to *blackburnii.* All legs with tuberculate tips bearing small brown claws identical to those of *blackburnii,* as are the position and number of stridulatory teeth on metathoracic legs. Endoskeletal figure of last abdominal segment ventrad of triangular area not quite as constricted as that of *blackburnii,* but very similar otherwise.

Egg yellowish white, oval, largest near one end, 4.5 mm. in length, 2.4 mm. at greatest width.

First instar, greatest width of head capsule 2.5 mm. Setal patterns of head and abdomen and leg structures similar to that described for third instar. Mandibles more elongate, endoskeletal structure of anal lobes rather indistinct, apparently quite similar to that of third instar. Spiracular plates, large and crescent-shaped in later stage, are small and circular in the first instar.

Second instar, maximum width of head capsule 3.1 to 3.3 mm., otherwise structurally similar to third instar.

Specimens examined: 562 males, 433 females.

CANADA

ONTARIO: 2 females. Toronto; (2) June.
QUEBEC: 2 females. Nominingue.

UNITED STATES

ALABAMA: 2 males, 1 female. Blount Springs, "Felix (Perry County)," Tuscaloosa County; (2) August.
ARIZONA: 1 female. Snowflake [? doubtful record].
ARKANSAS: 1 male. Osceola; (1) August.

DISTRICT OF COLUMBIA: 3 males.

CONNECTICUT: 7 males, 9 females. Cornwall, Marlboro, Pomfret, Ridgefield; (4) June, (1) August, (1) September.

FLORIDA: 1 female. Orlando (?).

GEORGIA: 4 males, 7 females. Athens, Atlanta, Clarke County, Margret, Neil Gap, Rabun Bald Mountain, Satolah; (1) February, (2) March, (1) April, (2) May, (2) June, (1) September, (1) December.

ILLINOIS: 38 males, 35 females. Algonquin, Beverly Hills, Champaign, Chicago, Cook County, Dubois, Edgebrook (?), Elgin, Grand Detour, Heyworth, Homer, Martinsville, north Illinois, Ogle County, Oregon, Palos Park, Peoria, Pittsfield, Princeton, Putnam County, Schiller Park, Urbana, White Heath, Willow Springs; (5) April, (16) May, (23) June, (8) July, (7) August, (4) September, (8) October.

INDIANA: 18 males, 11 females. Beverly Shores, Bloomington, Bluffton, Clarke, Hanover, Hessville, Monroe County; (3) May, (1) June, (4) July, (5) August, (15) September.

IOWA: 30 males, 19 females. Ames, "County 88," Davis County, East Gilbert, Forest City, Iowa City, McGregor, Moulton; (7) April, (17) May, (9) June, (6) August, (1) September, (3) October.

KANSAS: 28 males, 22 females. Argentine, Clay County, Douglas County, Franklin County, Lawrence, Muncie, Onaga, Osage City, Wichita; (1) March, (7) April, (5) May, (6) June, (3) August, (16) September.

KENTUCKY: 1 female. (University of Kentucky collection, No. 5602.)

MAINE: 3 males, 5 females. Bethel, Cape Rosier, Christmas Cove, Greenwood, Monmouth, Paris; (1) June, (1) July, (3) August, (1) September.

MARYLAND: 5 males, 2 females. College Park, Takoma Park; (1) May, (1) July, (1) August.

MASSACHUSETTS: 18 males, 17 females. Berkshire County, Concord, Framingham, Lenox, Montgomery (?), Mount Tom, Princeton, South Hadley, Springfield, Tyngsboro, Wakefield, Watatick [?]; (3) May, (3) July, (10) August, (9) September, (2) October.

MICHIGAN: 97 males, 63 females. Ann Arbor, Grosse Pointe, Cheboygan County, Commerce, Detroit, George Reserve (Livingston County), Galesburg, Huron County, Olivet, Portage Lake (Livingston County), Washtenaw County; (2) April, (2) May, (6) June, (17) July, (115) August, (5) September, (2) October.

MINNESOTA: 4 males. Duluth, Le Sueur County, Olmsted County; (2) August.

MISSISSIPPI: 1 male, 4 females. Iuka, Lucedale, Meridian, New Augusta; (1) June, (3) July, (1) August.

MISSOURI: 14 males, 16 females. Allenton, Clarksville, Columbia, Fulton, Kansas City, St. Louis, St. Marys; (3) April, (2) May, (3) June, (3) September, (9) October, (3) November.

NEBRASKA: 2 males, 3 females. Bennet, Niobrara, Omaha; (1) August, (1) September, (2) October.

NEW HAMPSHIRE: 12 males, 7 females. Antrim, Barnstead, Belknap County, Chocorua, Durham, Exeter, Farmington, Rumney, Shelburne, West Milton; (1) April, (1) May, (3) June, (5) August, (4) September.

NEW JERSEY: 13 males, 8 females. Burlington County, Chester, Dumont, Eagle Rock (Essex County), Fort Lee, Golden's Bridge (?), Lake Lackawanna (Stanhope), Montclair, Paterson, Phillipsburg, Ramsey, Riverton, Terrace Pond, Westville; (2) May, (1) June, (2) July, (6) August, (5) September, (1) October.

NEW YORK: 27 males, 27 females. Astoria, Bemus Point, Black Brook (Clinton County), Delmar, Flushing, Ithaca, New Lebanon, Plattsburg, South Fallsburg, Washington County, West Point; (6) June, (43) August.

NORTH CAROLINA: 61 males, 49 females. Andrews, Asheville, Balsam, Beaver Creek (Mill Hill), Black Mountain, Blue Ridge Parkway (Deep Gap), Bryson City (2,000 ft.), Cabarrus County, Carthage, Chapel Hill, Chimney Rock, Cullasaja Falls, Davidson, Delhaven, Haywood County, Hendersonville, Highlands, Hickory, Lake Lure, Lake Toxaway, Macon County, Marion, Mills River, Old Fort, Pisgah Forest, Raleigh, Whiteside Mountain; (2) January, (19) April, (15) May, (19) June, (2) July, (8) August, (9) September, (19) October, (7) November.

OHIO: 13 males, 14 females. Beamsville (Darke County), Clear Fork (Ashland County), Clermont County, Cleveland, Conneaut, Delaware County, Eaton, Geneva, Hocking County, Jefferson, Lima, Locust Creek (Adams County), Mercer County, Oxford, Preble County, Worthington; (1) April, (1) May, (3) June, (4) July, (3) August, (13) September, (2) October.

OKLAHOMA: 2 males. Alva (Oklahoma Territory), Payne County; (1) October.

PENNSYLVANIA: 43 males, 32 females. Allegheny County, Broomall, Castle Rock, Dauphin County, Delaware County, Downington [=Downingtown?], Forest County, Jeannette, Jefferson County, Mont Alto, Ohiopyle, Pittsburgh, Pocono Mountains, Pocono Pines, Rockville, Sumneytown, West View, Wilmerding, Windgap; (1) March, (2) April, (8) June, (24) July, (16) August, (7) September, (5) October, (2) November.

RHODE ISLAND: 1 male. Westerly; (1) September.

SOUTH CAROLINA: 99 males, 61 females. Cashiers Valley Road (Oconee County), Clemson College, Columbia, Greenville, Greenwood, Hardeeville, Kings Mountain, Mountain Rest, Oconee County, Rocky Bottom, Sassafras Mountain (3,500 ft.), Table Rock, Tunnel Walhalla; (1) February, (1) April, (1) May, (7) July, (11) August, (128) September, (7) October, (3) December.

TENNESSEE: 6 males, 6 females. Deer Lodge, Gatlinburg, Grassy Cove (Cumberland County); (1) May, (10) June, (1) September.

VIRGINIA: 5 males, 6 females. Basye, Falls Church, Harpers Ferry, Jones Creek (Lee County), Mountain Lake, Mount Vernon, Nelson, Suffolk; (1) June, (3) August, (3) September.

WISCONSIN: 5 males, 2 females. Dane County, Grant County, Kilbourn (?), Lac Vieux Desert, Madison, Wood County; (1) May, (1) June, (4) August.

Geotrupes splendidus miarophagus Say, new combination

Geotrupes miarophagus Say, 1823, p. 210 (type lost).—Jekel, 1865, p. 611.—Horn, 1868, p. 316.

Geotrupes gilnicki Jekel, 1865, p. 608.—Boucomont, 1912, p. 28.

Geotrupes mixtus Horn, 1868, p. 316.

Geotrupes splendidus (Fabricius) Blatchley, 1910, p. 939.—Dawson 1922, p. 197.

Length 15 to 20 mm., greatest width 9.5 to 12.5 mm.

Color of dorsum yellowish green with varying amounts of golden or reddish iridescence. Many specimens are very dark, some blackish with traces of reddish or purple color in the striae. Ventrally specimens are black with traces of green or purple iridescence on the legs.

Structurally many specimens cannot be separated from the eastern *splendidus*. However, in the majority of specimens the pronotum laterally is more convex and not as narrowed anteriorly as in many eastern *splendidus*. Other structures, such as carinae on legs, striae, and male genitalia, do not exhibit even moderately constant differences from *splendidus*.

NEOTYPE: Male (purplish black), Columbia, Mo., Apr. 24, 1935, Starr (USNM). No type locality given by Say.

This subspecies can be differentiated by the yellowish color of the dorsum, which is quite different from the deep "grass" green of the southeastern *splendidus*. In general the larger size and more rounded and slightly wider anterior portion of the pronotum will also distinguish *miarophagus*.

Say's description of *miarophagus* is woefully inadequate, and does not fit the usual western forms. A number of the western specimens examined were very dark (which is extremely rare in eastern specimens and it seems probable that Say merely described the less usual color phase of the western form).

Geotrupes gilnicki Jekel appears to be a fair description of the western subspecies, but is recorded (questionably perhaps) from Haiti.

The type of *Geotrupes mixtus* Horn is a large purple black male in the LeConte collection and again appears to be one of the unusual dark forms of *splendidus*. A very occasional large specimen, identical to Horn's *mixtus*, is found in the uniform southern population. I am unable to detect definite structural differences (other than size) between these unusual specimens and the usual southern *splendidus*, and for the present can consider it only a variety. Future investigation may prove this belief erroneous.

There has been a moderate amount of information published on the biology of *miarophagus*, here considered the western subspecies of *Geotrupes splendidus*. The references all use the name *splendidus*, but have, because of the locality in which the work was done, been referred to *miarophagus* by the present writer.

Brown (1927, p. 28) found the species commonly from April to June and from September to October in moist woods in Payne County, Okla. Mohr (1943, p. 278) mentions finding the adults at 2- or 3-day-old dung, while Park (1931, p. 200) lists finding "*splendidus*" at the fungus *Hydnum septentrionale* Fries on July 1, 1926. Blatchley (1896, p. 436) mentions finding specimens flying in March in Vigo County in Indiana. He states that he found a pair in copulation under a log in December, and follows this with the rather doubtful statement, "They usually mate in May."

R. W. Dawson, when at Lincoln, Nebr., published (1922, pp. 196–197) the following interesting account on the biology of *miarophagus:*

During the month of June, 1905, while the writer was spading in his home garden he had occasion to remove a quantity of lawn clippings that had been piled on a bare spot of ground several weeks previously. In turning up the soil that had been covered by the clippings a rather large and neatly formed pod of dead grass was discovered, and along with it a female *splendidus* [*miarophagus*]. Careful examination disclosed a branched tunnel with four additional food pods. One of the pods was preserved, and is before me at the present writing, the others were placed in a box of moist soil, from which the beetles emerged the following August. The food pods were all pear-shaped, and very uniform in size, measuring about two inches in length by one inch in their greatest diameter. The pods are interesting because of their relatively large size, and from being composed entirely of clean, fresh grass blades. A greater bulk of clean food seems to be required than is the case with the more concentrated material (droppings of animals) most frequently used by the beetles in this section of the family *Scarabaeidae.*

The above account indicates quite a difference in the habits of *miarophagus* from the eastern *splendidus*. North Carolina specimens of *splendidus* made a single "pod" of dead leaves at the bottoms of their burrows. In two instances caged specimens used cow dung to provision the larval cell. In addition to these food and burrow differences, there appears to have been some difference in the shape of the pod. The eastern beetles formed a mass best described as a stubby bent cigar-shape, 2½ to 3½ inches long, and of fairly uniform diameter, three-fourths of an inch to 1 inch wide.

It will be very interesting if future investigation further correlates these differences in biology between the two subspecies with the morphological differences already noted.

Geotrupes semiopacus Jekel

Geotrupes semiopacus Jekel, 1865, p. 612 (type, series in collection of H. Jekel, location unknown).—Horn, 1868, p. 316.—Blanchard, 1888, p. 106.—Blatchley, 1910, p. 939; 1928, p. 45.—Dawson, 1922, p. 196.—Bradley, 1944, p. 112.

Geotrupes blackburnii Melsheimer (not Fabricius), 1846, p. 139.

Geotrupes melsheimeri Jekel, 1865, p. 613.—Horn, 1868, p. 316.

Geotrupes ovalipennis Jekel, 1865, p. 614.—Boucomont, 1912, p. 28.

Length 12.5 to 19.5 mm., greatest width 8 to 11 mm.

Color of dorsum dull green to purple, faintly iridescent with underlying color of dark brown to black. Ventrally specimens are black with traces of bluish iridescence. Antennal club reddish brown, other segments dark reddish black. Eye canthus, clypeus, and small anterior portion of vertex coarsely, vaguely punctured. The three tubercles on the head only vaguely indicated. The Y-shaped sutural line on vertex and clypeal base entire, as in *blackburnii,* or only present medially. Clypeus margined, more arcuate anteriorly. Margined eye canthus forms a very obtuse angle with edge of clypeus. Sides of eye canthi gradually arcuate. Pronotum sometimes completely margined, usually with median portion of posterior margin obsolete.

Coarse punctures usually confined to lateral portions and along margins of the pronotum and sometimes in the vague median indentation. Minute secondary punctures usually not evident. Scutellum generally triangular, with sides slightly arcuate, more so anteriorly. Elytra with well developed striae, which, dorsally at least, lack punctures. Elytral margin narrow.

Foretibia of male with anteriormost of the seven external teeth expanded sharply inward and forward. Male also has tarsal claws of mesothoracic legs greatly enlarged, similar to *splendidus*. Hind femur of male without modifications, similar to female. Foretibia in both sexes with longitudinal raised carina, similar to *blackburnii*, running its entire length on the inner edge of the dorsal flattened surface. A row of setae is closely adjacent to the base of this carina throughout its length, being similar to the carina and setae of *splendidus*. External face of tibia of meso- and metathoracic legs each with three transverse carinae, the innermost sometimes poorly developed. Two partial carinae are usually present on the tibia of the metathoracic legs.

The genital capsule and elongate genitalia well developed, the dorsal parameres very distinctive (pl. 5, fig. 3).

Variation in size and color within the species is considerable. Otherwise the characteristics are rather constant, with no geographic or consistent population differences noted.

This species can most easily be distinguished by its dull green or purple color, without any coarse punctures in elytral striae. Other characteristics are the vague tubercles of the head, the carina of the foretibia similar to *blackburnii* but with the setae adjacent to the carina throughout its length rather than separated anteriorly (as it is in blackburnii), the enlarged tarsal claw of the mesothoracic leg of the male, and the distinctive genital armature of the male (pl. 5, fig. 3).

Geotrupes semiopacus Jekel occurs from southern Canada to the mountains of North Carolina and Tennessee. Predominantly a common northern species, it is active the entire summer from May until September.

Many of the specimens examined bore in addition to the locality label one reading "fungi." *G. semiopacus* has often been found in wooded areas frequenting the same general type of habitat as *balyi* or *hornii*.

Besides its habit of feeding on fungi, Spector (1943, p. 229) found *semiopacus* attracted to a heap of chicken heads and feathers placed under a flat rock. No other attractants were listed by Spector or other authors.

It is surprising that so little is known about the biology of this species, as there were a large number of adults represented in the various collections examined.

Specimens examined: 240 males, 220 females, 1 not sexed.

CANADA

MANITOBA: 1 male. Winnipeg; (1) August.

ONTARIO: 6 males, 1 female. Belleville, Lyn, Ottawa, Toronto; (1) June, (1) August, (4) September.

QUEBEC: 14 males, 4 females. Hemmingford, Joliette, Lake Nominingue (La Belle County), St. Césaire, Val Morin; (4) June, (2) July, (8) August.

UNITED STATES

CONNECTICUT: 7 males, 10 females. Cornwall, Marlboro (?); (3) June, (1) July, (4) August, (3) September.

DISTRICT OF COLUMBIA: 2 males. No data.

ILLINOIS: 36 males, 32 females. Algonquin, Beverly Hills, Bloomington, Bowmanville (Cook County), Chicago, Cook County, Edgebrook (?), Glen Ellyn, Havana, Normal, north Illinois, Palos Park, Peoria, Putnam County, Urbana, West Pullman (?), White Heath, Willow Springs; (1) May, (1) June, (1) July, (11) August, (9) September, (2) October.

INDIANA: 4 males, 1 female. Bloomington, Hessville, Wayne County; (3) August.

IOWA: 15 males, 22 females. Ames, "Counties #52, #88," Decorah, Forest City (Winnebago County), Mount Vernon; (1) April, (7) May, (9) June, (11) July, (5) August.

MAINE: 6 males, 7 females. Paris, Stoneham, Wallis; (2) June, (1) July, (7) August.

MARYLAND: 5 males, 7 females. Hagerstown, Montgomery County; (2) August, (1) September.

MASSACHUSETTS: 7 males, 6 females. Concord, Lenox, Springfield, Wilbraham; (2) September.

MICHIGAN: 2 males, 9 females. East Lansing, George Reserve (Livingston County), Macatawa Beach, Olivet, Paw Paw Lake, Port Huron; (5) May, (2) June, (2) August, (1) September, (1) October.

MINNESOTA: 8 males, 7 females. Fort Snelling, Le Sueur County, Minneapolis, Olmsted County, Winang (?); (1) June, (9) August.

MISSOURI: 1 male, 2 females. No data.

NEW HAMPSHIRE: 9 males, 9 females. Antrim, Barnstead, Franconia, Jaffrey, Lebanon, "Mt. Plst. Hse.," Rumney, White Mountains, Wilton; (2) June, (2) July, (5) August, (4) September.

NEW JERSEY: 6 males, 7 females. Hopatcong, Leonia, Phillipsburg, Somerville, Treasure Island; (3) May, (2) July, (3) August, (2) September.

NEW YORK: 27 males, 16 females. Buffalo, Cooks Falls, Greene County, Lancaster, Mount Vernon, New York City and vicinity, Onandaga County, Otto, Pike, Schroon River, Upper Saranac, West Hebron (?), West Point; (3) May, (1) June, (10) July, (14) September.

NORTH CAROLINA: 12 males, 19 females. Black Mountain, Great Smoky Mountains, Pisgah Forest, Sunburst; (2) May, (10) June, (3) July, (12) August, (2) September, (2) October.

OHIO: 5 males, 3 females. Cleveland, Columbiana County, Hudson, Nile (Scioto County), Oxford, Salineville, Summit County; (1) June, (1) July, (1) August, (2) September.

PENNSYLVANIA: 57 males, 45 females. Allegheny County, Aspinwall, Butler, Cumberland County, Delaware County, Dunbar, Easton, Elwood City, Forest County, Harrisburg, Indian Creek (?), Jeanette, Jefferson County, Langhorne, Lima, Mount Blaine (?), Philipsburg, Pittsburgh, Pocono Lake, Pocono Pines, Sumneytown, Washington, Westville; (2) May, (15) June, (19) July, (29) August, (7) September, (1) October.

TENNESSEE: 2 females. Elmwood, Mount Le Conte; (1) June.

TEXAS: 1 female. No data.

VERMONT: 1 specimen, Bennington County, East Burke; (1) August.

VIRGINIA: 1 male, 1 female. No data.

WEST VIRGINIA: 5 females. Cheat Mountain, White Sulphur Springs; (2) June.

WISCONSIN: 11 males, 4 females. Dane County, Gays Mills, Lone Rock, Madison, Worden (?) (Clark County); (1) May, (1) June, (2) July, (2) August.

Genus *Peltotrupes* Blanchard

Peltotrupes Blanchard, 1888, pp. 105, 109.—Boucomont, 1911, p. 345.—Bradley, 1944, p. 112.—Howden, 1952, p. 44.

Genotype: *Geotrupes chalybaeus* LeConte, by monotype *in* Blanchard, (1888).

Generic limitations: Given by Blanchard (1888, pp. 105, 109):

> Middle and hind tibia without external [transverse] apical ridge [carina].
> The anterior tibiae have on the upper surface the usual inner impressed line bearing a row of setae but the adjacent outer carina is quite absent . . . . in our other *Geotrupes* the middle and hind thighs [femora] are flattened posteriorly to receive the tibiae, and have the margins finely elevated each side while in *chalybaeus* [now *profundus*] they are convex behind with a single strong margin which is next to the upper side.

Other useful characteristics are: General body shape oval and rather flattened dorsoventrally, fine elytral striae, widely expanded elytral margins, complete margin around pronotum, and the modification of the foretibia in the males rectangularly inturned, strongly produced.

The unusual characters exhibited by *Peltotrupes* caused Blanchard (1888, p. 104) to state that it "is an obvious interruption in our series . . . . It seems equally out of place among any of the exotic subgenera mentioned by Jekel, and the proper course appears to be to establish a distinct genus for it."

I am inclined to agree with Blanchard and have elevated *Peltotrupes* to generic rank. It appears distinct from *Geotrupes* not only by many of its adult structural characteristics but also by many of its larval characteristics. Even biologically, *Peltotrupes* differs considerably in larval habits from the habits of other known Geotrupini.

Superficially, in general form *Peltotrupes* resembles some of the varieties of the European *Geotrupes vernalis*, particularly variety *fulgidus* Motschulsky, which occurs in Turkey. However, the resemblance is only in size and general shape, there being no indication of close relationship with *vernalis* or other species. This conclusion was also reached by Boucomont (1911, p. 345), who compares *Peltotrupes* with the oriental subgenus *Thorectes*.

The genus *Peltotrupes* presents an interesting taxonomic problem, due in part to the following causes. The species range almost entirely across Florida from near Tampa northward to the vicinity of Lake City; however, their distribution is very spotty. Young (1950, p. 88) states that their "rarity seems to be due to the restricted habitat[s] of the species and to [their] occurrence in the winter and early spring months." The habitat is St. Lucie and other deep sands covered with scrub oaks and pine but without much ground cover. The members of the genus appear to be deep burrowing (Howden, 1952, p. 42), placing their larval cells at some depth in the sands. The necessary sand ridges are irregularly scattered over northern Florida, some of them isolated by swamps or lowlands. Furthermore, there are the short winter period of adult activity and the insects' very doubtful powers of flight—I spent some time trying unsuccessfully to induce beetles to fly. Because of these facts, I distinguish between several rather distinct, isolated populations.

The development of distinct populations of isolated colonial beetles was early noted in the related genus *Pleocoma*, in which the females are flightless. Linsley (1946, p. 61) states: "There is little doubt that the various forms of *Pleocoma* to which names have thus far been applied represent distinct populations, but the exact taxonomic status of the more closely related of these must await future interpretation on the basis of longer series of both sexes from many more geographical areas than are now represented in collections." This last statement is equally applicable to the populations of *Peltotrupes*.

Isolation of the various populations appears to have occurred in recent geological times, as the populations, while distinct, are very close structurally. The male genital armature is very complex but is also quite variable, and a method of separation of the populations by constant genitalic characteristics was not found.

Descriptions have been based on examples that I believe are typical of the different populations. Care must be taken with worn specimens which before collection have burrowed sufficiently to obliterate some of the better distinguishing characteristics.

Characteristics distinguishing the larvae from known larvae of *Geotrupes* (Howden, 1952, p. 48) are: Greatly shortened third antennal segment, presence of tuberculate bases of the setae on the end of the tibiotarsus, the shape of the anal lobes, and the greatly swollen abdomen (pl. 2, fig. 1). The larvae have the metathoracic legs reduced, as does *Geotrupes.*

The range of the genus appears to be limited to the deep sand ridges of northern and central peninsular Florida (Young, 1950, p. 88).

Key to the species of Peltotrupes

1. Sutural stria by tip of scutellum definitely impressed, other striae evident; iridescent color largely purple (subspecies of *profundus*) 2
   Sutural stria by tip of scutellum not impressed, other striae generally obsolete; iridescent color largely green (4 miles west of Rodman, Fla.). **youngi**, new species
2. Median posterior edge of anterior pronotal margin lacking any trace of a tubercle (pl. 2, fig. 3b); elytron just behind and below humeral umbone sharply flared before the margin (pl. 2, fig. 4b) (west coast of Florida, Gainesville to Tampa) . . . . **profundus** Howden
   Median posterior edge of anterior pronotal margin with V-shaped tubercle (pl. 2, fig. 3c); elytron just behind and below humeral umbone moderately flared before the margin (pl. 2, fig. 4c) (east coast of Florida, Welaka and St. Augustine) . . . . **profundus dubius**, new subspecies

Only the larva of *Peltotrupes youngi* is known; it was described by the writer (Howden, 1952) under the name *Geotrupes* (*Peltotrupes*) *profundus.* Because of the very close relationship of the adults it is somewhat doubtful that consistent morphological differences will be exhibited by the larvae of the other species if they are discovered. Conversely, it is also possible that the larvae may be more easily separated than the adults, which is true in the case of some of the *Bolboceras.*

Peltotrupes profundus Howden

Geotrupes chalybaeus LeConte, 1878, p. 402 (type, male, Florida, LeConte collection, MCZ).—Blanchard, 1888, pp. 103, 110.—Blatchley, 1928, p. 44.—Young, 1950, pp. 88–92 (in part).
Geotrupes profundus Howden, 1952, p. 41 (in part).

Length 15 to 23 mm., greatest width 9 to 14 mm.

Color of dorsum dark reddish brown to almost black, suffused with purplish iridescence, sometimes with bluish and slight traces of greenish iridescence. Iridescence is general but most pronounced on head, margins of pronotum and elytra, and along elytral striae. Ventral surfaces largely dark brown, thorax slightly darker than abdomen. Femora of meso- and metathoracic legs and epipleura dark brown with traces of iridescence. Head with broadly rounded clypeus forming a very obtuse angle with eye canthus (pl. 2, fig. 1b). Both clypeus and anterior portion of canthus are margined. Clypeus coarsely, densely, irregularly punctate except on posterior tubercle. Vertex of head with only a few coarse punctures between the eyes. Prothorax sharply and completely margined. Anterior angles obtusely and gradually rounded (pl. 2, fig. 2b). Inner edge of the anterior margin forming an almost straight line usually curved slightly forward near the midline. A double row of coarse punctures runs entirely across the pronotum just behind the anterior margin (pl. 2, fig. 3b). A few coarse, moderately deep punctures are unevenly scattered over the pronotum, being most numerous near the posterior angles. A deep, almost circular indentation with numerous coarse punctures is present on each side of the pronotum near the middle. Numerous fine secondary punctures usually evident over entire pronotum, becoming more pronounced near the posterior angles, sometimes giving the pronotum in that area a rough appearance.

Elytra with at least the first three or four striae shallowly indented; sutural stria deep and continuous, not vague anteriorly near scutellum. Fifth stria obsolete, indicated only by a regular row of punctures, the other striae barely indicated. Moderately coarse deep punctures are present in all striae, often being the only indication of obsolete striae. These punctures in many cases joined by deep grooves, while others are not, giving the striae an interrupted appearance. Elytral intervals are at least slightly convex in appearance, their highest point being midway between the adjoining striae. Elytral margin broadly expanded and somewhat explanate, more so anteriorly, posteriorly ending in a very small sutural spine. Angle between normal convexity of elytra and beginning of margin rather sharp in outline, approaching a right angle (pl. 2, fig. 4b). Much of ventral surface covered with numerous, long, reddish yellow setae. Median portions of the last three or four abdominal segments shiny, generally lacking setae except along posterior margins. Tibia with many long spinelike setae lining outer edges and carinae. In the male the apical tooth of the outer margin of the foretibia is greatly modified, elongate, bent rectangularly inwards, slightly recurved with inner edge sinuate. In addition, the foretibia has a row of 4 (sometimes 3 to 7) elongate conical teeth on inner surface. The hind femur of the male is also modified by having a small spine present near the posterior margin by the coxa. None of these modifications is present in the female.

Male genitalia and genital capsule large and heavily sclerotized. Capsule with dorsal and ventral plates fringed with a few short setae. Genitalia quite complex with two dorsal parameres and a bilobed ventral phallobase, which are rather variable in shape. The short right dorsal paramere is very complex, the posterior edge of the large bulbular basal portion usually forming a wide oblique irregular V (pl. 2, fig. 5b).

Variation in size, previously noted, is considerable. Differences between the two sexes is also considerable. The modifications of the foretibia and hindfemora in males have already been noted.

Dorsally, the iridescence is more pronounced. The ground color is more often brown than black, and the elytral striae are usually deeper in the males than in the females. There also appears to be a vague difference in the slope of the elytral apices, but this is small and quite variable.

Variation, other than in size and sexual characteristics, is not pronounced. The anterior angles of the pronotum show some variation, but are most often as depicted (pl. 2, fig. 2b). Depth of punctures and striae vary within and between the sexes, but the sutural stria is generally evident and unbroken throughout its length, beginning at the scutellum. Color, punctures, width of angles of elytral margin, and other characteristics are all quite constant within one sex.

This species can usually be distinguished by its dark brown color with the pronounced purplish iridescence, the double band of punctures completely (in most cases) across the pronotum just behind the straight inner edge of the anterior margin (pl. 2, fig. 3b), noticeable elytral striae (particularly the sutural one) with intervals usually convex, fifth stria represented by a straight regular row of punctures, moderately deep punctures in all striae, and the rather sharp angle between the line formed by a normal curve of elytron and the expanded margin when viewed from the posterior (pl. 2, fig. 4b).

The above description was largely made from a Gainesville, Fla., specimen carefully compared by the author with the fragments of LeConte's type, which included the head, thorax, one elytron, and one male foreleg. It is possible that the elytron (and some of the other fragments) could have come from a female specimen, as the rounded contour of the posterior portion of the elytron matched a number of females and was not quite like the male homotype selected.

Very few specimens have been taken in the vicinity of Tampa, the type locality. Gainesville specimens from which the description has been made may have constant characteristics differentiating them from the Tampa population. If these differences occur they have been overlooked because of the paucity of specimens from the type locality. From the specimens examined, I believe that the various populations, ranging along the west coast of Florida and inland to Orlando, Gainesville, and Lake City, represent a moderately uniform group. Future collecting from isolated sand ridges should provide much useful and needed information concerning these interesting beetles.

Until Young's (1950) paper almost nothing was known about these beetles. In his paper Young discusses the distribution and adult habits of the species (here considered two species and one subspecies). Most of the information that has been accumulated by Young and myself concerns the Interlachen, Fla., population herein described as new. It seems reasonable to assume that the habits of all the species are similar, so the reader is referred to the subsequent discussion of the biology of the new species *youngi*.

A few other general notes have been published concerning the habits of *profundus* under the name *chalybaeus* LeConte. Leng (1887, p. 212) published a note that he received specimens from Orange County, Fla., collected Dec. 24, 1885, "late in the afternoon about a quantity of horse and mule manure on a sandy road running through high pine lands." Whether manure acted as an attractant is doubtful. Schaeffer (1913, p. 169) mentions that he noted "*G. chalybaeus*" attracted by stale urine. The only other early references to this beetle that I have seen were an occasional reference to its seeming rarity. Young and Hubbell have disproved this by collecting large numbers of *Peltotrupes* in traps containing fermenting molasses sunk in the ground.

Specimens examined: 66 males, 60 females.

FLORIDA: 66 males, 60 females. Croom (Hernando County), Enterprise, Gainesville, Gilchrist County, Hernando County, Kissimmee, Lake City, Orlando, Pensacola, Putnam County, Tampa, Tarpon Springs, Winter Park; (11) January, (57) February, (5) March, (1) April, (1) May, (1) November.

Peltotrupes profundus dubius, new subspecies

HOLOTYPE: Male. Length 17.5 mm., greatest width 12 mm.

Color of dorsum very dark blackish brown to black, suffused with bluish iridescence. Tinged with green iridescence, most pronounced on head, margins of elytra, and along elytral striae. Ventral surfaces blackish, femora black with traces of purplish iridescence. Head with margined clypeus and canthus forming angles almost identical to those of *profundus*. Margin of eye canthus usually slightly less rounded (pl. 2, fig. 1c). Pronotum sharply and completely margined. Anterior angles obtusely and gradually rounded (pl. 2, fig. 2c). Sides of thorax more evenly arcuate than is usual in specimens of *profundus*. Inner edge of the anterior margin with a small but definite triangular tubercle projecting posteriorly at midline (pl. 2, fig. 3c), interrupting the line of punctures across the pronotum behind the margin (also present in *profundus*). Very few coarse punctures on lateral portions of pronotum. Middle of lateral portion of pronotum with only a vaguely indicated circular indentation. Fine secondary punctures visible only laterally on pronotum, more so posteriorly.

First few elytral striae rather pronounced, with deep punctures, appearing identical to *profundus*. Fifth stria appears as an irregular double row of punctures in many places. The angle formed between the expanded elytral margin and the normal convexity of the elytron is slightly more obtuse than in *profundus* (pl. 2, fig. 4c). Setae of ventral portions similar, but appearing not quite as dense as on *profundus*. Tibiae and femora of holotype apparently similar to those of *profundus*, as are the genitalia and genital capsule. Angle at center of posterior portion of complex right dorsal paramere more V-shaped than in *profundus* (pl. 2, fig. 5c).

Allotype: Female. Length 18 mm., greatest width 12.5 mm.

Color of dorsum similar to that of holotype except that there is slightly more iridescent green suffusing the purple elytral margin near the apices. Except for the male modifications of the apical tooth of the foretibia and hind femur, which the female lacks, the allotype is very similar to the holotype. The lateral pronotal margin is slightly less evenly arcuate than in the holotype, but in other respects there is almost no difference.

Holotype, male, Welaka, Fla., Apr. 29, 1949, van Pelt (UnMich). Allotype, female, Welaka, Fla., Mar. 4, 1940, at light "(T–35)," Friauf (UnMich). Paratypes, 10 males, 2 females: 1 male, Florida; 3 males, Welaka, Fla., Apr. 29, 1949, van Pelt; 1 female, Welaka, Fla., Feb. 18–20, 1947, Moore; 6 males, 1 female, St. Augustine, Fla. Paratypes are in the collections of the University of Michigan, U. S. National Museum (USNM 61968), Carnegie Museum, and of the writer.

Variation in the few specimens at hand is moderate. Size ranges from 16 to 21 mm. in length and from 11 to 13.5 mm. in width. Sexual variation other than that mentioned for the tibia and femur is slight. The tubercle at the base of the foremargin of the pronotum is not clearly evident in a few of the specimens, particularly the females, and the anterior angle of the pronotum shows some variation, as does the amount of purple iridescence. Due to the variation of some of the characteristics, the small series, and its close similarity to *profundus*, I have attempted to point out the apparent differences without giving specific status to a population, which, with additional data and specimens, may prove distinct.

Distinguishing characteristics are the few thoracic punctures, the sharp triangular tubercle projecting posteriorly from the inner edge of the anterior margin of the pronotum, the purplish iridescence, and the usually evenly arcuate lateral pronotal margin which in *profundus* is usually distinctly bent near the middle.

In differentiating this form all characters should be considered, as no single character will consistently differentiate *dubius* from *profundus*.

The specimens from St. Augustine, Fla., are included here as paratypes because of their similarity to the Welaka specimens, but several differences in the populations can be noted. Two of these differences are the interrupted second elytral stria, which is broken at intervals in the St. Augustine specimens, and the lateral margins of the pronotum, which are not as evenly arcuate as are the margins of the Welaka specimens.

The range of *dubius* probably extends along the northeastern coastal area of Florida.

So far, nothing has indicated that the habits of *dubius* vary in any way from those of the preceding species. The "at light" label on one specimen is interesting, but ordinarily light does not appear to be a good attractant.

Peltotrupes youngi, new species

Adult biology by Young (1950, pp. 88–92), as *chalybaeus* LeConte.

Description of larva by Howden (1952, pp. 41–48), as *profundus* Howden.

Holotype: Male. Length 17.5 mm., greatest width 12 mm.

Color of dorsum dark reddish brown to black, suffused with pronounced iridescent green, only occasional slight traces of blue or purple. Iridescence is general but most pronounced on head, margins of thorax and elytra, and along elytral striae. Ventral surfaces are very dark brown to black, thorax slightly darker than abdomen. Femora and epipleura blackish with traces of iridescence. Head with broadly rounded clypeus forming a rather sharp obtuse angle with eye canthus (pl. 2, fig. 1a). Both clypeus and anterior portion of canthus are margined. Clypeus coarsely, moderately, irregularly punctate, except on posterior tubercle. Vertex of head with a very few coarse punctures between the eyes. Pronotum sharply and completely margined. Anterior angle sharply rounded, slightly obtuse (pl. 2, fig. 2a). Posterior edge of the anterior margin slightly curved posteriorly. Double row of coarse punctures noted in *profundus* lacking at midline (pl. 2, fig. 3a). A few coarse, moderately deep punctures are unevenly scattered over lateral portions of pronotum, very slightly more numerous posteriorly. The deep, circular, coarsely punctured indentation noted on each side near the middle of the pronotum of *profundus* is almost obsolete. The fine secondary punctures (less pronounced than is usual in *profundus*) are generally evident only laterally.

Elytra with striae obsolete, first stria vaguely indented, but not in the basal millimeter, where the stria is indicated only by a few small punctures. All the other striae are indicated only by rows of shallow punctures. Punctures generally about half the depth of those of *profundus*. Very small punctures indicating fifth stria forming a slightly irregular row anteriorly. Some of the second to sixth elytral intervals in places slightly concave, with their highest points next to the punctures. Elytral margin expanded, explanate, anteriorly less so than in *profundus*. Angle between normal convexity of elytron and beginning of margin much more obtuse than in *profundus* (pl. 2, fig. 4a). Much of ventral surface covered with long reddish setae. Median portions of the last three or four abdominal segments shiny, setae generally sparse medially. Tibia with many long spinelike setae lining outer edges and carinae. In the holotype the apical tooth of the outer margin of the foretibia is greatly modified, elongate, bent rectangularly inwards, slightly recurved with inner edge sinuate. In addition, the foretibia has a row of four elongate conical teeth on inner surface. The hind femur is also modified by having a small tubercle present near the posterior margin of the coxa.

Genitalia and genital capsule large and heavily sclerotized. Capsule with dorsal and ventral plates fringed with a few short setae. Genitalia quite complex, with two dorsal parameres and a bilobed ventral phallobase (pl. 3, fig. 7). The short complex right dorsal paramere with the posterior edge of bulbular basal portion usually forming a wide irregular V, slightly less oblique than in *profundus* (pl. 2, fig. 5a).

ALLOTYPE: Female. Length 19 mm., greatest width 13 mm. Color of dorsum black with bluish green iridescence lacking except along elytral margins, where it is most pronounced near the elytral apices. The allotype differs from the holotype in several other respects. In the allotype the punctures of the clypeus are pronounced and numerous, the fine secondary punctures of the pronotum are almost absent, the elytral striae are obsolete, and the rows of elytral punctures are slightly less pronounced than in the holotype. The hind femur of the allotype lacks the tubercle present in the male, and the foretibia has the unmodified apical tooth similar in shape to the penultimate tooth. Tarsal claws are identical in size and shape to those of the holotype, as are other major characteristics.

Holotype, male, Putnam County, Fla., T. 11 S., R. 25 E., 4 miles west of Rodman, Mar. 18, 1949, "#544 traps," Young (UnMich). Allotype, female, Interlachen, Putnam County, Fla., Apr. 3, 1951, malt trap, H. and A. Howden (Howden). Paratypes, 113 males, 261 females: 240 specimens, Putnam County, Fla., Sec. 17, T. 11 S., R. 25 E., 4 miles west of Rodman, Young, Feb. 27, 1949, Mar. 3, 8, 18, 26, 1949, and Apr. 6, 1949; 14 specimens, Interlachen, Fla., H. and A. Howden, Apr. 1, 2, 3, 1951. 120 specimens, 8 miles southeast of Interlachen, Fla., Howden and Dozier, Mar. 20, 21, 22, 1953, in malt and propionic acid traps.

Paratypes are deposited in the collections of the American Museum of Natural History, British Museum (Natural History), California Academy of Sciences, Canadian Department of Agriculture, Cornell University, Museum of Comparative Zoology, North Carolina State College, Oregon State College, U. S. National Museum (USNM 61969), and the University of Michigan, and in the personal collections of

O. L. Cartwright, B. K. Dozier, C. A. Frost, M. Robinson, F. N. Young, and the writer.

Variation in size is considerable, ranging from 16 to 22 mm. in length and from 10.5 to 14.5 mm. in width. Sexual differences have already been noted in color, depth of striae and punctures, and in the male modifications of the foretibia and hind femur. In the males the row of irregular teeth on the underside of the foretibia is composed of from 3 to 7 teeth which are usually somewhat longer than those of *profundus* or *dubius*. While there is general uniformity in the lack of a double line of punctures behind the median anterior pronotal margin, there is often a suggestion of a V-shaped tubercle, noted in *Peltotrupes profundus dubius*. This tubercle is never as pronounced as that of *dubius*, nor does a double row of punctures run on either side of it as is the case in *dubius*. The anterior pronotal angles exhibit such variation that their usefulness as a distinguishing characteristic is slight. Depth of striae and punctures also show some variation, but seldom approach the degree of development noted in *profundus* or *dubius*. The greenish iridescence is quite constant, but its extent is varied, being much more evident in the males. Other differences in morphological characteristics noted are slight.

The obsolete elytral striae indicated by the rows of small punctures, the very obtuse angle (pl. 2, fig. 4a) anteriorly between normal convexity of elytra and beginning of elytral margin, and the green iridescent color usually readily separate *youngi* from either *profundus* or *dubius*. Other differences are the sparse thoracic punctures, and the posteriorly curved inner edge of the anterior margin of the pronotum, which lacks the sharply defined tubercle of *dubius* (pl. 2, fig. 3a).

The known range of this species is very restricted, being confined to a small isolated sand ridge south of Interlachen, Fla., which was discovered and carefully described by Frank N. Young. This species has been named after Dr. Young in appreciation for his interest and the help that he has given me.

The biology of this species is better known than the other species of *Peltotrupes*, having been discussed by Young (1950) under the name *chalybaeus* and by Howden (1952) under the name *profundus*.

To my knowledge, nothing of importance since these papers has been added to the known facts of the habits of this interesting species.

The adults, which occur from January to April, are colonial and deep burrowing, and confine their surface activity to the hours of darkness. Adults are readily attracted to decaying fungi, malt, or molasses, and even banana peels and propionic acid. No evidence was seen of their feeding on dung, but it is quite possible.

The burrowing activities of the adults are amazing, both in the number of burrows in a restricted area (pl. 17, fig. 2) and in the depth, which averages about 6 feet in the loose sand! At the opening of the burrow is a large push-up of sand (pl. 18, fig. 1) about 5 inches across and 2 or 3 inches high. At one side of this pile is the burrow entrance, plugged with sand and sloping away from the push-up. (This is radically different from the burrows of other known Geotrupini, which all have the burrow entrance opening under the center of the push-up.) After descending at an angle for 4 to 6 inches the burrow turns and descends vertically, usually becoming open shortly after the turn. Young (1950) believed this plug of sand near the surface perhaps serves to prevent undue moisture loss in the rather zeric habitat of the high sand ridge.

The broad burrow, after the initial bend, descends without further turning until it reaches a depth of from 4 to 9 feet, where it bends sharply at almost a right angle. An inch or so after this bend a large cavity 6 or 7 inches long with a maximum diameter of about 2 inches is found loosely filled with bits of surface litter. Plate 10, figure 4, shows a diagram of a typical burrow.

The rather loosely packed cell of surface litter, composed largely of live-oak leaves (*Quercus virginiana* Miller) and needles and male cones of the sand pine (*Pinus clausa* (Engelmann) Vasey), contains a single larva. The larval cells are apparently provisioned by the female with any litter near the opening of the burrow. In only two instances were more than one cell found at the end of a burrow. (Young did not mention nor did the writer find a pair of the beetles in any of the burrows.) Apparently the female digs the burrow, provisions a single cell after laying an egg near the terminal end, and then departs, repeating the entire process in a different place.

The egg hatches a week or so after oviposition, and early larval growth apparently is rather rapid, for many of the larvae are third-stage in April, three months after the earliest adult activity in January. The larvae then remain as third instar for a period of 6 to 8 months. Only third-stage larvae were found in the middle of November, so pupation must occur in late November, December, and perhaps January, when some of the adults begin emerging.

The larva of *youngi* has one very interesting adaptation to its sandy surroundings. The larva uses its own fecal matter to construct a tube around itself (pl. 18, fig. 2), thus keeping the loose litter and sand from caving in. The flattened anal lobes of the larva are kept applied to the edge of the tube, while the larva, by extending its head and thorax, pulls the litter to its shelter. As the larva grows the tube increases both in length and diameter, until finally, when all the food is consumed, the larva closes the ends, making a cell about 2 inches long by 1 inch in diameter. The tube itself is rather fragile, externally rough, showing the shape of the individual fecal pellets, and internally smooth. Unfortunately, only large fragments of these tubes were found after digging up the cells. However, the larvae kept alive in salve boxes quickly constructed new ones.

The biology of *Peltotrupes youngi* is particularly interesting because of its numerous differences from the known biology of beetles in the closely related genus *Geotrupes*. The major differences are in the larval food and the loose manner it is placed in the cell, the use the larva makes of its own fecal material, and in the opening and depth of the burrows.

The larva, previously described (Howden, 1952), exhibits several interesting morphological peculiarities. The head capsule (pl. 9, fig. 3) is asymmetrical, similar to the North American *Geotrupes*, but the third (terminal) antennal segment (pl. 7, fig. 6), which is reduced to a mere cap on the second segment, is quite different. However, the mandibles (pl. 9, figs. 4, 6), maxillae, and hypopharynx (pl. 9, fig. 5) do not show any noteworthy departure from those of *Geotrupes*. The glossa is not emarginate in *youngi* as it is in most *Geotrupes*. The presence on the epipharynx (pl. 9, fig. 1) of 25 or more chaetae on each chaetoparia and the shape of the endoskeletal figure of the anal lobes (pl. 9, fig. 2) are both quite distinctive for *youngi*.

Metathoracic legs are reduced in the same way as in *Geotrupes*. All legs lack claws, but are terminated by several long stiff setae with tuberculate bases. One quite distinctive characteristic is the general body shape of *youngi* (pl. 11, fig. 1) with the head and thorax small in proportion to the tremendously swollen abdomen.

The egg of *Peltotrupes youngi* is yellowish white, almost oval, slightly longer at one end than the other. Length 4.6 to 4.7 mm., greatest width 3.0 to 3.5 mm.

Maximum width of larval head capsules: First instar 2.5 mm.; second instar 3.5 to 3.7 mm.; third instar 4.4 to 4.7 mm.

Genus *Mycotrupes* LeConte

Mycotrupes LeConte, 1866, pp. 381–382.—Horn, 1868, p. 314.—Blanchard, 1888, p. 109.—Bradley, 1944, p. 112.—Olson, Hubbell, and Howden, 1954, pp. 1–59.

Genotype: *Geotrupes retusus* LeConte, by monotype, *in* LeConte, 1866.

Generic limitations: Given by LeConte (1866, p. 381):

> The elytra are broadly ovate, very convex, connate and destitute of striae; the clypeus is semicircular, with the lobes before the eyes large and rounded; the front in the male is armed with a short horn or acute tubercle, which in the female is reduced to a feeble elevation; the prothorax of the male is flattened and declivous before the middle, and longitudinally broadly excavated, thus producing a transverse somewhat lunate elevation about the middle; in the female a slight dorsal channel is seen, and a feebly impressed fovea each side, halfway between

the middle and lateral foveae. The apical tooth of the anterior tibia of the male is broadly emarginate at tip, and prolonged inwards into a slender acute process. The middle tarsi of male are slightly larger than those of female, but not thickened as in *G. splendidus* and its allies. The upper surface is opaque and very densely granulated; the second joint of the antennal club is normal that is, not received in the first.

This description will suffice to separate the species of *Mycotrupes* from other North American Geotrupinae. However, one important detail not mentioned above is the absence of the metathoracic wings. Dr. T. H. Hubbell has noted that all of the species of *Mycotrupes* have a groove by the posterior pronotal angles into which the elytral marginal humeral carinae fit, forming accessory articulation points. Dr. Hubbell has further pointed out in correspondence to me that this unusual modification is also present in *Geotrupes ulkei* Blanchard but has not been noted in other species.

The above information, along with extremely detailed generic and specific descriptions and an excellent key, is presented by Olson and Hubbell (1954, pt. 1). Part 2 of the same work consists of a very interesting discussion by Hubbell on the relationships and distribution of *Mycotrupes*, and part 3 consists of biological observations and a description of the larva of *Mycotrupes gaigei* by Howden.

A number of the characteristics of *Mycotrupes* such as the granulate dorsal surface, posterior edge of pronotum sinuate and unmargined, and the peculiar thoracic modification of the males are not to be noted in the supposedly related forms such as *Chelotrupes* Jekel and *Thorectes* Mulsant. This fact, coupled with the obvious dissimilarity between *Mycotrupes* and other North American *Geotrupes*, has led me to treat *Mycotrupes* as a distinct genus, following the conclusions expressed by Olson and Hubbell (*in* Olson, Hubbell, and Howden, 1954, pt. 1).

The speciation occurring in *Mycotrupes* appears to present almost the same problem as that already described for *Peltotrupes*. The various species are apterous, active from late fall to early spring, and are seemingly limited in their activity to inland deep sand ridges. The spotty distribution of these sand ridges, coupled with the poor dispersal powers of the beetles, has led to the development of a number of closely allied but rather distinct forms. Interestingly, one of the species appears to have a range almost identical to that of *Peltotrupes profundus*.

Since a revision of the genus *Mycotrupes* has just been completed by Olson and Hubbell (*in* Olson, Hubbell, and Howden, 1954), no detailed account of the adult morphology of the various species is given here. The few characteristics mentioned are those which, coupled with distributional data, should be sufficient for identification.

The larva of *Mycotrupes gaigei* (the only species in which the larva is known) can be separated from any of the known larvae of *Geotrupes* by the shape of the endoskeletal figure, which lacks the sharp lateral expansions and abrupt angles found in the larvae of *Geotrupes.*

The discovery of the larva of *Mycotrupes* was made following the completion of the plates and descriptions for the present work. Since a discussion on biology and a larval description is given in the paper by Olson, Hubbell, and Howden (1954), only a brief account of my observations is included here.

All of the known species in the genus range in areas of deep sand from southern peninsular Florida northward to central South Carolina, and from the coast near Brunswick, Ga., westward to southwestern Georgia.

Mycotrupes retusus (LeConte)

Geotrupes retusus LeConte, 1866, pp. 381–382 (type, male, LeConte collection, MCZ).—Horn, 1868, p. 314.—Blanchard, 1888, p. 109.

Mycotrupes retusus (LeConte) Olson and Hubbell, *in* Olson, Hubbell, and Howden, 1954, pt. 1, pp. 28–33.

?*Geotrupes aeneus* Felsche, 1909, pp. 759–765.

This species, long incorrectly considered a synonym of *lethroides,* can be distinguished by the following characteristics: Clypeus rounded anteriorly and laterally; median pronotal tubercle often absent in both sexes, when present indicated in the male by a linear triangular callus confluent with the margin, and in the female by a small subtriangular expansion of the median anterior pronotal margin; dorsal circular granules generally evenly spaced; lack of elytral striae; and the inwardly produced hatchet-shaped tip of the extended left ventral portion of the phallobase of the male genitalia (pl. 5, figs. 5, 7).

Adults of *retusus* have been found active during the spring and fall months. They have been collected only in areas of deep sand where they have been noted feeding on fungi and dung.

In September 1951 P. O. Ritcher and I collected several specimens at White Pond, S. C., in burrows ranging from 17 to 36 inches deep. The weather had been dry and no surface activity was noted. The burrows were found by scraping away pine litter under thick stands of long-leaf pines, exposing the traces of the old push-ups marking the burrow entrance.

No signs of any food or larval cells were found. Several of the beetles were kept alive and later placed in a rearing cage at Raleigh, but, while both dung and fungi were supplied and the adults remained alive for almost a year, no larval cells were produced. At no time were males and females found in the same burrows.

The species seems to be restricted to central and southern South Carolina. I have examined specimens from Blaney, Columbia, Lexington, White Pond, and Windsor.

Mycotrupes lethroides (Westwood)

Geotrupes lethroides Westwood, 1837, pp. 256–257 (type, male, Westwood collection).—Boucomont, 1911, pp. 349–350.—Blatchley, 1928, p. 45.—Bradley, 1944, p. 112.—Olson and Hubbell, *in* Olson, Hubbell, and Howden, 1954, pt. 1, pp. 33–38.

Since I was unable personally to examine specimens of this species, the following descriptive information was summarized from information presented by Olson and Hubbell. Characteristics which distinguish the species are: Clypeus anteriorly rather truncate, sharply rounded laterally; dorsal granulations dense but not confluent, pronotal tubercle in male represented by a strong laterally compressed longitudinal ridge which is highest near its midpoint, tubercle in female large, tetrahedral or subconical in shape and confluent with anterior pronotal margin. Phallobase of male genitalia of the same general shape as that described for *retusus*.

Most of the specimens of *lethroides* are rather large. Dr. van Emden has stated in correspondence to me that Westwood's type, a male, is 20 mm. long with a strong, long, keel-shaped median tubercle present behind the foremargin of the pronotum.

The species, according to Olson and Hubbell, is found in Georgia near the Savannah River in the vicinity of Augusta.

Mycotrupes gaigei Olson and Hubbell

Mycotrupes gaigei Olson and Hubbell, *in* Olson, Hubbell, and Howden, 1954, pt. 1, pp. 15–19. Type, male, Columbia County, 3.9 miles north of Santa Fe River bridge at High Springs, Fla., Hubbell (UnMich).

Mycotrupes gaigei is a rather distinctive species, as there are several vaguely indicated striae on each elytron. In addition to this, the coarse granules of the elytra are often confluent and larger than in other species in the genus. Also serving to distinguish the species is the median tubercle about 0.5 mm. behind the anterior margin of the pronotum, the deep punctures lateral to and posterior to the ridge of the pronotal modification of the male, and the shape of the phallobase (pl. 5, fig. 6) of the male genitalia.

In late March 1953, through Dr. Hubbell's directions, B. K. Dozier and I were able to observe several aggregations of *gaigei* near High Springs and Archer, Fla. A large series of the adults was collected both by digging and by trapping, using malt and propionic acid.

Many of the specimens, particularly the males, appeared to be freshly emerged and there was much fresh burrowing activity. Some of the push-ups were 5 or 6 inches in diameter, and as much as 4 inches high with the burrows descending to a depth of 6 or more feet.

An area which encompassed several old slumped burrows was excavated and it yielded three third-stage larvae in pupal cells. One cell was at a depth of 5½ feet, the others were at 6 and 6½ feet. From the position of the cells it seemed probable that they branched off a central burrow, but this could not be definitely ascertained.

One cell was found in which the larva had failed to develop. This cell was composed of tightly packed cow dung 2½ inches long and three fourths of an inch in diameter. Also a number of old cells were found, but it was impossible to tell if the food had been dung or surface litter.

Only the three third-stage larvae were found and no information on the other immature stages was obtained.

The range of the species is rather similar to that of *Peltotrupes profundus*, being the western part of central and northern peninsular Florida from Citrus to Columbia Counties.

Mycotrupes cartwrighti Olson and Hubbell

Mycotrupes cartwrighti Olson and Hubbell, *in* Olson, Hubbell and Howden, 1954, pt. 1, pp. 20–24. Type, male, Leon County, Fla., 6.5 miles east of Tallahassee, Hubbell (UnMich).

The species can usually be distinguished by its large size (15 to 20 mm. in length), the fairly uniform circular granulations of the elytra, elytral apices usually joining without forming a notch, the large elongate tubercle behind the median anterior pronotal margin in the male, the V-shaped tubercle connected to the margin in the female, and the slightly incurved ventral tip of the phallobase (pl. 5, fig. 5) of the male genitalia.

The habits of the adults probably do not differ greatly from *retusus* or *gaigei*. Several specimens examined were labeled "at dung" and one specimen was labeled "light."

The species ranges across northern Florida and southern Georgia in almost a straight line from Atlantic Beach, Fla., to Thomasville and Americus, Ga.

Mycotrupes pedester Howden

Mycotrupes pedester Howden, *in* Olson, Hubbell and Howden, 1954, pt. 1, pp. 24–28. Type, male, Punta Gorda, Charlotte County, Fla., Ramstadt (UnMich).

This species, which is closely allied to *cartwrighti*, can be distinguished by its normally small size (13 mm. to 16 mm. in length), by the fairly uniform and well separated granulations of the elytra, by the male genitalia (pl. 5, fig. 8), by the elytral apices which usually form a small notch where they meet, and by the sharply delimited posterior edge of the anterior pronotal margin in the male, which usually lacks the tubercle present on the female at the midpoint of the pronotal margin.

The species has been found in southwestern peninsular Florida, ranging from Punta Gorda southward.

Discussion

In the preceding sections the similarities and dissimilarities of the morphology and biology of the North American Geotrupinae have been treated in some detail. It is the purpose of the following sections to discuss the Geotrupinae of the world with particular reference to biological differences.

PHYLOGENY AND DISTRIBUTION

Discussion of the phylogenetic position and rank of the group as a family or subfamily has been scrupulously avoided, as I feel that even now there is insufficient evidence upon which to base tentative assumptions. Certainly any such dogmatic statement as the following is premature: "Without exception the Scarabaeoidea have been proved capable of easy delineation into the identical groups, families, subfamilies, tribes, genera, and feeding complexes, no matter whether the larvae or adults were used for the comparisons" (Edwards, 1949, p. 92). Other investigators, while not expressing this attitude, have

TABLE 5.—*Geographic distribution of* Geotrupini

	Enoplotrupes	*Ceratophyus*	*Ceratotrupes*	*Typhoeus*	*Geotrupes*	*Thorectes*	*Mycotrupes*	*Peltotrupes*	*Total*
Europe	–	1	–	1	11	14	–	–	27
Russia	–	2	–	–	6	4	–	–	12
Eastern Asia, Japan	8	–	–	–	29	6	–	–	43
India, Burma, Malaysia	2	1	–	–	3	–	–	–	6
Australia	–	–	–	–	–	–	–	–	–
South Africa	–	–	–	–	–	–	–	–	–
North Africa, Near East	–	1	–	3	6	10	–	–	20
South America east of Andes	–	–	–	–	–	–	–	–	–
South America west of Andes	–	–	–	–	–	–	–	–	–
North America east of Rocky Mts	–	–	–	–	9	–	5	3	17
North America west of Rocky Mts	–	–	–	–	–	–	–	–	–
Central America	–	–	3	–	7	–	–	–	10
Total	10	5	3	4	71	34	5	3	135

written numerous papers debating the exact status and phylogenetic position of the "family" or "subfamily" Geotrupinae and its relation to other groups, particularly to the genus *Pleocoma.* For a full discussion of the problem the reader should consult the papers of Gerstaecker (1883), Smith (1888), Horn (1888a, 1888b, 1888c), Paulian (1941), Hayes and Chang (1947), and others on this argument.

Any discussion on the erection of a separate family, Geotrupidae, should be delayed until considerably more information has been accumulated. The arguments presented by Arrow (1904), Böving and Craighead (1930–1931), Paulian (1939), and Edwards (1949) for the establishment of a family were based only on very limited and carefully selected cases. One of these, the presence of 11-segmented antennae, not only is found in the Geotrupinae but also in other scarabaeids, such as *Pleocoma*. The rather distinctive genital capsule, not even considered by most workers, occurs not only in the Geotrupinae but in the Hybosorinae, Ochodaeinae, and Taurocerastinae. Arguments for establishing a separate family have been based on the reduced third leg found in the larvae of the genus *Geotrupes*. In this instance, what the investigators seem to have completely and conveniently overlooked was the fact that *Geotrupes*, *Peltotrupes*, and *Mycotrupes* are the only genera known that have the reduced metathoracic legs. *Typhoeus*, in the same tribe, does not have the reduced legs, nor do any of the known larvae in Lethrini or Bolboceratini. Our present knowledge still seems inadequate in these groups and no further comments will be made on phylogeny.

TABLE 6.—*Geographic distribution of* Lethrini

	Abrognathus	*Microlethrus*	*Lethrulus*	*Heteroplistodus*	*Ceratodirus*	*Scelolethrus*	*Teratolethrus*	*Autolethrus*	*Lethrus*	*Goniolethrus*	*Total*
Europe	–	–	–	–	–	–	–	–	–	–	-
Russia	–	–	–	2	3	5	–	4	2	–	16
Eastern Asia, Japan	–	–	–	4	–	1	–	2	–	1	8
India, Burma, Malaysia	–	–	–	–	–	–	–	–	–	–	-
Australia	–	–	–	–	–	–	–	–	–	–	-
South Africa	–	–	–	–	–	–	–	–	–	–	–
North Africa, Near East	1	4	2	6	2	2	2	18	2	1	40
South America east of Andes	–	–	–	–	–	–	–	–	–	–	–
South America west of Andes	–	–	–	–	–	–	–	–	–	–	-
North America east of Rocky Mts	–	–	–	–	–	–	–	–	–	–	–
North America west of Rocky Mts	–	–	–	–	–	–	–	–	–	–	–
Central America	–	–	–	–	–	–	–	–	–	–	–
Total	1	4	2	12	5	8	2	24	4	2	64

Representatives of the subfamily Geotrupinae are worldwide in distribution (see tables 5–7), being found on all the continents with the exception, of course, of Antarctica. The habits of many of the genera are unknown, but all of them seemingly are strong burrowers, provisioning food for the nutrition of their larvae. Further investigation may prove the second part of this statement at least partially incorrect, for in the subfamily Geotrupinae there have been lumped three really diverse tribes, both in form and in habits.

These three tribes, the Lethrini, Geotrupini, and Bolboceratini, have little in common. The Lethrini are confined to eastern Europe, the Near East, and Asia, with the greatest speciation occurring in the Near East. The distribution of the major component of this tribe, the genus *Lethrus*, has been discussed by Semenov (1901, p. 251) and Reitter (1890, pp. 288–295). The Geotrupini are circumpolar in the Northern Hemisphere, absent in the Southern Hemisphere. The Bolboceratini are also circumpolar, but in this case they are largely

TABLE 7.—*Geographic distribution of* Bolboceratini

	Athyreus	*Stenaspidius*	*Bolbocerastes, Bolborhombus and 5 subgenera*	*Bolboceras*	*Bolbochromus*	*Bolbocerosoma*	*Eucanthus*	*Kolbeus*	*Bolbelasmus*	*Bolbotrypes*	*Elaphastomus*	*Eubolbitus*	*Total*
Europe	–	–	–	1	–	–	–	–	1	–	–	–	2
Russia	–	–	–	–	–	–	–	–	–	–	–	–	–
Eastern Asia, Japan	3	–	4	–	–	2	–	1	–	1	–	–	11
India, Burma, Malaysia	2	–	32	–	12	–	–	–	–	–	–	–	46
Australia	–	2	70	–	–	–	1	–	–	–	2	–	75
South Africa	6	–	40	–	–	–	–	–	–	–	–	–	46
North Africa, Near East	1	–	1	–	–	–	–	–	3	–	–	2	7
South America east of Andes	42	1	12	–	–	–	1	–	–	–	–	–	56
South America west of Andes	7	–	13	–	–	–	–	–	–	–	–	–	20
North America east of Rocky Mts	–	–	6	9	–	11	3	–	–	–	–	–	29
North America west of Rocky Mts	–	–	5	1	–	1	1	–	2	–	–	–	10
Central America	9	–	1	–	–	–	–	1	–	–	–	–	11
Total	70	3	184	11	12	14	6	2	6	1	2	2	313

restricted to the Southern Hemisphere with a few species occurring in the dry, hot regions of the Northern Hemisphere. Since the habits of these three groups are almost as diversified as their ranges, a brief account of the biological information accumulated on each of the tribes follows.

BIOLOGY OF THE LETHRINI

Living as they do in inaccessible areas, most of the Lethrini are poorly known. The one notable exception is the single European representative of the tribe, *Lethrus apterus* Laxman. One of the first works on its biology was by Emich (1884, pp. 184–188), in which he briefly discusses its metamorphosis. Perhaps the best paper on the development and habits of *Lethrus apterus* was by Schreiner (1906, pp. 197–208), in which he fully describes the peculiar habits and development of the "Rebenschneider" or vine-cutter.

Burrowing beetles usually confine their activities to the surface of the ground, but this is not true of *Lethrus*. The adults were found

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by Schreiner climbing shrubs and trees, where they cut off the buds or leaves and then carried them down the tree into their burrow.

References to the peculiar habits of these beetles are scattered throughout the European literature because their promiscuous pruning occasionally is done on crops, causing some damage. Schreiner (1906, pp. 197–208) lists *Euphorbia*, *Artemisia*, *Plantago*, flax, turnip, wheat, buckwheat, young sunflowers, rape, hemp, dill, dahlias, narcissus, tulips, peonies, and shoots of fruit and forest trees among the plants pruned by *Lethrus apterus*. Other species seem to have similar habits. Reymond (1933, pp. 209–211) has discussed the adult habits of *Lethrus potanini*, which he found in one place pruning a species of *Ephedra*. The ravages of *Lethrus cephalotes* have been briefly mentioned by Shipley (1887, p. 335) and Schwarz (1891, p. 484).

According to the references cited above, adult activity, which is often diurnal, occurs in March, April, and May. Each cylindrical burrow made by the beetles is marked by a push-up and is about 15 to 30 cm. deep. Each burrow is occupied by a pair of beetles, the male doing most of the above-ground foraging, bringing the cut leaves to the burrow. According to Schreiner, *Lethrus apterus* packs the leaves into the cell after the egg is laid. The egg is not deposited in the cell, but is placed in a small cavity just beyond its termination. A diagram of the burrow and the shape and position of the 6 or 8 oval cells can be found in a recent booklet by von Lengerken (1952, opposite p. 45). The habit of placing the egg in a cavity beyond the food cell not only occurs in the genus *Lethrus* but has been accredited to *Typhoeus* (*Minotaurus*) by Fabre (1922, p. 93) and to *Bolboceras* by the present writer.

After the egg of *Lethrus* hatches, development was observed by Schreiner to be very rapid. The larva became third instar in 3 to 3½ weeks and emerged as an adult in another 3½ to 4 weeks. This rapid development seemed to me to be more typical of some of the Bolboceratini than it did of the Geotrupini.

The habit of using living leaves is almost unique. Dawson (1922, p. 196) noted a rather similar case in *Geotrupes splendidus miarophagus* using fresh cut grass to provision the larval cells, and I have found *G. splendidus* and *Peltotrupes youngi* using dead leaves for larval food. However, the habit of *Lethrus* of climbing vegetation to procure its larval food is not found in other groups. The oddly shaped asymmetrical mandibles that the males use for their pruning are likewise very characteristic.

BIOLOGY OF THE BOLBOCERATINI

The next tribe considered, the Bolboceratini, should perhaps precede the Lethrini on a phylogenetic basis, but when considered on a behavioristic basis its position is not important. The tribe varies considerably both in morphology and habits from either the Lethrini or Geotrupini. Additional information on the group may show that its present grouping in the subfamily Geotrupinae is illogical, but its status has not been changed at present. Certainly, a heterogeneous mixture of genera are included in the tribe. Because of this, generalization on the habits of the group would be useless, for the biologies of only a few species are known.

Most of the members of the tribe are nocturnal, and moderately colonial, with burrows in rather restricted habitats. With the exception of several species of *Bolboceras* (formerly *Odontaeus*) and the European species of *Bolbelasmus*, which have been found to feed on certain subterranean fungi, none of the adults in this large tribe has ever been noted feeding, or doing much else for that matter except burrowing.

Fabre, who accumulated many obscure facts concerning the biology of the Geotrupinae, added considerably to our knowledge in his writings (1919, pp. 300–330) about *Bolbolasmus* (formerly *Bolbolceras*) *gallicus* (Mulsant). He found that the beetles dig directly down to and feed on underground trufflelike fungi, one species being *Hydnocystis arenaria* Tulasne. He later showed, by burying bits of fungi in a flower pot, that the *Bolbelasmus gallicus* are able to unerringly dig down to the food. Fabre also mentioned that when investigating the burrows, which are often found in sandy pine woods, the beetles were usually discovered with a bit of fungi on which they had been feeding. He did not mention finding the larva.

The only other European genus in the tribe contains one European representative and a number of North American species. The genus is *Bolboceras*, for a number of years known as *Odontaeus*, the European species being *Bolboceras mobilicornus* Fabricius (=*armiger* Scopoli of a number of authors).

There are several scattered references to the one European species, all using the name *Bolboceras armiger*. Notes on the habits of this species have been published by Lebedeva (1906, p. 436), Arens (1922, pp. 241–246), Bedel (1911, pp. 99–100), and Muller (1948, pp. 4–6, etc.). While the works of Arens and Muller on *armiger* were not available to me, the work of Bedel was. In it he mentions its nocturnal activity and compares its feeding habits to those of *Bolbelasmus gallicus*. He believed that *armiger* fed on subterranean fungi, such as some of the members of the genus *Rhizopogon*. He wrote nothing about the larval habits.

One very questionable observation on *armiger* was reported by Saunders (1936, p. 178). A nonentomological friend, after using worm killer on his lawn, found a number of dead *Bolboceras armiger* beside what he thought were worm holes. From this rather secondhand information, Saunders concluded that they did not burrow but used worm holes instead! This reference should and would have been left in the obscurity it deserves had it not been the one reference to the genus used by the late G. J. Arrow (1951) in his book "Horned Beetles." In this book, Arrow's statements on biology do not seem to be based on any personal field experience. His section on *Bolboceras armiger* is one such case. He cited Saunder's reference, which stated that even though the beetles were found beside the worm holes, "the same burrow never produced both worm and beetle." After quoting this reference, which at least should have given rise to some doubts, Arrow said (1951, p. 48), "It is clear that this insect escapes the necessity of excavating its own burrow, for which the male is so unsuitably equipped, by adopting a ready-made one. Can there be some connection between the extravagant development attained by the horns and the abandonment of the labours for which, in related species, they are found useful accessories?" If Arrow had ever placed a live, well-armed, male *Bolboceras* on hard ground and observed its actions he would not have made the above statement but would have concluded that it was an excellent burrower.

The biologies of some of the North American representatives of the genus *Bolboceras* are better known. The adults of *Bolboceras darlingtoni* have been found feeding on species of *Rhizopogon* by Sim (1930, p. 144) and myself. Other *Bolboceras* were collected by using fermenting malt as an attractant, which would presumably indicate that they feed on some decomposing materials.

During the course of the present work a considerable amount of information was accumulated on *Bolboceras darlingtoni* and *liebecki*. Both species were found to provide for their larvae finely divided surface humus, which they packed into the bottom of their burrows. The former species deposits a single egg in a small cavity just beyond the packed humus (pl. 14, fig. 1). The larvae, after hatching, burrow through the humus, rapidly becoming third instars. Before pupation, the larvae leave the food, burrowing about an inch to one side where they make pupal cells (pl. 10, fig. 1), emerging as adults shortly thereafter. Development from egg to adult takes two to three months. Whenever larvae were found, an adult, either male or female, was found in the same burrow or in an adjoining one. What the relationship between the adult and larva was, if any, could not be ascertained. While there was a long period when adults of most species could be found, the times of surface activity varied—*darlingtoni*, *alabamensis*, and *floridensis* being active in the fall, winter, and spring, while the other species were found in the spring and summer.

The genus *Eucanthus*, which is largely confined to North America, has been found by the writer to have habits seemingly similar to those of *Bolboceras*. Pairs of adults were found in burrows during the winter, and in the spring larvae and adults were taken from the same burrow. While the larval food appeared to be the finely divided surface humus, its use was not definitely established. In one way *Eucanthus* differed markedly from *Bolboceras*—the adults were never seen to feed, nor were they ever found near anything that could seemingly be used for food. None was taken by any chemical attractant or by fermenting malt, but specimens did come freely to light. In these last respects, the habits of *Eucanthus* were the same as those of *Bradycinetulus*, *Bolbocerastes*, and *Bolborhombus*. The species in all of these genera burrow strongly, but there is a dearth of information concerning their habits.

The biology of only one other genus (*Bolbocerosoma*) in the Bolboceratini is even partially known. One species, *farctum*, has had its biology partially described for the first time in this paper. From the small amount of information derived from the single larva, the food is similar to that used by *Bolboceras* and *Eucanthus*, i. e., finely divided surface humus packed into a burrow. The larva apparently pupates at one end of its food cell, and in this respect it differed from *Bolboceras darlingtoni*. Also, the larval burrow was deeper and less tortuous than that of *darlingtoni*. The burrow of *farctum* is diagrammed in plate 10, figure 3. The dimensions of a typical burrow of *Bolbocerosoma* are discussed at some length by Bryson (1939, p. 249). While the larval development was fully as rapid as in *Bolboceras* or *Eucanthus*, taking about two months, the adults were not found associated with the larva as they sometimes were in the cases of *Bolboceras* and *Eucanthus*.

From the above information concerning a few diverse genera in the Bolboceratini, one can only conclude that some of the adults may feed on decaying or fermenting vegetable matter. They are, as a group, strong burrowers, nocturnal in their activity, often coming to light. In the few cases where the larvae are known, finely divided black surface humus was provided by the adults for the larval food. Also, rapid larval development and a long period of adult activity may at present be considered a characteristic of the tribe.

BIOLOGY OF THE GEOTRUPINI

The members of the remaining tribe, the Geotrupini, have been subjected to more biological investigation than the other members of the subfamily. This is largely due to two causes; first, the tribe is well represented in the Northern Hemisphere, and, secondly, many of the species can be fairly easily reared in cages. Most of the work has been done in Europe, and, because of the rather voluminous literature and repetition of observations on many species, only the very briefest of summaries is given here. Much of this information can be found summarized in works by Heymons and von Lengerken (1929, pp. 531–613) and von Lengerken (1939, 1952), who is now bringing some of his earlier publications up to date.

One of the European genera of Geotrupini, *Typhoeus*, has been the subject of much investigation, particularly one widely ranging species, *Typhoeus typhoeus* Linné, which early aroused the interest of Fabre, the famous French naturalist. Fabre (1922, Mattos translation, pp. 72–171) published an account of his investigations of these beetles using the name *Minotaurus*. Main (1917, p. 21) has said, "A good deal has been written about them [*Minotaurus*] by Fabre in which speculation however plays a large part. His votaries did not show him the insect actually engaged on much of their work, but his assiduity and devotion in recording in most delightful language his observations and speculations makes his works an inspiration to many besides his own countrymen." (Despite his occasional digressions into fantasy, Fabre was a very astute observer and subsequent workers have added little to his basic information on the biology of *Typhoeus*.)

From information contained in the works of Fabre (1922, Mattos translation, pp. 72–171), Carpenter (1928, p. 209), Ohaus (1909, pp. 105–111), Füessly (1794, p. 66), Main (1917, pp. 18–22; 1918, p. 90), and Arrow (1951, pp. 40–42), the habits of *Typhoeus* are briefly summarized as follows. In the early spring, adults, working in pairs, construct burrows 3 to 5 feet deep in shady, sandy localities. The male then provisions the burrow with pellets of rabbit, sheep, cow, or horse dung, which the female works into elongate pods of food for the future larva. The eggs are deposited singly in a small cell in the sand outside of the food, in a manner similar to *Lethrus*. Larval development, at first rapid, becomes slower, pupation not occurring until late in the summer and the imago emerging in the fall. Main (1918, p. 90) found that in England pupation occurred in the second summer. Six or eight larval cells are constructed, branching off of one burrow. This type of burrow with the larval cells branching off of it has also been recorded for many of the European *Geotrupes*. Except for the depth of the burrow, the oviposition of the egg outside of the food cell, and possible 2-year cycle, the habits of *Typhoeus typhoeus* differ only in minor ways from the European species of *Geotrupes*. However, the larva differs strikingly from that of *Geotrupes* by not having the metathoracic legs reduced in size.

It appears from the numerous works on European *Geotrupes* that the species all have similar habits and use either horse or cow dung to provision their larval cells. There are a number of excellent works to which the reader could profitably refer. The biology and larval morphology of *Geotrupes stercorarius* (Linné) have been briefly discussed by Blair (1934, p. 89), Frisch (1736, pp. 13–15), Korschefsky (1940, p. 45), Lebedeva (1906, p. 436), Perris (1876, p. 361), Sano (1915–1916, pp. 25–28), Schiødte (1874, pp. 227–376), and Schjelderup-Ebbe (1925, pp. 97–98). Kolbe (1929, p. 187) summarized the habits of the European subgenera of *Geotrupes* and treated briefly of several of the species. Ohaus (1909, pp. 105–111) discussed the habits of *Geotrupes stercorarius*, *vernalis*, *sylvaticus*, and (*T.*) *typhoeus*, while in the following year Spaney (1910, pp. 625–634) not only gave an excellent biological account of the same species but pictured the anal lobes of the larvae and the pupae of all the above species. Fabre (1918, Mattos translation, pp. 189, 234) gave, in his usual vivid and slightly fanciful style, a detailed discussion of the life history of *Geotrupes stercorarius* (believed by Main (1917) to be in actuality *Geotrupes spiniger*).

As the biologies of the European *Geotrupes* appear to be quite similar in the discussions of the works just mentioned, no attempt is made to give a detailed review of their life histories. Essentially all of the species fit into the following pattern. A burrow is made from 2 to 12 inches deep beneath cow or horse dung, often in the woods in a somewhat shaded spot. On numerous occasions the beetles have been noted working in pairs with the male bringing the dung to the female in the burrow. The female, in a side branch of the vertical burrow, makes a compact wad of dung 2 or 3 inches long and the width of the burrow. Near the terminal end she leaves a small cavity, sometimes lined with a thin coating of clay. Usually four to six food cells for the larvae are made branching off the main burrow, but the total number of burrows and food cells that a single female may construct is apparently unknown. Main (1917, pp. 18–22) did mention that the female does not need the assistance of the male as she is perfectly capable of doing all of the work.

After oviposition, the egg, which is large, oval, slightly wider at one end, and yellowish-white, swells to almost twice its regular size before hatching. Several hours after eclosion the larva starts feeding, and it increases rapidly in size until the third instar. The developmental time for each instar of the various European species has not been sufficiently studied to enable any generalized statements to be made. The larva, upon attaining maximum size or upon consuming all available food, remains quiescent for a period, coats the walls of its cell with a thick layer of its own feces, and then pupates. Two or three weeks after pupation ecdysis occurs, and after a few days the adult leaves the cell.

Any mention of the time of oviposition, hibernation, or emergence of the adults has been avoided until now, as it is there that the differences have been noted between the species. Main (1917, pp. 18–22) noted that *spiniger* (the *stercorarius* of Fabre) oviposits in the fall and then dies, new adults emerging the next fall. The adults of *stercorarius* emerge in the fall and begin egg laying in the spring; nearly grown larvae overwinter, and the adults do not appear until fall of the second year. *Geotrupes mutator* was noted by Main ovipositing at the same time as *stercorarius*, but the larvae of *mutator* completed their development during the summer and the adults came out the same fall. Those species illustrate the three general patterns of development for the European *Geotrupes* insofar as they have been reported in the literature. A good summary of some of the biologies of the Geotrupinae was written by Paulian (1949, pp. 1013–1015). In this work Paulian has included a diagram of a typical burrow of the European species of *Geotrupes*.

Some variance has been noted due to climatic differences but, at present, records are not available that would make possible any comparisons of developmental rates for the same species in different climatic areas. I have tried to point out the close similarities between the habits of the various European *Geotrupes*, even though several are in different subgenera, which exhibit a number of morphological differences. When differences such as different dates of oviposition were found they often occurred between closely related species.

Compared with the uniform habits of the European species, the variation found in the habits of the American species was striking. Available detailed biological information has been given after the description of each species, and much of it is not repeated here. Clark (1895, p. 61) stated that North American *Geotrupes* were entirely dung or carrion feeders. If he had included fungi and decaying or fermenting vegetable matter in his statement, it could be considered generally correct in reference to the adults. In the European species, both the adults and larvae utilized the same substances for food, while this association was not always the case for American species. In the latter, the adults often were found feeding on one food, later using an entirely different material to provision their larval cell. *Geotrupes blackburnii* often uses dung for both the adult and larval food. *Geotrupes ulkei* and *splendidus* commonly feed as adults on fungi while the larvae develop on decaying leaves. *Geotrupes egeriei* and *hornii* are usually fungus feeders as adults, but provide their larvae with dung.

The larval food differences mentioned above are not as great as they might at first seem, if one takes into consideration an experiment conducted by Fabre (1922, pp. 219–224) many years ago. The astute French naturalist noted the similarity between old dung, which the European *Geotrupes* larvae used for food, and the rotting leaves of the forest floor. Taking some leaves, he rammed them tightly into a tube along with an egg of *Geotrupes.* After hatching, the larva began feeding on the leaves without any hesitation, feeding on any part of the leaf it encountered, vein and all. All the specimens he treated in this way were reared to normal-sized adults. Fabre then elaborated upon this experiment by taking a dead-leaf-feeding *Cetonia* grub and rearing it successfully on cow dung. The implications in Fabre's work on adaptability of various insects to their food and even the fundamental similarity of the seemingly different materials have been neglected by subsequent investigators.

I found several cases that substantiated Fabre's findings. *Geotrupes splendidus* adults, when put in a cage containing only cow dung, constructed a few larval cells using the dung; when put in a cage containing both dung and dead leaves, they used only the dead leaves. The larvae feed indiscriminately on the food at hand. From this it seemed that not only did the larva develop on different foods, but the adult habits were not as inflexible as has formerly been believed.

This same flexibility of habit was noted to a lesser extent in *Geotrupes blackburnii.* The larval food provided by the adults in the rearing cages consisted of cow dung, even though leaves were in the cage. Larval cells of *blackburnii* found at Faison, N. C., seemed to be at least partially composed of dead leaves and grass, but, as much of the cells had already been consumed by the larvae when they were discovered, the major component of the cells, whether dung or leaves, could not be determined.

The above remarks on variability of food utilization should be kept in mind while reading the subsequent discussion on the habits of the American species of *Geotrupes,* as future investigation may indicate an even wider variation in food and other habits than is at present known. Considerable interspecific variation has been found in the time of oviposition, length of life cycle, and depth and type of burrow. While known larval morphology differs, several structural and developmental characteristics are common to all species. All of the eggs found, while differing slightly in size, are yellowish white, elongately oval, and wider near one end. Plate 14, figure 2, showing an egg of *Geotrupes blackburnii,* illustrates these characteristics. The eggs of the European species have been described as having the same general elongately oval shape. After hatching, initial larval development usually is quite rapid, taking perhaps a month for each of the first two stadia. In the species studied, the development of the third instar took much longer. The minimum time noted was about three months in the case of *blackburnii* and *splendidus.* The third-stage larvae of *hornii* overwinter, taking a much longer time to complete their development. Adult emergence from the larval cell occurs largely in the summer and fall.

While all of the data accumulated have been given after the taxonomic discussion of each species, a general summary of the available biological information can be found in table 2. In this table one of the most noticeable and constant of the interspecific differences shown is the variation in the burrow types. The burrows of *splendidus* are similar to those of *blackburnii*, but are slightly deeper and contain leaves instead of dung. The burrows of *egeriei* and *hornii* are considerably deeper than *blackburnii* and *splendidus* and both use old cow dung as larval food. However, *hornii* has a number of cells branching off a burrow, as has been noted for European species, while *egeriei* only had a single cell in the two cases found. An interesting subspecific difference in burrow habits may possibly exist between the eastern *splendidus* and the western *splendidus miarophagus*. I found the eastern subspecies making a single cell of dead leaves at the bottom of its burrow, while Dawson (1922, p. 196) recorded finding a burrow of *s. miarophagus* with several cells branching off the burrow, the pods being composed of fresh cut grass.

When considered in conjunction with adult and larval morphology, the burrow and food characteristics seem to have possible taxonomic importance, at least in a consideration of phylogeny and in generic and subgeneric groupings. On the basis of adult morphology I would consider that, of all the North American Geotrupini, *Geotrupes hornii* is the species most closely related to *Geotrupes stercorarius*. The same conclusion could be reached from a comparison of their burrows. The diagram of the burrow of *Geotrupes hornii* (pl. 10, fig. 5) closely approximates ones given for *stercorarius*. I believe, on the basis of adult and larval morphology and on the burrow characteristics, that the present subgeneric groupings of the North American Geotrupini are in need of some rearrangement, but hesitate to do so until something is learned about the larvae of *Geotrupes opacus*, *semiopacus*, and *balyi*.

In this paper I have elevated Blanchard's subgenus *Peltotrupes* to generic rank because of certain adult and larval characteristics which are not known to exist in any *Geotrupes*. Biological differences are in strong support of this generic separation.

The adults of *Peltotrupes* are active in the winter months, with oviposition occurring largely in January, February, and March.

The deepest burrow of any species of *Geotrupes* known to me did not approach 4 feet, even in the areas where *Peltotrupes* occurred. The burrows of *Peltotrupes* averaged 6 feet deep with one burrow reaching 9 feet. One great difference noted between *Peltotrupes* and the known *Geotrupes* was in the method of packing the larval cell. In *Geotrupes* the food material, whether it was dung or leaves, was tightly packed so that the cell retained its shape when removed from the ground. The cell of *Peltotrupes*, which was a conglomeration of any surface litter near the burrow entrance, was so loosely packed that it would begin to crumble as the encompassing sand was dug away. The method of feces disposal of *Peltotrupes youngi*, which has been described in detail under that species, also seems to be different from any known *Geotrupes*. Certainly such biological differences should be considered to have some taxonomic value when found in conjunction with good morphological characters, both in the larvae and adults.

Only the immature stages of *gaigei* in the genus *Mycotrupes*, the last group of the North American Geotrupini to be discussed, are known. Information on the larval biology is scanty. The larval cells are found 5 or more feet deep, being composed of dung. Apparently several cells branch off one burrow, but this may not always be true. From the meager information at hand, the larval biology of *Mycotrupes* appears to be similar to that of the North American *Geotrupes*. The adults of all of the members of the genus are apterous with fused elytra, superficially resembling some of the Lethrini. They are found in isolated localities on some of the deep sand ridges in the southeastern United States, and are active in the fall, winter, and spring. Newly transformed adults appear during the early spring. They have been noted feeding on fungi burrowing under dung, and coming to fermenting malt or propionic acid placed in a sunken can. I found *Mycotrupes retusus* LeConte in September in 3-foot burrows under stands of pine, but no larval cells were found at that time. From the present available data the habits of all the species appear to be quite similar.

MISCELLANEOUS STUDIES

Apparent economic damage caused by any of the groups seemingly is slight, as there are few references to this aspect. The ravages of *Lethrus* through its habit of leaf cutting have already been mentioned. Thomas (1939, pp. 23–24) mentions a reference to a 10 percent loss of edible mushrooms, *Boletus edulis* Fries, in south Germany because of the activities of *Geotrupes stercorosus* Scriba. Wetzel (1935, pp. 188–191) implicates *Geotrupes sylvaticus* as an intermediate host of the fowl tapeworm, *Davainea proglottina*.

As a group, the Geotrupinae seem to be more beneficial to man than harmful, as they take a large amount of decaying material and dung underground rather rapidly, but just how much value this has remains an unanswered question.

Several desultory studies have been conducted on some of the Geotrupinae. Sharp and Muir (1912, p. 581) have discussed the morphology of the male genitalia of a few species, while Hardenburg (1907, pp. 548–602) and Mohr (1930, pp. 263–284) have compared the mouthparts of some of the genera. Structures used in sonification have been mentioned by Arrow (1904, pp. 727–732), and the evolution of the antennae was considered by Warnke (1934, pp. 217–224).

The attractiveness of ammonia, indol, and skatol to several European species of *Geotrupes* was discussed by Warnke (1931, pp. 121–199), and this motivated the use of the chemicals listed in tables 3 and 4. Vaternahn (1924, pp. 20–27) previously had noted that certain chemicals would attract *Geotrupes*, and this fact was also noted by Dethier (1947, p. 285). However, all of these studies were very desultory and merely indicated the possibilities for further investigations.

Another line of investigation, the study of predators, parasites, and commensals of the Geotrupinae, has not been discussed here. I have observed both the adults and the larvae of the carabid *Scarites subterraneous* Haldeman feeding on the larvae of *Geotrupes blackburnii*. Also, several commensal organisms, Diptera and Collembola, have been taken in the larval cells. This material was given to J. Theodorides, who has already published several papers on the parasites and commensals of *Geotrupes* (1949, 1950a, 1950b, 1951, 1952) and is continuing his work. Van Emden (1950, p. 190), in his work on dipterous parasites of Coleoptera, expresses doubt that any of these parasites occur on the larvae of *Typhoeus*.

The most interesting case of parasitism on a species of Geotrupinae known to me was recorded by Chapman (1869–1870). He stated that he found as many as five or six pairs of *Geotrupes stercorarius* (actually the species we now call *spiniger*, according to Main, 1917, p. 19) burrowing under a piece of cow dung. He observed that they made a vertical burrow 6 to 12 inches deep, merely compacting the earth as they burrowed instead of bringing it to the surface. Six or eight cells branched off this burrow, the beetles making the upper cells first. Each cell, 4 or 5 inches long by 1 inch wide, contained a single egg measuring "3/16 inch in length," lying loosely in a cavity near its terminal end.

While making these observations, Chapman noticed an *Aphodius* (*A. porcus*) entering the egg cavity of the larval cell. The *Aphodius* then destroyed the egg, whether by eating it or not was not definitely ascertained. After destroying the *Geotrupes* egg, the *Aphodius* then laid its own eggs, using the food supply furnished by the *Geotrupes* to nourish its own larvae. Whether this is a normal occurrence has not been confirmed by subsequent investigators, but it does serve to show the unexpected complexities that may be encountered, and the need for more adequate biological information on the Geotrupinae and the insects associated with them.

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Explanation of Plates 1–10

Plate 1

Some adult Geotrupinae. Left row, top to bottom: *Mycotrupes cartwrighti* Olson and Hubbell; *Geotrupes splendidus miarophagus* Say; *Peltotrupes profundus* Howden; and *P. youngi*, new species. Right row, top to bottom: *Bolbocerosoma cartwrighti*, new species; *B. ritcheri*, new species; *B. pusillum townesi*, new subspecies; *Eucanthus lazarus subtropicus*, new subspecies; and *E. alutaceus* Cartwright.

Plate 2

1. Left eye canthus and lateral portion of clypeus of (a) *Peltotrupes youngi*, new species; (b) *P. profundus* Howden, (c) *P. profundus dubius*, new subspecies.
2. Left anterior angle of pronotum of (a) *P. youngi*, (b) *P. profundus*, (c) *P. profundus dubius*.
3. Anterior pronotal margin of (a) *P. youngi*, (b) *P. profundus*, (c) *P. profundus dubius*.
4. Outline cross section of anterior left elytral margin of (a) *P. youngi*, (b) *P. profundus*, (c) *P. profundus dubius*.
5. Posterior edge of left paramere of male genitalia of (a) *P. youngi*, (b) *P. profundus*, (c) *P. profundus dubius*.
6. Right eye canthus, eye, and antenna of *Eucanthus lazarus subtropicus*, new subspecies.
7. Right eye canthus, eye, and antenna of *E. lazarus lazarus* (Fabricius).
8. Diagram of first four striae of right elytron of *E. lazarus subtropicus*.
9. Diagram of first four striae of right elytron of *E. lazarus lazarus*.
10. Diagram of teeth on ventral surface of the left foretibia of male *Geotrupes blackburnii blackburnii* (Fabricius).
11. Diagram of teeth on ventral surface of the left foretibia of male *G. blackburnii excrementi* Say.
12. Diagram of dorsal surface of left foretibia of female *G. egeriei* Germar, showing longitudinal carina.
13. Diagram of dorsal surface of left foretibia of female *G. blackburnii blackburnii*, showing longitudinal carina.
14. Diagram of dorsal surface of left foretibia of female *G. balyi* Jekel, showing longitudinal carina.

Symbols: A, antenna; AT, anterior tooth; CL, clypeus; EC, eye canthus; LC, longitudinal carina; PT, penultimate tooth; S, elytral suture; SP, row of setigerous punctures; TC, transverse carina; 2E, second elytral interval; 4E, fourth elytral interval.

Plate 3

1. Right lobe of male genital capsule of *Bolbocerosoma tumefactum* (Palisot de Beauvois).
2. Right lobe of male genital capsule of *B. ritcheri*, new species.
3. Right lobe of male genital capsule of *B. farctum* (Fabricius). (Half the magnification of 1 and 2.)
4. Right lobe of male genital capsule of *B. cartwrighti*, new species.
5. Right lobe of male genital capsule of *B. elongatum*, new species.
6. Right lobe of male genital capsule of *B. pusillum* Dawson and McColloch. (Half the magnification of 4 and 5.)
7. Dorsal aspect of male genitalia of *Peltotrupes youngi*, new species.
8. Tip of male genitalia of *Geotrupes hornii* Blanchard.
9. Dorsal aspect of male genitalia of *G. hornii*.

10. Tip of male genitalia of *G. balyi* Jekel.
11. Dorsal aspect of male genitalia of *G. balyi.*

Symbols: LP, left paramere; PLL, phallobase; RP, right paramere.

Plate 4

1. Dorsal aspect of male genitalia of *Geotrupes splendidus splendidus* (Fabricius).
2. Dorsal aspect of male genitalia of *G. stercorarius* (Linné).
3. Dorsal aspect of male genitalia of *G. ulkei* Blanchard.
4. Dorsal aspect of male genitalia of *G. blackburnii blackburnii* (Fabricius).
5. Same as 4, but another specimen.
6. Dorsal aspect of male genitalia of *G. blackburnii excrementi* Say.

Symbols: LP, left paramere; PLL, phallobase; RP, right paramere.

Plate 5

1. Dorsal aspect of male genitalia of *Geotrupes egeriei* Germar.
2. Dorsal aspect of male genitalia of *G. opacus* Haldeman.
3. Dorsal aspect of male genitalia of *G. semiopacus* Jekel.
4. Ventral aspect of male genitalia of *Mycotrupes cartwrighti* Olson and Hubbell.
5. Dorsal aspect of male genitalia of *M. retusus* LeConte.
6. Ventral aspect of male genitalia of *M. gaigei* Olson and Hubbell.
7. Ventral aspect of male genitalia of *M. retusus.*
8. Ventral aspect of male genitalia of *M. pedester* Howden.

Symbols: LP, left paramere; PLL, phallobase; RP, right paramere.

Plate 6

1. Left antenna of third instar of *Eucanthus lazarus subtropicus*, new subspecies.
2. Left antenna of third instar of *Bolbocerosoma farctum* (Fabricius).
3. Left antenna of third instar of *Bolboceras liebecki* (Wallis).
4. Epipharynx of third instar of *Bolbocerosoma farctum.*
5. Epipharynx of third instar of *Eucanthus lazarus subtropicus.*
6. Labium and hypopharynx of third instar of *E. lazarus subtropicus.*
7. Caudal view of last abdominal segment of third instar of *E. lazarus subtropicus.*
8. Labium and hypopharynx of third instar of *Bolboceras darlingtoni* (Wallis).
9. Epipharynx of third instar of *B. darlingtoni.*
10. Caudal view of last abdominal segment of third instar of *B. darlingtoni.*
11. Labium and hypopharynx of third instar of *B. liebecki.*
12. Epipharynx of third instar of *B. liebecki.*

Symbols: ASL, anal slit; DAL, dorsal anal lobe; DX, dexiotorma; GL, glossa; LT, laeotorma; O, oncylus; PH, phoba; SE, sensory organ.

Plate 7

1. Left galea of third instar of *Geotrupes ulkei* Blanchard.
2. Last two antennal segments of third instar of *G. splendidus splendidus* (Fabricius).
3. Last two antennal segments of third instar of *G. ulkei.*
4. Last two antennal segments of third instar of *G. blackburnii blackburnii* (Fabricius).
5. Last two antennal segments of third instar of *Geotrupes egeriei* Germar.
6. Last two antennal segments of third instar of *Peltotrupes youngi*, new species.
7. Last two antennal segments of third instar of *G. hornii* Blanchard.
8. Head of third instar of *G. egeriei.*

9. Head of third instar of *G. splendidus splendidus* (Fabricius)
10. Tip of right mesothoracic leg of third instar of *G. hornii.*
11. Left mandible of third instar of *G. egeriei.*
12. Right mandible of third instar of *G. egeriei.*
13. Left mandible of third instar of *G. splendidus splendidus.*
14. Right mandible of third instar of *G. splendidus splendidus.*
15. Caudal view of last abdominal segment of third instar of *G. hornii.*
16. Tip of right mesothoracic leg of third instar of *G. egeriei.*
17. Caudal view of last abdominal segment of third instar of *G. egeriei.*

Symbols: A, antenna; AA, setae of anterior angle of frons; AF, anterior frontal setae; AS, antennal segment; BP, bifurcate process; EFS, exterior frontal seta; ESF, endoskeletal figure; L, labrum; MO, molar area, PFS, posterior frontal seta; SA, scissoral area; SE, sensory organ; TU, tubercle.

Plate 8

1. Epipharynx of third instar of *Geotrupes splendidus splendidus* (Fabricius).
2. Labium and hypopharynx of third instar of *G. blackburnii blackburnii* (Fabricius).
3. Maxilla, labium, and hypopharynx of third instar of *G. splendidus splendidus.*
4. Epipharynx of third instar of *G. egeriei* Germar.
5. Labium and hypopharynx of third instar of *G. blackburnii excrementi* Say.
6. Maxilla, labium, and hypopharynx of third instar of *G. egeriei.*
7. Epipharynx of third instar of *G. hornii* Blanchard.
8. Labium and hypopharynx of *G. hornii.*

Symbols: CPA, chaetoparia; DX, dexiotorma; ETA, anterior epitorma; ETP, posterior epitorma; GL, glossa; LT, laeotorma; MSA, maxillary stridulating area; O, oncylus; SEN, sensilla.

Plate 9

1. Epipharynx of third instar of *Peltotrupes youngi*, new species.
2. Caudal view of last abdominal segment of third instar of *P. youngi.*
3. Head of third instar of *P. youngi.*
4. Left mandible of third instar of *P. youngi.*
5. Maxillae, labium, and hypopharynx of third instar of *P. youngi.*
6. Right mandible of third instar of *P. youngi.*

Symbols: A, antenna; AN, anal lobe; BP, bifurcate process; CPA, chaetoparia; DX, dexiotorma; ETA, anterior epitorma; ETP, posterior epitorma; GL, glossa; L, labrum; LT, laeotorma; MO, molar region; MSA, maxillary stridulatory area; O, oncylus; PFS, posterior frontal setae; PH, phoba; SN, scissorial notch.

Plate 10

1. Diagram of brood burrows of *Bolboceras darlingtoni* (Wallis).
2. Diagram of burrow of *Bradycinetulus ferrugineus* (Palisot de Beauvois).
3. Diagram of brood burrow of *Bolboceras farctum* (Fabricius).
4. Diagram of brood burrow of *Peltotrupes youngi*, new species.
5. Diagram of brood burrow of *Geotrupes hornii* Blanchard.
6. Diagram of brood burrow of *G. blackburnii blackburnii* (Fabricius).
7. Diagram of brood burrow of *G. splendidus splendidus* (Fabricius).

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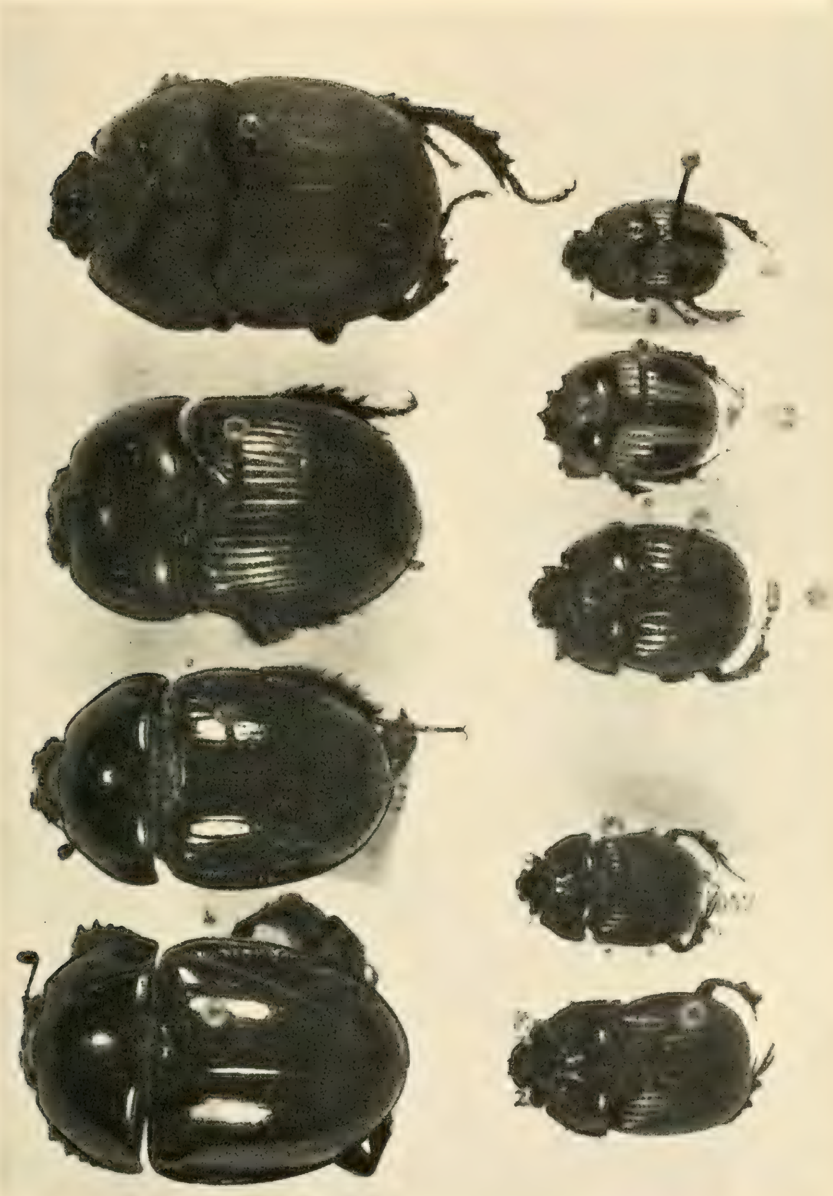

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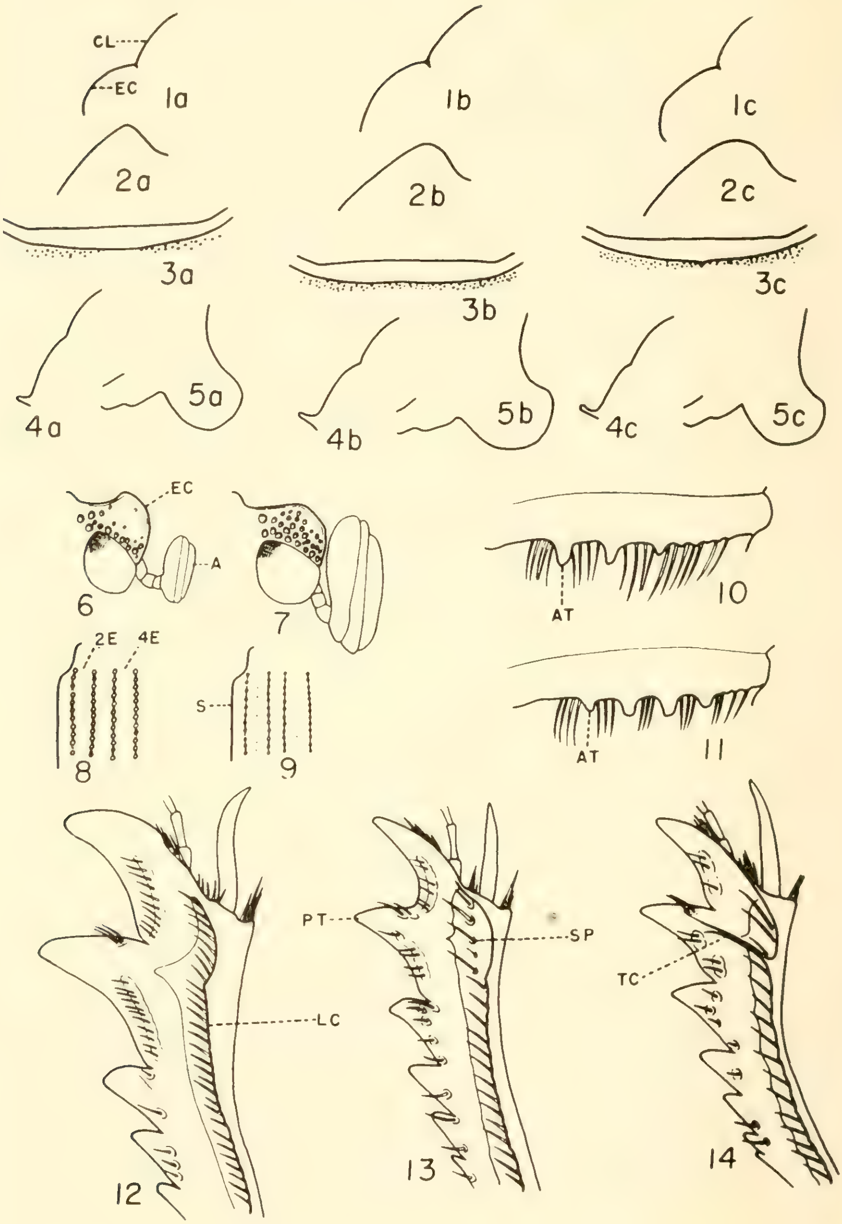

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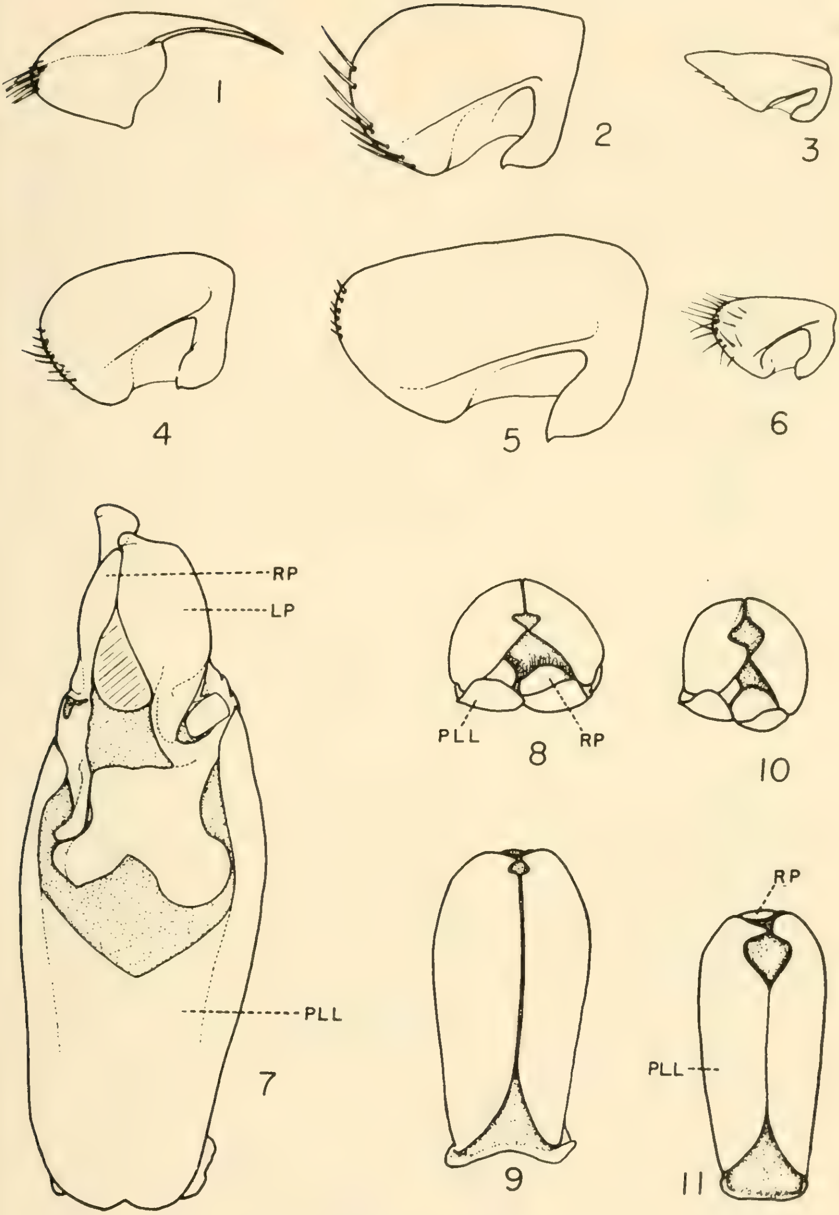

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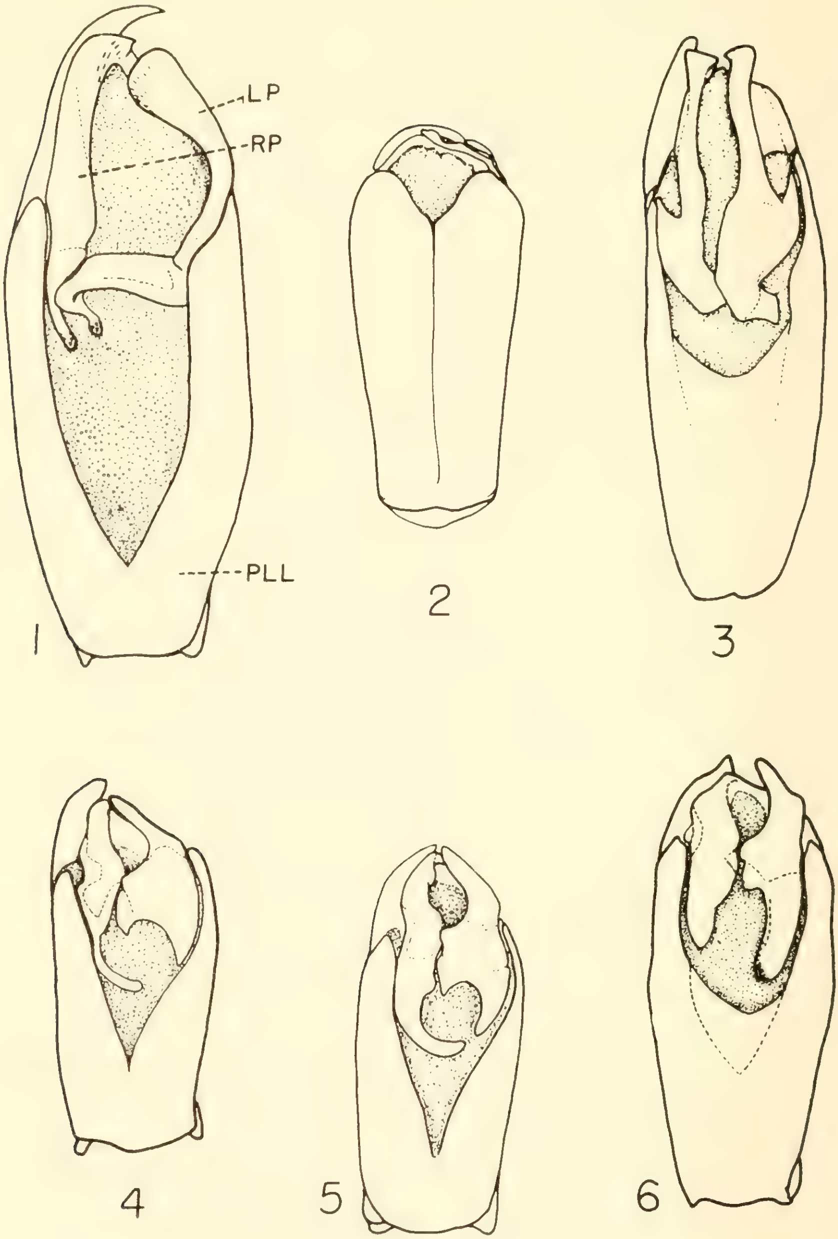

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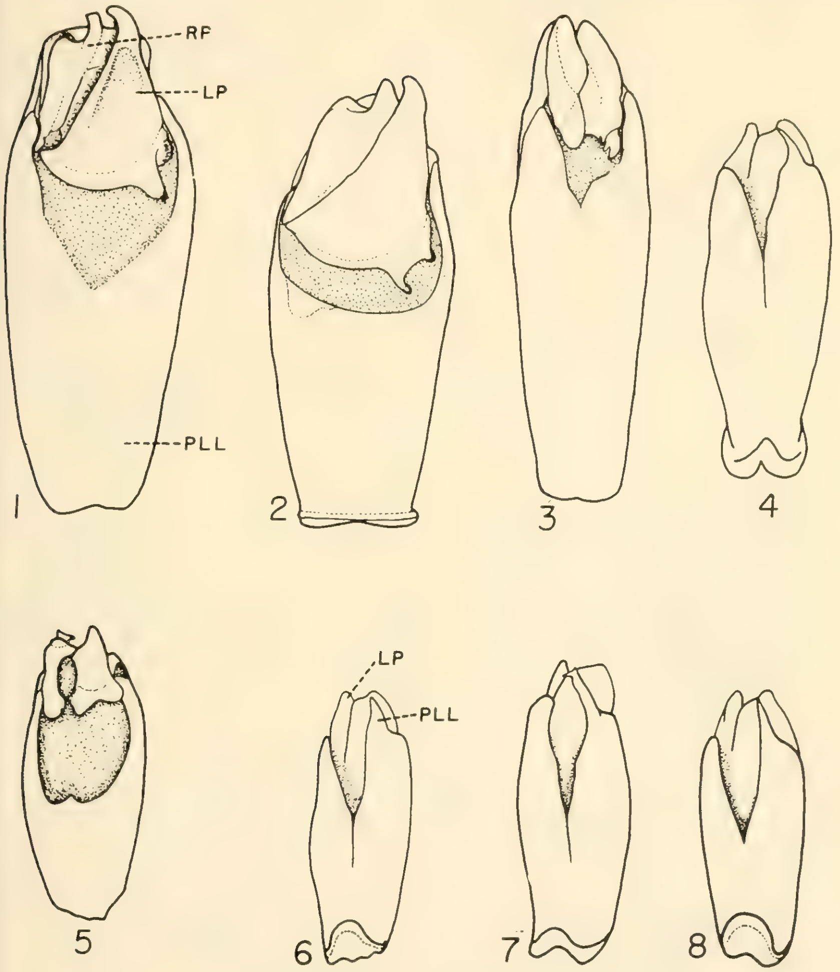

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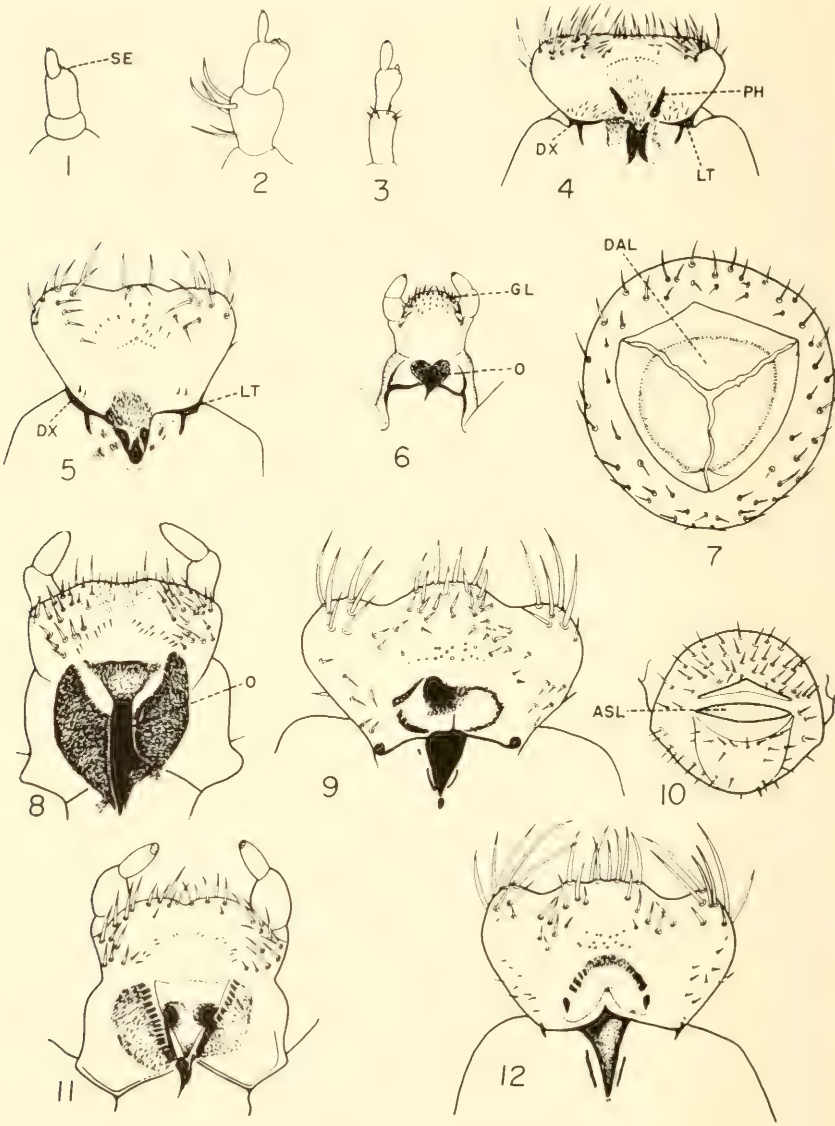

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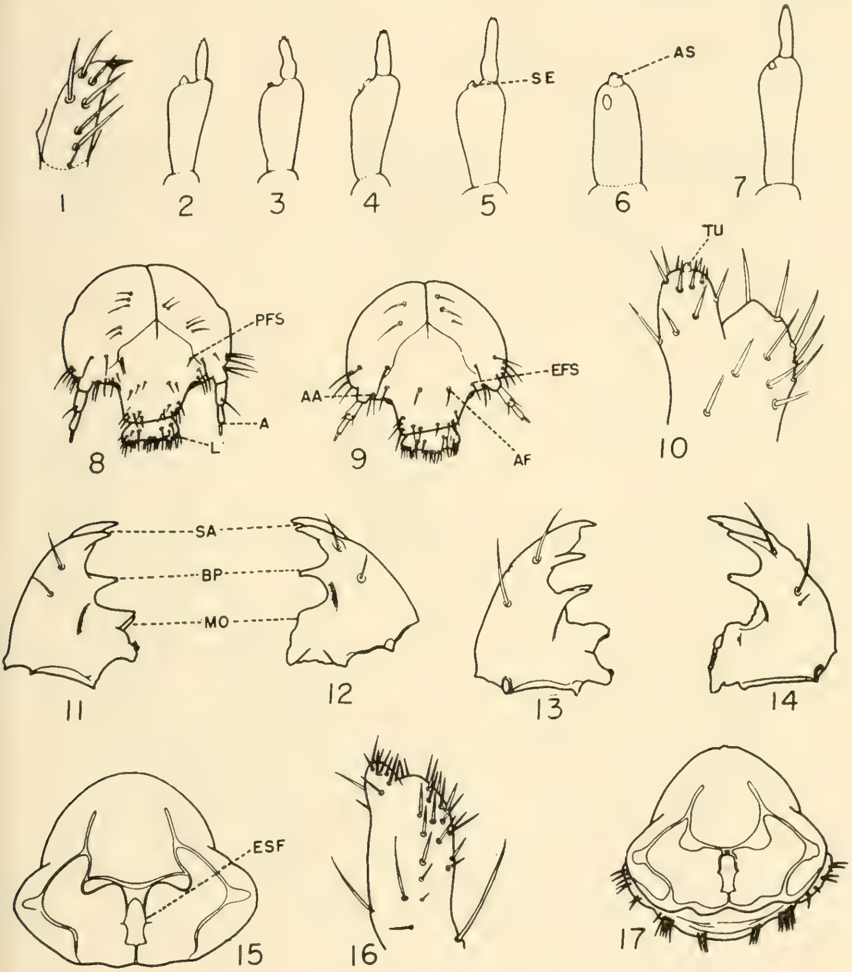

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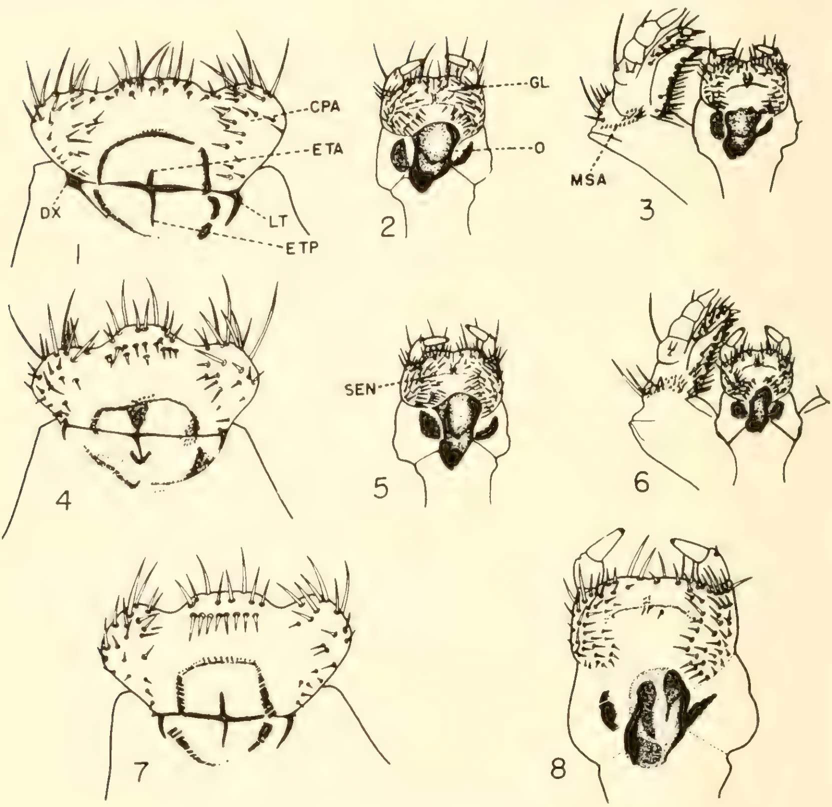

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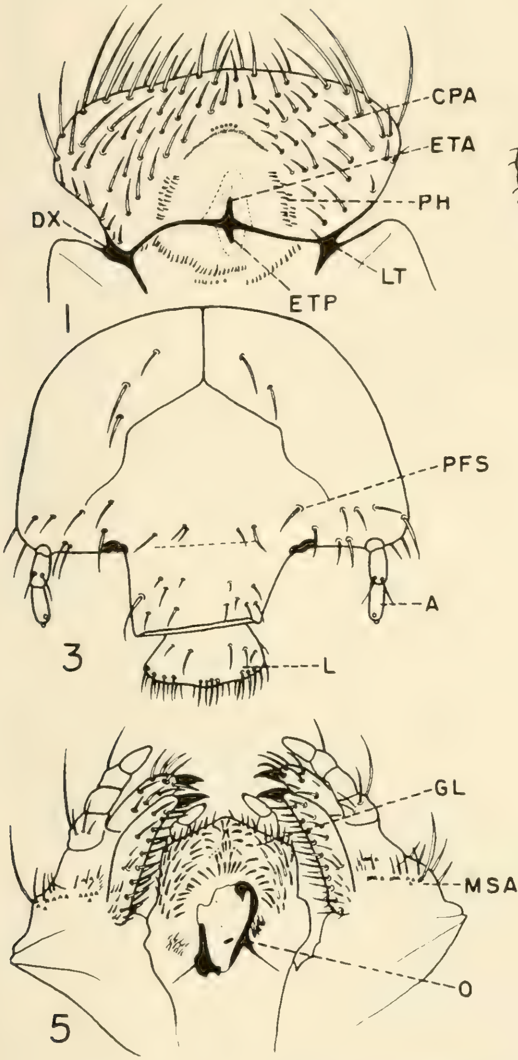

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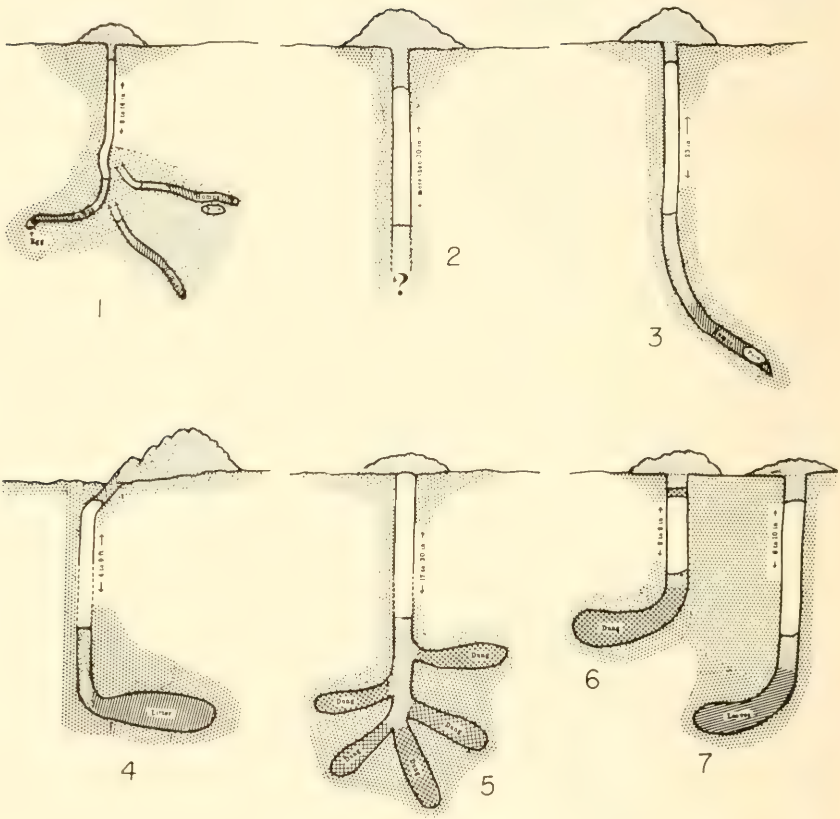

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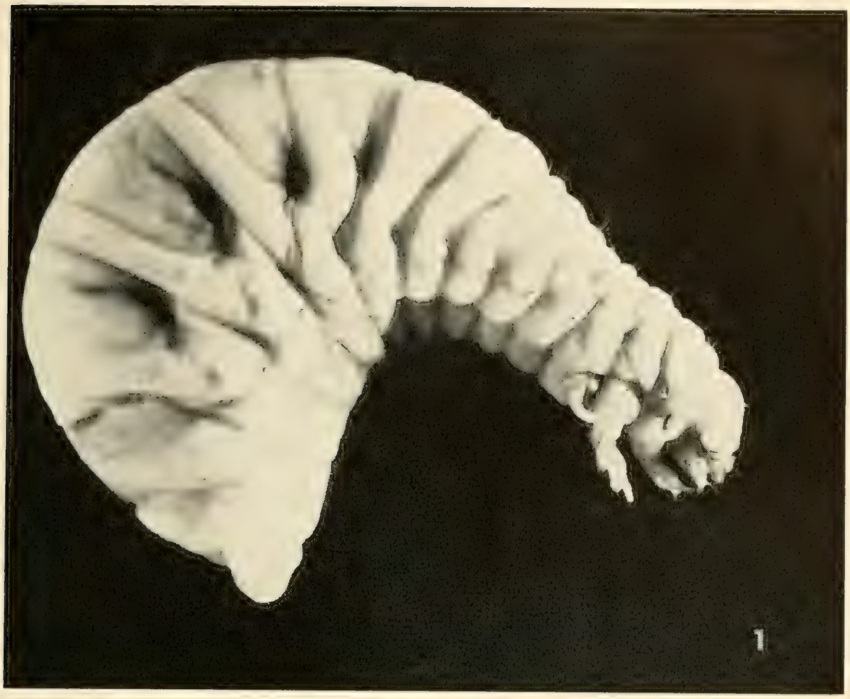


1. Third instar of *Peltotrupes youngi*, new species.
2. Third instar of *Geotrupes egeriei* Germar.

1

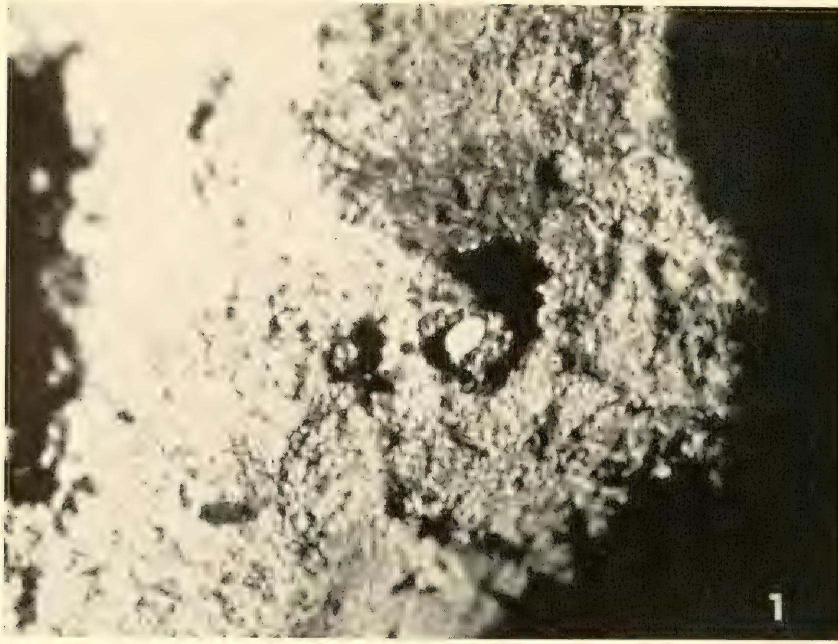
2

1. Third instar of *Bolboceras darlingtoni* (Wallis).
2 Third instar of *Eucanthus lazarus subtropicus*, new subspecies.

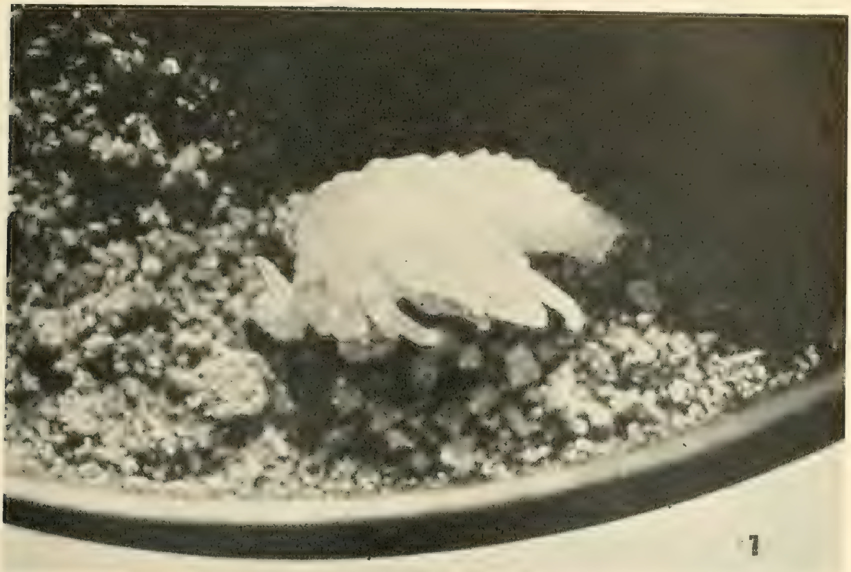
1

2

1. Third instar of *Bolbocerosoma farctum* (Fabricius).
2. Third instar of *B. farctum* in pupal cell, showing a portion of the cell (black) provisioned by the female.



1. Egg of *Bolboceras darlingtoni* (Wallis) in cavity, made by the female just below the provisioned cell (dark gray).
2. Egg of *Geotrupes blackburnii blackburnii* (Fabricius) in cavity, at the terminal end of the dung wad provisioned by the female.



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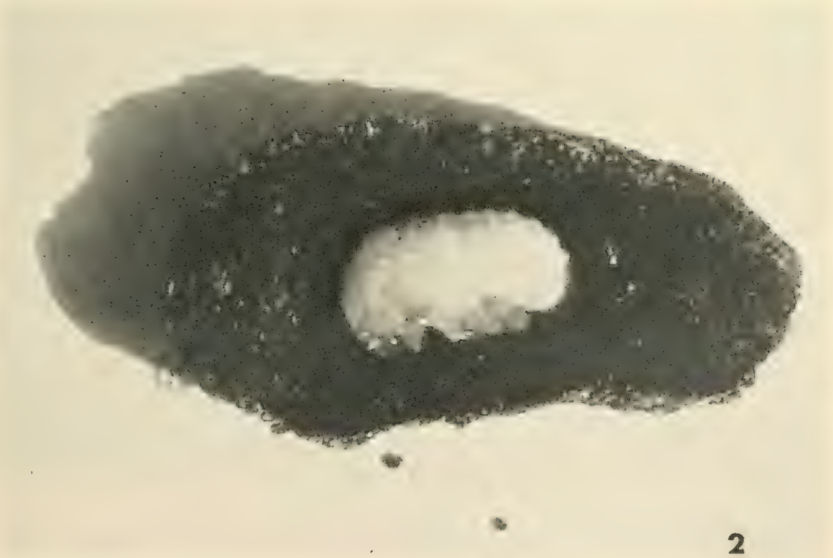

2

1. Pupa of *Bolboceras darlingtoni* (Wallis).
2. Pupa of *Geotrupes blackburnii blackburnii* (Fabricius) in cell.

1. Portion of the sandy woods at Faison, N. C., where *Geotrupes blackburnii blackburnii* (Fabricius), *G. egeriei* Germar, *G. hornii* Blanchard, *Bolbocerosoma farctum* (Fabricius), and *Bolboceras darlingtoni* (Wallis) were found.
2. Area in the Faison, N. C., woods where larvae of *Bolbocerosoma farctum* and *Bolboceras darlingtoni* were collected.

1. Old road at Southern Pines, N. C., where many burrows of *Eucanthus lazarus subtropicus*, new subspecies, were found. Five of these burrows are indicated by straws.
2. Push-ups marking the burrows of *Peltotrupes youngi*, new species. Four miles west of Rodman, Putnam County, Fla.

1. Push-up of *Peltotrupes youngi*, new species, surrounded by the typical surface litter which the female used to provision the larval cell.
2. Fecal tube constructed by the larva of *P. youngi*. This tube prevented the loose sand from caving in on the larva as the litter was eaten.

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FRUIT FLIES OF THE GENUS TOMOPLAGIA COQUILLETT (DIPTERA, TEPHRITIDAE)

By Martin L. Aczél [1]

Introduction

The original generic name *Plagiotoma* was proposed by Loew in 1873 as a subgenus of *Trypeta*, with *obliqua* Say designated as type, but is preoccupied by Clarapede and Lachmann in 1858, in Protozoa. The valid name *Tomoplagia* was proposed by Coquillett (1910, p. 615) to replace *Plagiotoma*. The first attempt to bring together the described species was made in 1914 by Hendel, when he listed 20 species and published the first key. His paper dealt with 16 new forms, the others having been described by Say in 1829 (*obliqua*), Loew in 1862 (*discolor*) and 1873 (*biseriata*), and by Williston in 1896 (*incompleta*). In 1918 Lutz and Costa Lima described three new species from Brazil (*jonasi*, *rudolphi*, and *trivittata*). The genus remained untouched until the present paper except for the description of a few new species by Curran (1931), Costa Lima (1934) and Hering (1937, 1938, 1941, 1942). Hering (1941) published a partial key that contained nine Peruvian species.

In all these subsequent papers the authors used principally the wing pattern and the black markings on the thorax and abdomen. The late F. H. Benjamin (1934) was the first to describe the genital apparatus in both sexes and the early stages of *T. obliqua* (Say). The writer (1950) included 30 species in his catalog of the family as it occurs in the Neotropical region.

In the present paper the writer describes 15 new and 12 already existing species. Undoubtedly many more new species will be found if all the numerous morphological characters of these flies are taken into consideration as in the present paper.

[1] Fundación Miguel Lillo, Universidad Nacional de Tucumán, Argentina.

The following 15 species have not been seen by the writer: *arsinoë* Hering, *atelesta* Hendel, *atimeta* Hendel, *biseriata* (Loew), *conjuncta* Hendel, *diagramma* Hendel, *jonasi* (Lutz and Lima), *penicillata* Hendel, *pura* Curran, *quadriseriata* Hendel, *quadrivittata* Lutz and Lima, *separata* Hendel, *stacta* Hendel, *titschacki* Hering, and *tripunctata* Hendel. The writer did not think it desirable to give a redescription of *obliqua* (Say), having seen only two specimens of this species.

In the material of the Fundación Miguel Lillo (FML), the collection of Dr. E. E. Blanchard, and the Colegio Máximo de San José, 11 species from Argentina were found; of these, only *trivittata* has been previously reported from that country. In addition to the 28 old names presented herein, 15 new ones are proposed; these 43 presumably valid species are united in a new key. The writer would be indebted to all entomologists and institutions for the loan of more material.

There is also great need for further biological work, as the food plants are known for only four species. Adults of *obliqua* were reared from larvae feeding in the bases of the inflorescences of *Vernonia scaberrima*, *V. blodgetti*, and *V. gigantea* (Compositae) in the United States (Benjamin, 1934). Adults of *rudolphi* were reared from larvae feeding in variably formed stem galls of *Vernonia polyanthes* Less. (Costa Lima, 1934) and *V. tweediana* Baker (Hering, 1938) p. 415, "*T. vernoniae*" in Brazil. Larvae of two species may damage cultivated fruits, feeding in the fleshy parts. Adults of *cressoni* were reared by L. D. Christensen from peach (*Prunus persica* (L.) Batsch.) in California, and those of *costalimai*, *phaedra*, and *trivittata* were reared by K. J. Hayward (Hayward, 1942) from sweet orange (*Citrus sinensis* (L.) Osbeck) and guava (*Psidium guajava* L.) in Argentina (Tucumán). Adults of *brevipalpis*, *deflorata*, and *stonei* were trapped in fruit fly traps by Zetek in Panamá, those of *costalimai* and *trivittata* in fruit fly traps among citrus trees by K. J. Hayward in Argentina (Entre Ríos, etc.), adults of *incompleta* in fruit fly traps in roseapple trees by J. W. Baker in Puerto Rico, and an adult of *discolor* in a fruit fly trap in a guava tree by J. W. Balock in Puerto Rico. M. Kisliuk and C. E. Cooley have collected specimens of *unifascia* on olive trees in Chile (Arica, etc.). According to Hayward's data, however, the economic importance of the species reared by him was subordinate to that of some species of *Anastrepha*.

The preparation of the present revision has been greatly facilitated by the assistance rendered by the following entomological workers and institutions: Dr. Remington Kellogg, Director of the U. S. National Museum (USNM), Washington, and Dr. Alan Stone, entomologist, U. S. Department of Agriculture Research Service, made available valuable material; Dr. Messias Carrera, entomologist of the Depar-

tamento de Zoologia in São Paulo, Brazil, submitted for study all the material in the collection there; Dr. Everard E. Blanchard, chief entomologist of the Instituto de Sanidad Vegetal in Buenos Aires, loaned all his material, including his undescribed new species which the author describes under the manuscript names applied by him; Dr. Gregorio Willinier, subrector of the Colegio Máximo de San José, San Miguel, Province of Buenos Aires, lent all the material available; Professor A. da Costa Lima (Distrito Federal, Brazil) contributed the paratypes of his *rudolphi* for study and kindly supplied information on the types of various Brazilian species; Mr. Jean L. Laffoon, entomologist of Iowa State College, Ames, Iowa, was also very helpful. The writer expresses his deep gratitude to all.

The line drawings were made by the writer; 5× or 10× oculars and the 8× objective of a Zeiss binocular microscope, and camera lucida were used, and the drawings reduced to half size. The original photographs of the wings represent enlargements of 12 to 32 diameters and all were photographed by Mr. V. Brennan of the Fundacíon Miguel Lillo.

Genus *Tomoplagia* Coquillett

This American genus is distributed from the United States to Chile and Argentina, but attains its greatest development in South and Central America within the tropics of the Neotropical region. As far as is known, only two species occur in the United States: *obliqua* (Indiana, New Jersey, Pennsylvania, Illinois, Iowa, Kansas, New Mexico, California) and *cressoni* (Arizona and California). Benjamin (1934) was doubtful about the records of *obliqua* from the West Indies and México, but they seem very reasonable to the writer. Much remains to be learned concerning the geographic distribution of the various species.

The following outstanding characters readily distinguish this genus from all known genera of Trypetini of the subfamily Trypetinae: Body and bristles yellow; oral margin of concave mesofacial plate raised and more or less prominent; basic wing pattern usually consisting of four coherent oblique bands, yellow with narrow brown distal border; inner and outer cross-veins oblique and closely placed, both included in the median band of wing pattern; fourth longitudinal vein (M_1) excurved near base of second posterior cell (Cp_2); some black spots present on thorax and abdomen; third longitudinal vein (R_{4+5}) spinulose from base to apical yellow band on superior, and from base to anterior cross-vein on inferior surface.

Additional morphological characters of the genus are as follows:

Length of body of the species examined (females without ovipositor sheath) 2.8 to 7.7 mm.; length of thorax (including scutellum) 1.3 to

3.9 mm.; wings equal to, slightly shorter than, or longer than the body, 1.8 to 2.8 times as long as broad. Head generally wider than length or height and higher than long. Upper half of postcranium with the cerebral plate concave in profile, inferior margin of cerebral plate raised and slightly prominent, lower part of postcranium more or less convex. Eyes in profile shorter or longer oval, with axis nearly vertical in nearly all species examined; with sparse, erect whitish microscopical hairs in the larger species, apparently bare in the smaller species; ratio of height to width of eye in profile 1.3 to 2.4. Genae below eyes in most species very narrow, usually one-half as wide to wider than postpedicel. Frons at vertex always more or less wider than one eye and usually slightly shorter than width at vertex (measured from lunula to vertex in the median line); flattened, slightly produced near antennae and gradually narrowed to anterior margin. Mesofacial plate (face) sunken, not visible in profile, slightly receding beneath, with indistinct and superficial antennal fovae, oral margin raised and more or less prominent. Head in all species yellow, without black spots, genae slightly darkened below the eyes in some species; with or without conspicuous pruinosity; mesofacial plate may be evenly and densely dusted in some species. Only four of the known species have frons distinctly vittate by pruinosity; lateral borders of frons along eyes and a median vitta along frontal stripe in these species densely white pruinose, the bare parts of frontal stripe forming two broader, intensive, testaceous to reddish yellow vittae. Antennae and mouthparts as yellow as other regions of head, except for the mostly brown labella. Scape of antenna very short; pedicel with some short and thickish hairs and with conspicuous dorsal bristle. Postpedicel short-lobate, with widely rounded, truncated apex, 1.1 to 2.2 times as long as wide and slightly shorter than mesofacial plate. Shape of maxillary palpi variable in the genus but constant as a specific character, distinctive in being slightly curved and broadly sickle-shaped, although in some species it is oval and not curved and with a differently formed apex. Prementum very short and small, yellow. Cephalic bristles somewhat flattened, usually brownish yellow but genal bristle (*ge*) mostly darker in color. Usually three pairs of convergent lower orbital bristles (*ori*), anterior pair usually shorter than posterior pairs but in some forms all three pairs subequal in length. Two pairs of recurved upper orbitals (*ors*), posterior pair shorter and weaker than anterior. One pair of divergent ocellars (*oc*), usually long and robust. Outer pair of divergent verticals (*vte*) more or less shorter than inner pair (*vti*), the longest and strongest of the cephalic bristles. Postverticals (*pvt*) parallel and relatively short.

Body yellow in ground color with conspicuous black markings on thorax and abdomen; spots may occasionally vary in size and color (black to yellowish brown) but their presence or absence is nearly always constant in the species. Mesonotum usually covered with dense dusting except for a narrow margin in front of scutellum, which is shining; dusting may be silky white, whitish or pale to light brass yellow. Visible black spots covered with black dusting. Dusting of mesonotum in majority of species even and uniform, without a trace of vittae, but in some species vittae present; these may be composed of differently colored dusting or may be structural. In many species the ground color of mesonotum vittate or spotted with black, but these black markings not visible without the removal of dusting (see figure, in which the contours of the black vittae have been marked by dotted lines). Three darker almost linear vittae on the uniformly dusted mesonotum of several species (one median and two lateral on dorsocentral line), visible only from behind; these vittae are structural, that is, composed of minute squamulae of the same color as the other apressed ones, but slightly raised. Insertion points of some mesonotal bristles of some species conspicuously large, shining and dark colored. Hairs of mesonotum short, somewhat thickish and apressed, usually pale yellow in color. The following thoracic bristles present: One pair of humerals (*h*), one pair of presuturals (*prst*), two pairs of notopleurals (*npl*), one pair of dorsocentrals (*dc*), one pair of supra-alars (*sa*), two pairs of postalars (*pa*), one pair of prescutellars (*prsc*), two pairs of scutellars (*sc*), one pair of sternopleurals (*st*), two pairs of mesopleurals (*mpl*) and one pair of pteropleurals (*ptpl*); all brownish yellow and somewhat flattened. As in *Blepharoneura*, *Hexachaeta*, etc. (tribe Acanthorheurini) species dorsocentrals and prescutellars stand almost in a transverse line with the upper postalars very near the scutellar suture; prescutellars very closely spaced. There appears to be little doubt that the dorsocentrals and prescutellars represent the posterior pairs of dorsocentrals and achrostichal bristles (*acr*=*prsc*); posterior pair of notopleurals slightly shorter than, to one-half as long as anterior; ratio of lengths of the two pairs of mesopleurals may be more diverse in the various species; lower postalar (*pa*=infra-alar) shorter than the upper in all species.

Scutellum shining, with some yellow, brownish yellow, or nearly black hairs laterally. Apical pair of scutellars parallel or convergent and crossing, nearly as long as, to two-thirds as long as, basal pair.

Basic wing pattern, unique in subfamily Trypetinae, consists of five diagonal translucent yellow bands, usually with more or less distinct, sometimes interrupted, translucent brown to dark brown distal borders and tips. The three median bands attain posterior wing margin, but the fifth (basal) strongly abbreviated in the majority of species, usually forming an irregular transparent spot or an indistinct blurred cloud, pale to dark brown in color, at apical process of anal cell. Each of the three distal bands connected to stem band, which extends from wing base to marginal cell along anterior wing margin; the two proximal bands unite with yellow wing base; apical band borders costa from submarginal cell usually to tip of third longitudinal vein (R_{4+5}), with apex slightly penetrating into first posterior cell; subapical band rather straight, extending from submarginal cell to tip of fourth longitudinal vein (M_1); median band running from tip of subcosta to tip of fifth vein (M_3+Cu_1), covering both inner (*ta*) and outer (*tp*) cross-veins—an outstanding generic character; prebasal band as curved as median, running parallel with latter from base, attaining posterior margin of wing halfway between tips of fifth and anal ($Cu+An_2$) veins; basal band running from base toward tip of anal vein. Three variable dark brown to black spots in stem band bordering anterior wing margin from wing base to middle of second costal section (marginal cell): one at tip of humeral cross-vein (*th*), one surrounding rectangularly bent tip of subcosta, and one at tip of stem band at middle of second costal section; distad of this spot usually a variable hyaline spot; a dark costal spot is present in the apical band proximad to tip of second longitudinal vein (R_{2+3}) in several species, but absent in many others; often a small hyaline spot at tip of second longitudinal vein.

Venation in this genus shows the general characters of the family Tephritidae and of the subfamily Trypetinae in having apical portion of subcosta rectangularly bent toward costa; apical part of this vein again rectangularly bent, turning parallel with costa toward base; anal (cubital) cell with acute and rather long apical process; first vein (R_1) densely spinulose on upper surface of wing. Inner and outer cross-veins very closely spaced; third vein usually spinulose from base to apical yellow band on superior, and from base to anterior cross-vein on inferior surface; base of ultimate section of fourth vein (M_1) more or less distinctly curved upward toward anterior wing margin, the tip usually straight or very slightly upcurved; second vein usually nearly straight, sometimes slightly curved; apical part of third vein more or less distinctly downcurved toward wing apex, apical portions of third and fourth veins usually slightly divergent. Humeral cross-vein running obliquely from costa toward wing base; outer cross-vein (*tp*) usually nearly perpendicular to anterior margin of wing; anterior cross-vein (*ta*) nearly always more oblique than *tp*, extending from fourth longitudinal vein toward apex of stigma; *ta* and *tp* cross-veins nearly parallel in some species, in others distinctly divergent toward anterior wing margin. Section of fifth vein posteriorly bordering discoidal cell nearly straight or curved toward posterior wing margin. Inner cross-vein subequal to, shorter or longer than penultimate section of fourth vein between both cross-veins. Second costal section the longest, fourth and first sections shortest, basal section of fourth longitudinal vein shorter than, equal to, or longer than the ultimate; anal (cubital) cell with a longer or shorter apical process by rectangular curvature of vein Cu_2. Ratio of entire length of anal cell to length of apical process variable, ranging from 1.8 to 4.5; entire cell 2.2 to 3.2 times as long as apical process; petiole of anal cell usually weaker toward posterior wing margin and rarely attaining it, except for a foldlike continuation in some species; second basal cell hyaline and yellowish in the majority of species. Axillary lobe well developed; alula relatively small, the basal part bare, without microtrichiae. Halteres usually yellow, in some species the knob partly brownish.

Legs usually without special characters except in two species, which have apical third of midtibiae anteroposteriorly compressed and dorsoventrally dilated, with a dorsal group of short, strong, black bristles; legs and coxae entirely yellow; distal one or two tarsal segments of middle and hind legs sometimes infuscated. A conspicuous posterodorsal row of rather closely spaced, brownish yellow to black, short and erect bristlelike hairs on hindtibiae of all species.

Preabdomen mostly wide-oval, almost as wide or slightly wider than long, in some species oval to long-oval. Preabdomen of male of five segments, that of female of six; tergites and intersclerital membrane well developed, sternites rather narrow; first and second tergites coalesced, forming the first and second syntergite; first tergite with a pair of lateral processes, as usual in the higher flies. Fifth tergite of male 1.2 to 2.5 times as long as fourth and tapering toward posterior margin; fifth tergite of female approximately as long as, shorter, or longer than fourth, contradicting Hering's (1947) definition of the subfamily Trypetinae ("Letztes tergit des ♀ stets kürzer als das vorletzte"). Tergites covered with brownish yellow to black apressed hairs. Male postabdomen small, revolute, hidden under fifth tergite; epandrium (ninth and tenth syntergite) together with the short, incurved surstyli oval to wide-oval, terminal surface with cerci turned downwards, similar in structure to that of some higher Tephritinae (*Trupanea*, *Paroxyna*, etc.); short surstyli usually forming, in profile, a direct continuation of body of epandrium, thus very different from that of *Rhagoletis* and allied genera. Usually two pairs of shining black, toothlike gonapophyses present, but posterior (lateral) pair more acute and more or less reduced, weaker and shorter than anterior pair, sometimes entirely absent. Irretractable basal part of ovipositor (sheath) flattened dorsoventrally, sometimes subconical; shining, usually entirely translucent to opaque yellow; surface covered with short, fine, apressed hairs; subequal to, slightly shorter than, or slightly longer than width at base; ratio of length of thorax to length of sheath 1.9 to 4.9 (sheath measured in flattened condition, only exposed dorsal portion measured); apical portion of ovipositor (ovipositor proper) translucent reddish yellow, dorsoventrally flattened, lanceolate, with variable tip either arrowheadlike, somewhat delimited, with minute dorsal hook at apex, or simple.

In the present paper, as in former publications, the writer has sought new and better taxonomic methods and, considering the species as natural units, has attained satisfactory results. The more extensive application of morphological and biometric methods undoubtedly would be advantageous for the development of entomological taxonomy.

The genus *Tomoplagia* represents a phylogenetically homogeneous group which it would be unnatural to divide into further genera. In this genus there are many species with very similar wing pattern, as in other genera of the family *Tephritidae* (e. g., in *Xanthaciura*, *Parastenopa*, *Rhagoletis*, etc.) and some species with distinctly different pattern. It is very interesting to find four species in this genus, each of which, with regard to a conspicuous character, has a counterpart or "twin" species; these are *penicillata-pseudopenicillata* (special armature of the midtibiae), *atimeta–kelloggi*, *discolor–pura*, *incompleta–argentiniensis* (each pair with a special wing pattern).

The most highly developed and at the same time most crowded groups of *Tomoplagia* are apparently the *obliqua–monostigma–minuta* (excluding *kelloggi* and *incompleta*) and the *pleuralis–reimoseri* groups.

There are, however, many highly specialized species which cannot be placed in groups, such as *propleuralis*, *atimeta*, *kelloggi*, *carrerai*, *quadriseriata*, *quadrivittata*, *fiebrigi* and *unifascia*.

In this genus the following principal tendencies of evolution can be noted: Toward the reduction of the anterior *ori*, posterior *ors*, posterior *npl*, inferior *mpl*, apical *sc* bristles; toward the reduction of the black ground color of the thorax and abdomen; advance of the *dc* and *prsc* (=*acr*) bristles toward the anterior region of the thorax; and toward the reduction of the posterior pair of gonapophyses in the male postabdomen.

The modern form of the epandrium and the dense dusting of the mesonotum apparently represent progressive characters in *Tomoplagia*.

The following key includes all the known species and is based principally upon the presence of the black spots of the thorax. Since it is not known whether the species *pura* Curran and *tripunctata* Hendel have postscutellum black or black-spotted, and since the black spots of the postscutellum in *incompleta* (Williston) are recently in a state of disappearance, these three species will be found in both alternatives of couplet 1.

Key to the species of Tomoplagia

1. Postscutellum black, the median part more or less extensively yellow. Mediotergite usually testaceous yellow to brown but sometimes partly or entirely black 2
– Postscutellum and usually the mediotergite uniformly yellow to brownish yellow, without dark brown to black lateral spots 26
2. Two black or dark brown markings on the sides of mesonotum: a short vitta-like one below the posterior notopleural bristle and a semicircular spot above wing base. Only the usual pair of lateral black spots present on hind region of mesonotum between the prescutellar and upper postalar bristles. Wing pattern normal. Pteropleuron with black spot. Dorsocentrals slightly behind the level of the supra-alars. (*phaedra* group). 3
– Only one black marking present on sides of mesonotum above wing base. Only the usual pair of lateral black spots present on the hind region of mesonotum. Wing pattern normal. Dorsocentral bristle pair inserted in hind two-fifths of distance between suture and *sa* bristles. Two black spots on pleura, a large one on sternopleuron and a smaller one on pleurotergites. Inferior mesopleural bristle almost as long as superior. Sheath of ovipositor shorter than breadth at base; thorax 3.7 times as long as the sheath. Preabdomen yellowish brown, tergites with wide yellow hind margins, third to sixth tergites each with a pair of incised lateral black spots, irregular in shape. Eyes in profile 1.9 times as long as wide. 6 mm. Argentina.
♀ **minattai** Blanchard (MS.), new species (p. 368)
– Both black markings absent from sides of mesonotum 4
3. Frons twice as broad as one eye, with five incurved lower orbital bristles (*ori*). Mediotergite entirely shining black. Sternopleura black with yellow upper margin; one black spot above hind coxa, and another on pleurotergites. Mesonotum ochraceous yellow, dusted, with five dark yellow linear vittae. Second basal cell entirely yellow. Male abdomen without lateral black spots. 7 mm. Bolivia, Argentina.
♂ **stacta** Hendel
– Frons approximately twice as broad as one eye, with the usual three incurved *ori*. Mediotergite shining testaceous yellow, with pair of elongated lateral black spots. Pleura with only one black to brown spot on pteropleuron. Mesonotum evenly dusted with yellow, without linear vittae. Second basal cell yellow, with large anterobasal hyaline spot. A pair of black to brown lateral spots always present on sixth tergite of female; sometimes the fifth, exceptionally the fourth and fifth tergites, with a smaller pair of lateral spots. Fifth tergate of male with a pair of lateral black to brown spots, very variable in size, occasionally absent; 1.5–1.7 times as long as fourth. Eyes in profile 1.9–2.0 times as high as wide. Sheath of ovipositor slightly shorter than broad at base; thorax 2.8–3.0 times as long as sheath. Postpedicel 1.4–1.6 times as long as wide. Dorsocentral bristles inserted almost in line with supra-alar (*sa*) bristles (♀) or in hind fourth of distance between transverse suture and *sa* bristles (♂). 5.1–7.0 mm. Perú, Argentina.
♂ ♀ **phaedra** Hendel (p. 378)
4. Four black spots present on hind region of mesonotum 5
– Hind region of mesonotum with three black spots, one spot between the usual pair which almost reach the scutellar suture. Three pairs of incurved *ori* present 6
– Only the usual pair of black spots present on hind region of mesonotum. . 8

5. Inner pair of black spots closely placed between the usual pair. Incurved orbital bristles absent. Mesopleuron with triangular black spot, sternopleuron black except for yellow upper margin, bordered with black line; a black spot above the hind coxa on pleura and another on the pleurotergites. Second to fifth abdominal tergites each with two pairs of lateral black spots. Second basal cell entirely yellow. Ovipositor sheath as long as last two tergites together, with tip black. Apical process of anal cell about one half as long as entire cell. 5.3 mm. Perú.
♀ **quadriseriata** Hendel

– Lateral pair of black spots exceptional, each stands between upper and lower postalar bristles (*pa*), inner pair commonly present. Inner vertical and genal bristles, outer occipital cilia (*occe*), and genal hairs black. Three pairs of incurved lower orbital bristles. Pleura with three black spots: one on sternopleuron, one above hind coxa, and one on pleurotergites; upper margin of sternopleura bordered with black line. Eyes in profile wide oval, 1.6 times as high as wide. Fifth abdominal tergite 1.6 times as long as fourth. Entire anal cell 2.0–2.2 times as long as the long apical process. Dorsocentral bristle pair halfway between suture and supra-alar (*sa*) bristles. 4.9–5. 1 mm. Southern Brazil: São Paulo.
♂ **carrerai** new species (p. 341)

6. Wing pattern as in *kelloggi:* a well-delimited large roundish opaque brownish black spot present on apical process of anal cell. Frons without vittae. Pleura black except for reddish yellow upper half of mesopleuron and pteropleuron. Mediotergite entirely shining black. A pair of small black spots on mesonotum, each situated at termination of branches of transverse suture; last third of mesonotum shining black, separated by two longitudinal linear vittae into three large spots (the median being the largest). Abdomen shining reddish yellow, third to fifth tergites each with a pair of large lateral black spots, variable in form and size. 4.5 mm. Bolivia . . . . ♂ **atimeta** Hendel

– Wing pattern normal. Pleura yellow with black spots. Frons conspicuously vittate: two lateral vittae along eyes and a median one covered with shining white pruinosity; between these, two testaceous yellow vittalike intervals. Anterior part of mesonotum without black spots. Mediotergite shining testaceous yellow to reddish brown, without black spots 7

7. Apical third of median tibia brownish, compressed, and dorsoventrally dilated, with a dorsal group of about 20 strong black bristles as in *penicillata.* Pleura with three black spots: a large one on sternopleuron, one above hind coxa, and a double one on pleurotergites; narrow upper margin of the sternopleuron bordered with black. Second to fourth abdominal tergites each with a pair of large lateral black spots; the short fifth tergite (only 1.3 times as long as fourth) with pair of lateral black vittae. Apical process of anal cell long (entire cell 2.3 times as long as process). Stigma short, only 2.2 times as long as breadth at base. Eyes in profile twice as high as wide. Dorsocentral bristles inserted halfway between transverse suture and supra-alar bristles. Inferior mesopleural bristle but slightly shorter than superior. Second basal cell yellow with a large anterobasal hyaline spot. 5 mm. Southern Brazil: São Paulo.
♂ **pseudopenicillata,** new species (p. 387)

– Legs without special armature. Pleura whitish dusted, with only one black spot on the pleurotergite. Third to fifth tergites each with a pair of well-delimited blackish lateral spots. Second basal cell almost entirely hyaline. 5 mm. Paraguay . . . . ♂ **tripunctata** Hendel

8. Pleura with black spots 9
– Pleura entirely yellow, without black spots 24
9. Pteropleuron with a black spot 10
– Pteropleuron yellow, without black marking 11
10. Wing pattern modified as in *discolor:* apical yellow band separated from subapical at anterior wing margin but broadly connected with subapical band in apex of first posterior cell. Abdomen shining reddish yellow with black hairs, third to fifth tergites each with a pair of large lateral black spots. Pleura with three black spots: a circular one on pteropleuron, a triangular one on pleurotergite, and another circular one on sternopleuron. 4 mm. Puerto Rico . . . . ♂ **pura** Curran
— Wing pattern normal. Entire mediotergite and dorsal pleurotergite, ventral pleurotergite except for the yellow superior margin, and adjacent lower hind part of pteropleuron black; metapleura above hind coxa extensively black, this large spot separated from above-mentioned black parts by a testaceous yellow narrow vitta extending forward over superior margin of metapleura and sternopleuron; sternopleuron entirely black except for narrow upper margin and separated from the black of metapleura only by the yellow median coxa. Third and fourth abdominal tergites of male each with three black spots (one median and two leteral), very variable in size; fifth tergite with a pair of very large lateral black spots separated by a testaceous yellow median vitta narrower than the spots. Third to fifth tergites of female each with three variable black spots; sixth tergite with a pair of lateral black spots and sometimes with a median triangular third spot. Fifth tergite of male 1.7–1.8 times as long as fourth. Postpedicel very short, only 1.1–1.2 times as long as wide. Inferior mesopleural bristle but slightly shorter than superior. Ovipositor sheath slightly shorter than width at base; apex of ovipositor with a minute dorsal hook; thorax 3.0–3.2 times as long as the sheath. 3.2–4.2 mm. Paraguay; Argentina . . . . ♂ ♀ **fiebrigi** Hendel (p. 355)
11. At least the dorsocentral and prescutellar bristles inserted on very conspicuous shining dark brown to brownish black circlets on mesonotum. Fifth abdominal tergite of male 1.7 times as long as fourth. (*stonei* group) . 12
— Insertion points of mesonotal bristles very small and yellow, normal . . . 13
12. Presutural, dorsocentral, prescutellar, supra-alar, postalar, and scutellar bristles inserted on very conspicuous shining brownish black circlets. Pleura marked with two small dots: a circular one on sternopleuron and an oval one on inferior part of ventral pleurotergite (latter may be absent). Fourth and fifth abdominal tergites in both sexes each with a pair of short, vittalike lateral black markings, third tergite with a pair of small black to pale brown lateral dots; sixth tergite of female without black markings. Ovipositor sheath slightly longer than breadth at base; thorax only 2.4–2.5 times as long as sheath; apex of ovipositor lanceolate with rounded tip and without minute dorsal hook. Postpedicel long, 2.0–2.2 times as long as wide. Eyes in profile twice as high as wide. Dorsocentral bristles inserted halfway between transverse suture and supra-alar bristles. Maxillary palpi long-oval with long bristles on outer margin. 5.8–7.3 mm. Panamá . . . . ♂ ♀ **stonei,** new species (p. 402)
— Only dorsocentral and prescutellar bristles inserted on conspicuous shining dark brown circlets of mesonotum. Pleura with three black spots: an oval one on sternopleura, a large one above hind coxa, and a double one on pleurotergites. Third to fifth abdominal tergites in both sexes each with a pair of large rounded lateral black spots, fifth tergite of female usually with a pair of small yellowish brown to brownish black lateral

dots. Ovipositor sheath slightly shorter than width at base; thorax 3.0–3.1 times an long as sheath; apical part of ovipositor wide lanceolate with blunt tip, tip with minute dorsal hook. Postpedicel shorter, 1.1 times as long as wide in male, longer (1.4–1.5 times) in female. Eyes 1.5–1.7 times as high as wide. Dorsocentral bristles inserted in posterior fourth of distance between suture and supra-alar bristles. Maxillary palpi broad oval with very short bristles and widely rounded apex. 4.5–4.9 mm. Argentina . . . . ♂ ♀ **punctata,** new species (p. 390)

13. Pleura with the usual three black spots: one on sternopleuron, one above hind coxa, and one on inferior portion of the pleurotergites 14

— Pleura with two black spots, one of these on inferior portion of pleurotergites. 19

— Pleura with only one black spot, above hind coxa.
♂ ♀ **costalimai** Blanchard (MS.), new species (p. 344)

14. Apical fourth of midtibia brownish, compressed and dorsoventrally dilated, with a dorsal bunch of short and strong black bristles (as in *pseudopenicillata*). Upper margin of sternopleuron with black border. 3.5 mm. Perú . . . . ♂ **penicillata** Hendel

— Legs without exceptional armature 15

15. Frons with two conspicuous broad testaceous yellow vittae between densely whitish pruinose narrower vittae, as in *pseudopenicillata* and *tripunctata*. Mesonotum densely whitish dusted, conspicuously marked with three equally wide, golden to reddish brown, dusted vittae, one median and two laterals on dorsocentral line. Eyes in profile high, 2.1 times as high as wide. Third to fifth abdominal tergites of male each with a pair of lateral black spots. Mediotergite in some specimens partly black. 4.5–5.5 mm. Brazil: Mato Grosso, São Paulo; Argentina.
♂ ♀ **trivittata** (Lutz and Lima) (p. 405)

— Frons without conspicuous vittae. Mesonotum without broad and conspicuous reddish brown dusted vittae (except in *heringi* which has three linear bright golden-yellow dusted vittae) 16

16. Maxillary palpi almost as broad-oval as in *punctata*, with very short marginal bristles and with apex widely rounded. Third to fourth abdominal tergites of female each with a pair of roundish black spots, second tergite with a more widely spaced pair of pointlike small black dots; fifth and sixth tergites entirely spotless. Ovipositor sheath shorter than breadth at base; thorax 3.6 times as long as sheath. 4.2 mm. Brazil: São Paulo.
♀ **ovalipalpis,** new species (p. 374)

— Maxillary palpi curved, sickle-shaped, with longer marginal bristles. Fifth abdominal tergite in both sexes and sixth tergite of female each with a pair of lateral black spots, which may be absent on the sixth tergite in *reimoseri*. Second tergite with a pair of lateral black spots in *heringi* and *pleuralis* 17

17. Only upper mesopleural bristle present. Sternopleuron sometimes almost entirely black, mesopleuron shining. Dorsocentral bristle pair inserted in anterior fourth of distance between suture and supra-alar bristles. Third to fifth adbominal tergites of male and second to sixth of female each with a pair of lateral black spots. Mesonotum covered with pale brass-yellow dusting, without pruinose or structural vittae of different color. Fifth tergite of male 1.7 times as long as fourth. Ovipositor sheath slightly shorter than breadth at base; thorax 2.7–2.8 times as long as sheath. 3.0–3.8 mm. Ecuador; Perú; Argentina.
♂ ♀ **pleuralis** Hendel (p. 381)

— Both mesopleural bristles present, the lower shorter and weaker than the upper. Mesopleuron whitish dusted and with faint greasy luster. except in *formosa.* Dorsocentral bristle pair inserted in anterior third of distance between suture and supra-alar bristles. Sternopleuron never extensively black 18

18. Mesonotum densely silky whitish dusted, with three linear bright golden-yellow dusted vittae as in *punctata.* Postpedicel 1.6 times as long as wide. Eyes in profile only 1.6 times as high as wide. Second to sixth abdominal tergites each with a pair of large black spots. Ovipositor sheath shorter than breadth at base; thorax 3.5 times as long as sheath. Apex of ovipositor in profile with somewhat delimited tip. 4 mm. Paraguay . . . . ♀ **heringi,** new species, (p. 360)

— Mesonotum densely bright brass-yellow dusted, with three linear structural vittae, visible only from behind, in darker color. Postpedicel short, 1.1–1.3 times as long as wide. Eyes in profile higher. 1.8–2.0 times as high as wide. Fifth abdominal tergite of male 1.2–1.3 times as long as fourth; third to fifth tergite in both sexes with lateral black spots; a pair of small lateral black spots sometimes present on sixth tergite of female. Ovipositor sheath a short trapezoid in shape, much shorter than breadth at base; thorax 4.6–4.9 times as long as sheath. Blunt apex of ovipositor with a minute dorsal hook. 4.0–4.3 mm. Paraguay; Brazil; São Paulo; Argentina: Misiones, Corrientes . . . **reimoseri** ♂ ♀ Hendel (p. 392)

— Mesonotum densely silky white dusted, without vittae. Postpedicel 1.5 times as long as wide. Third to sixth abdominal tergite each with a pair of lateral black spots which, on the third to fifth, are placed exceptionally close to the lateral margins. Ovipositor sheath the longest in this group, approximately as long as breadth at base; thorax only 2.2 times as long as sheath. Apical part of ovipositor with simple apex. 4.5 mm. Argentina: Formosa . . . ♀ **formosa,** new species (p. 358)

19. Second black spot placed on sternopleuron (no black spot above hind coxa). 20

— Second black spot placed above hind coxa (sometimes absent in *incompleta*), sternopleuron without black spot. Fifth abdominal tergite of male with two pairs of lateral black spots 22

20. Wing pattern modified as in *incompleta:* subapical band absent except for a brown spot on tip of fourth longitudinal vein (M_1). Anterior part of mesonotum with two pairs of supernumerary black spots: a pair of long oval spots before dorsocentral bristles at termination of branches of transverse suture; a pair of smaller oval spots, each situated between presutural and anterior notopleural bristles. Third to fifth abdominal tergites each with a pair of black spots, fifth tergite only 1.4 times as long as fourth. Postpedicel short, 1.3 times as long as wide. Apical process of anal cell short, entire cell three times as long as process (the latter half as long as remainder of cell). 4.4 mm. Argentina: Tucumán. ♂ **argentiniensis,** new species (p. 337)

— Wing pattern normal. Anterior portion of mesonotum without black spots. Abdomen of male with only one pair of elongate lateral black spots on fifth tergite 21

21. Scutellum with an apical brown dot. Apical band of wing not separated from costa by a hyaline line. The broad brown basal band attains posterior wing margin. Anteromedian portion of second basal cell hyaline. 7 mm. Colombia . . . . ♂ **arsinoë** Hering

— Scutellum entirely yellow. Apical band of wing separated from costa by a narrow hyaline border; basal band abbreviated, not attaining posterior wing margin. 4.5 mm. Perú . . . . ♂ **separata** Hendel

22. Wing with modified wing pattern as in *argentiniensis*. Abdominal tergites in both sexes with four pairs of lateral black spots; third and fourth tergites of male and third to sixth tergites of female each with a pair of lateral black spots (the pair on third tergite may be absent). Lateral brown spots of postscutellum sometimes absent. Eyes in profile 1.6–1.7 times as high as wide. Postpedicel long, 1.6–1.7 times as long as wide. Fifth abdominal tergite of male unusually long, 2.0–2.2 times as long as fourth. Ovipositor sheath slightly longer than basally wide; thorax only 1.9–2.0 times as long as sheath. Apical part of ovipositor lanceolate in dorsal view, with apex somewhat delimited in lateral view. 3.6–4.1 mm. St. Vincent (island); Paraguay; Argentina: Córdoba, Santa Fé, Tucumán, Jujuy, Chaco, Misiones . . . . . ♂ ♀ **incompleta** (Williston) (p. 362)

— Wing with the usual pattern 23

23. Only median third of mesonotum dusted densely with white pruinosity, the lateral thirds shining, bare. Abdomen of male with 10 pairs of lateral black spots, second to fourth tergites each with a pair; fifth tergite of male 1.7 times as long as fourth. Eyes in profile 1.7 times as high as wide. Postpedical short, only 1.2 times as long as wide. Inferior mesopleural bristle absent. Dorsocentral bristle inserted in anterior fifth of distance between suture and supra-alar bristles. 3,6 mm. Chile.
♂ **unifascia** Hendel (p. 408)

— Mesonotum normally dusted, except for a narrow hind margin. Preabdomen with lateral black spots similar to *incompleta*. Black spot on pleurotergites sometimes absent. Eyes in profile twice as high as wide. Postpedicel 1.4 times as long as wide. Fifth abdominal tergite of male short, only 1.3 times as long as fourth. Ovipositor sheath almost as long as width at base; thorax 2.5–2.8 times as long as wide. Apical part of ovipositor very narrowly lanceolate in dorsal view, with apex somewhat delimited in lateral view. Inferior mesopleural bristle distinctly shorter and much weaker than superior. Dorsocentral pair inserted in anterior third of distance between suture and supra-alar bristles. 3.8–4.8 mm. Brazil; Argentina: Tucumán, Entre Ríos.
♂ ♀ **costalimai,** Blanchard (MS.) new species (p. 344)

24. Mesonotum wholly bright reddish brown dusted, without shining bare hind margin in front of scutellum and with the following special black markings: two lateral black vittae not attaining the anterior margin nor scutellar suture, a pair of circular black spots each between presutural and anterior notopleural bristles and the usual black spots on hind region which are elongated toward the transverse suture. Mediotergite shining dark brown, pleura yellowish brown, inferior part of sternopleuron dark brown. Abdomen with three pairs of lateral black spots. 10 mm. Brazil . . . . ♂ **quadrivittata** Lutz and Lima

— Mesonotum normally dusted with posterior margin bare and shining, without black vittae or black spots on anterior region. (*conjuncta* group) . . 25

25. Apical band of wing separated from costa by a narrow hyaline border. Abdomen with four pairs of lateral black spots, second to fifth tergites each with a pair. Second basal cell almost entirely hyaline. 5 mm. Perú . . . . ♂ **titschacki** Hering

— Apical band not separated from costa, submarginal cell without hyaline spot. Bands of wing unusually broad, reddish yellow in color. Abdomen with only two pairs of lateral black spots on fifth tergite. Postpedicel approximately 1.5 times as long as wide. Second basal cell yellow ,with an anteromedian hyaline spot. 6.5 mm. Perú; Bolivia.
♂ **conjuncta** Hendel

— Apical band of wing not separated from costa, submarginal cell with hyaline marginal spot bordered with brown. Abdomen with three pairs of lateral black spots, third to fifth tergites each with one pair; fifth tergite approximately 1.5 times as long as fourth. Eyes in profile twice as high as wide. Postpedicel long, 1.7 times as long as wide. Dorsocentral bristles inserted halfway between suture and supra-alar bristles. Inferior mesopleural bristle absent. Maxillary palpi unusually short and almost semicircular in shape. 5.6 mm. Panamá.
♂ **brevipalpis** new species (p. 339)

26. Two black to dark brown markings on sides of mesonotum: a short vittalike dot below posterior notopleural bristle and a semicircular spot above wing base, below supra-alar bristle. (A small group with exceptional characters.) 27

— No black markings below posterior notopleural bristle or above wing base . 30

27. Hind region of mesonotum without black spots, even the usual ones absent; four black markings on pleura: a horizontal short linear vitta on propleuron attaining upper margin of first spiracle, a double spot on inferior margin of ventral and dorsal pleurotergites, an oval spot above hind coxa, and another on lower hind region of pteropleuron. Yellow apical band entirely separated from rest of wing pattern. 4 mm. Puerto Rico . . . . ♀ **propleuralis**, new species (p. 385)

— Hind region of mesonotum with the usual pair of lateral black spots, each between prescutellar and upper postalar bristles; between these another pair of black spots nearer to scutellar suture than the usual pair (sometimes these are absent in *rudolphi*). Propleura without black markings. Apical band of wing connected with rest of pattern in submarginal cell (*atelesta* group) 28

28. Pleura with three black markings: inferior part of sternopleuron entirely black, one black spot on pteropleuron and another above hind coxa. The four black spots on hind region of mesonotum almost equal in size. Black markings below posterior notopleural bristle and above wing base form an interrupted black vitta. Mesonotum whitish yellow dusted, with three reddish brown dusted vittae (the two lateral are broad, the median is linear). Scutellum with a pair of laterobasal brown spots. Third to fifth abdominal tergites each with a pair of lateral black spots. Basal part of second basal cell hyaline. 3–4 mm. Perú.
♂ **diagramma** Hendel

— Pleura without black markings. Second basal cell wholly yellow. Larger species 29

29. Inner pair of four black spots on hind region of mesonotum considerably smaller than lateral pair, rarely absent. Third and fourth abdominal tergites of male each with one pair of black to blackish brown small lateral spots (third tergite sometimes spotless); fourth to sixth tergite of female each with one pair of lateral black spots (sometimes third tergite also marked with a pair of dark spots). Subapical yellow band of wing sometimes very pale. Dorsocentral bristles inserted in line with supra-alar bristles or slightly before them. 6.5–7.5 mm. Southern Brazil: São Paulo, Santa Catarina . . . . ♂ ♀ **rudolphi** (Lutz and Lima) (p. 395)

— Four black spots on hind region of mesonotum equal in size. Third to fifth tergites of male each with a pair of lateral black spots, the pair on fifth tergite usually elongated. Dorsocentral bristle pair slightly behind line of supra-alars. Black spot below posterior notopleural bristle large. 6mm. Bolivia . . . . ♂ **atelesta** Hendel

30. Hind region of mesonotum with three black spots, a median spot between the usual pair. 5 mm. Paraguay . . . . . . ♂ **tripunctata** Hendel

— Hind margin of mesonotum with the usual pair of lateral black spots (*obliqua-monostigma-minuta* group) 31

31. Pteropleuron with a black spot. Apical yellow band separated from subapical at anterior margin of wing, but connected to subapical band in apex of first posterior cell. 4 mm. Puerto Rico . . . . . . ♂ **pura** Curran

— Pteropleuron without black spot 32

32. Wing pattern as in *atimeta:* a well-delimited large roundish opaque black spot on apical process of anal cell. Sternopleuron black except for a narrow yellow upper margin bordered by a narrow black vitta along suture. One black spot above hind coxa and a double one on inferior portion of pleurotergites. Second basal cell yellow with a hyaline dot. Second to fifth tergites each with a pair of lateral black spots, the pair on fifth tergite elongated. 4.7 mm. Perú . ♂ **kelloggi** new species (p. 365)

— Wing with the usual or with a modified pattern. Sternopleuron yellow with or without black spot 33

33. Pleura with three black spots: one on sternopleuron, one above hind coxa, and one on pleurotergites. Wing pattern normal 34

— Pleura with two black spots: one above hind coxa and one on inferior part of pleurotergites 35

— Pleura with only one black spot, which is on inferior part of pleurotergites. Mesonotum with three indistinct linear structural vittae of darker color, visible only from behind 36

— Pleura without black spots 38

34. Second basal cell almost entirely hyaline. Second to fifth abdominal tergites of male and second to sixth of female each with a pair of lateral black spots. Ovipositor sheath as long as last three tergites together. Posterior pair of gonopophyses much reduced and short in male epandrium. 3.3–3.9 mm. United States of America; México? . . . ♂ ♀ **obliqua** Say

— Second basal cell yellow with a large anteromedian hyaline spot. Only three pairs of lateral black spots on abdominal tergites of male. Posterior pair of gonapophyses as long as, but more slender than, anterior. 4 mm. Brazil: Distrito Federal . . . . ♂ **jonasi** (Lutz and Lima)

35. Wing pattern modified; subbasal band absent except for a brown apical part on tip of fourth longitudinal vein. Third and fourth abdominal tergites of male and third to sixth tergites of female each with a pair of lateral black spots; fifth tergite of male with two pairs (sometimes spotless). Eyes in profile 1.6–1.7 times as high as wide. Postpedicel only 1.1–1.2 times as long as wide. Fifth tergite of male elongated, 2.0–2.2 times as long as fourth. Ovipositor sheath slightly longer than basal width; thorax only 1.9–2.0 times as long as sheath. 3.6–4.1 mm. St. Vincent (island); Paraguay; Argentina . . ♂ ♀ **incompleta** (Williston) (p. 362)

— Wing pattern normal. Only fifth abdominal tergite of male (which is 1.5–1.6 times as long as fourth) with one pair of lateral black spots; abdomen of female spotless. Postpedicel longer 1.5–1.6 times as long as wide. Ovipositor sheath shorter than width at base; thorax 4.4–4.6 times as long as sheath. 4.4–5.1 mm. Costa Rica; Panamá.

♂ ♀ **deflorata** Hering (p. 350)

36. A well-delimited small oval opaque brownish black dot at apical process of anal cell. Fifth abdominal tergite of male only 1.5 times as long as fourth. Eyes in profile wide-oval, only 1.4 times as high as wide. Dorsocentral bristles inserted almost in transverse suture. Third to fifth abdominal tergites each with a pair of rounded lateral black spots. 2.5–2.8 mm. Southern Brazil: São Paulo, Santa Catarina.

♂ **minuta** Hering (p. 370)

— A blurred translucent dark brown cloud on apical process of anal cell. Eyes in profile higher, 1.7 times as high as wide. Dorsocentral bristles inserted in anterior third to fourth of distance between suture and supra-alar bristles. Fifth tergite of male with two pairs of lateral black spots. Slightly larger species, 3.5–4.0 mm 37

37. Apex of scutellum with a small brown dot. Inferior mesopleural bristle shorter and much weaker than superior. Second abdominal tergite of both sexes with a pair of small brown to black dots. Ovipositor sheath relatively long, thorax only 2.0–2.3 times as long as sheath. 3.6–4.0 mm. United States of America: California, Arizona.
♂ ♀ **cressoni,** new species (p. 347)

— Scutellum entirely yellow. Inferior mesopleural bristle absent. Second abdominal tergite of both sexes without brown or black lateral spots. Ovipositor sheath relatively shorter, thorax 2.7–2.8 times as long as sheath. 3.5–3.6 mm. Perú . . . ♂ ♀ **monostigma** Hendel (p. 373)

38. Wing pattern modified as in *pura:* apical yellow band separated from subapical at anterior wing margin, but broadly connected with subapical band in apex of first posterior cell. At least apical part of abdomen entirely black, basal part yellow, without black spots. 3.4 mm. Puerto Rico; Cuba . . . . ♀ **discolor** (Loew) (p. 353)

— Wing pattern normal. Abdomen yellow with lateral black spots on tergites 39

39. Second basal cell entirely yellow. Second to sixth abdominal tergites of female each with one pair of lateral black spots. Brazil.
♀ **biseriata** (Loew)

— Second basal cell yellow with large hyaline spot; a well-delimited small opaque brownish black spot at apical process of anal cell, distad to anal vein. Dorsocentral bristles inserted almost in transverse suture 40

40. Smallest species of the genus, testaceous yellow. Sometimes a brownish black spot present on pleurotergites. Third to fifth tergites of male each with a pair of roundish black lateral spots. Eyes in profile wide-oval, only 1.4 times as high as wide. Fifth tergite of male only 1.5 times as long as fourth. 2.5–2.8 mm. Brazil: São Paulo, Santa Catarina.
♂ **minuta** Hering (p. 370)

— Slightly larger species, pale yellow. Third and fourth abdominal tergites of male each with a pair of small black dots, fifth tergite spotless, very long, 2.3–2.5 times as long as fourth. Eyes in profile higher oval, 1.8 times as high as wide. 3.8–4.0 mm. Southern Brazil: São Paulo.
♂ **salesopolitana,** new species (p. 400)

Tomoplagia argentiniensis, new species

FIGURES 98,*a-d;* 102,*n;* PLATE 22, FIGURE 13

A well-defined aberrant species of the *arsinoë* group with the same modified wing pattern as *incompleta,* differing from the allied species in having two pairs of lateral black spots on the anterior region of the mesonotum.

MALE: Length of body 4.4 mm.; wing 3.9 mm. long, 1.8 mm. wide, 2.1 times as long as wide.

Head entirely testaceous yellow; mesofacial plate very sparsely whitish dusted, oral margin raised and slightly prominent. Head 0.66 mm. long, 1.21 mm. wide, and 1.00 mm. high. Frons 0.54 mm. at vertex, 0.38 mm. broad at anterior margin. about as broad as one eye, and 0.43 mm. long in the medial line. Ocellar plate raised. Antennae and maxillary palpi testaceous yellow. Postpedicel 0.23 mm. long and 0.18 mm. wide, almost 1.3 times as long as wide; seta shining black, bare, only the basal third testaceous yellow; approximately twice as long as the postpedicel. Labella yellowish brown. Eye in profile 0.85 mm. high and 0.50 mm. wide, 1.7 times as high as wide. Inferior part of cerebral plate very slightly raised, invisible in profile. Genae below the eyes (0.07 mm.) and inferior part of the postcranium in profile (0.11 mm.) very narrow.

Cephalic bristles brownish yellow, except for black genal bristle; considering the insertion points, the usual garniture present, but nearly all bristles of the type specimen are broken except for lower orbital, ocellar, and occipital bristles. Genal hairs brownish black.

Thorax with scutellum 1.7 mm. long and 1.5 mm. wide, dark testaceous yellow; mesonotum densely dusted with light brownish yellow, golden iridescent dusting and pale yellow appressed hairs, except for the shining hind margin. Anterior region of mesonotum silky whitish dusted, this whitish dusted area ending posteriorly in two wedge-shaped processes between the dorsocentral bristles, reaching level of supra-alar bristles. Mesonotum with the following black spots: the usual pair, each oval one between the prescutellar and upper postalar bristles; one pair of long-oval black spots just before dorsocentral bristles, each one at upper termination of short branches of transverse suture; one pair of small wide-oval spots, each situated between presutural and anterior notopleural bristle, and a black dot behind wing base. The special black markings on anterior region of mesonotum make this species easily distinguishable from *incompleta*. Pleurae shining, except for major part of mesopleuron (anepisternite); on central part of sternopleuron (katepisternite) is a large trapezium-shaped black spot, and ventral pleurotergite is almost wholly black except the narrow brownish black upper margin. Scutellum shining, with some appressed brownish yellow hairs. Postscutellum and mediotergite shining golden brown; postscutellum yellowish dusted with lateral parts black in color; these lateral black spots continue in a pair of narrow black vittae which border lateral margins of the shining mediotergite.

Thoracic bristles brownish yellow; lower mesopleural bristle considerably shorter and weaker than superior. Dorsocentrals situated approximately in anterior third of distance between transverse suture and supra-alar bristle, their spacing slightly wider than the prescutellars, which stand approximately in posterior fourth of distance between supra-alar and upper postalar bristle. Apical pair of scutellar bristles slightly convergent and two-thirds as long as the divergent basal pair.

Wings with the same modified wing pattern as in *incompleta;* subapical band completely absent, except for brown spot on tip of fourth longitudinal vein. A small hyaline dot at apex of second longitudinal vein. Apical half of humeral cross-vein brownish black. Basal band abbreviated and terminated in a subtriangular translucent brown spot at tip of apical process of anal cell. Anterior half of second basal cell hyaline. Fourth longitudinal vein (M_1) densely and very distinctly setulose on upper surface of wing almost to tip of vein; lower surface very loosely setulose between base and inner cross-vein. Subcostal cell (stigma) 3 times as long as broad at base. First section of costa 0.66, second 1.25, third 0.68, and fourth 0.50 mm. long. Basal section of M_1 1.11, penultimate 0.25, and ultimate 1.16 mm. long. Inner cross-vein 0.33 mm. long and nearly parallel to outer cross-vein (0.53 mm.). Anal cell, including apical process, 3 times as long (0.77 mm.) as apical process itself.

Halteres yellow. Legs testaceous yellow, without special armature.

Preabdomen 1.9 mm. long and 1.5 mm. wide, shining dark testaceous yellow, covered with appressed brownish black hairs and marked with four pairs of lateral black spots, one each on second to fifth tergites; spots on third and fourth tergites rounded, spots on second tergite narrow, long, transversely placed, and spots on fifth tergite long-oval in shape. Fifth tergite approximately 1.4 times as long (0.57 mm.) as fourth (0.41 mm.).

Postabdomen testaceous yellow; epandrium very wide-oval, with normally shaped surstyli and with two pairs of shining black gonapophyses, posterior pair shorter and more acute than anterior.

Female: Unknown.

Types: Holotype ♂ (FML), Argentina, Tucumán, Quebrada de Cainzo, near Tafi Viejo, November 18, 1950, R. Golbach.

Tomoplagia brevipalpis, new species

Figures 91; 97,*e;* Plate 19, figure 2

This rather large species belongs to the *conjuncta* group and may be distinguished from the related species by the characters of the wing and by the black markings of the abdomen.

Male: Length 5.6 mm.; wing 5.6 mm. long and 2.5 mm. wide, 2.2 times as long as wide.

Head 1.07 mm. long, 1.75 mm. wide, and 1.59 mm. high, ochraceous yellow, mesofacial plate, lunula, and lower half of the occiput paler in color; frons at vertex 0.93, at anterior margin 0.68 mm. wide, and in median line 0.75 mm. long, considerably shorter than wide at vertex. Frontal vitta bare and slightly darker than genovertical, parafacial, and ocellar plates, except for a wedge-shaped area in front of ocellar plate. Mesofacial plate impressed, oral margin raised and but very slightly prominent. Ocelli transparent whitish. Antennae and maxillary palpi of same color as head, palpi rather unusually short and wide.

Postpedicel (third antennal segment) 0.34 mm. long and 0.20 mm. wide, 1.7 times as long as wide. The shining seta more than twice as long as the postpedicel, with basal two-thirds yellowish and with apical third blackish brown. Eyes in profile exactly twice as high as wide, sparsely beset with tiny hairs, erect and white.

Head bristles and hairs are yellow to brownish yellow, rather acute, not flattened; three incurved lower orbital bristles (*ori*), all equally long, and about as long as anterior pair of recurved upper orbital bristles (*ors*). Posterior pair of *ors* slightly shorter, the strongly divergent ocellar and outer vertical bristles are slightly longer than these; inner vertical bristles are the longest. There is a weak but distinct genal bristle, darker in color than the others.

Thorax pale ochraceous yellow in ground color, 2.3 mm. long and 1.8 mm. wide; mesonotum densely covered with pale brownish yellow dusting and with short hairs of the same color, except the narrow bare posterior part in front of scutellum, which is subshining and sparsely whitish dusted; in the dusting of mesonotum there are three indistinct and nearly linear vittae, slightly darker in colour: one in median line and two lateral in line of dorsocentrals; on posterior part of mesonotum are a pair of rather rounded black spots, each between the upper postalar and the prescutellar bristles, and another pair of black spots, each beneath the wing basis, on the side of the postalar callosity.

The long and strong thoracic bristles are brownish yellow and rather acute, not flattened; on the examined specimen only one mesopleural bristle present on each side (the upper pair); dorsocentral pair is situated about in middle between transverse suture and (imaginary) transverse supr-aalar line.

On the whitish dusted pleurae no black or brown spot present but a triangular black marking occurs on each side of postscutellum. Scutellum ochraceous yellow, subshining, with some brownish yellow appressed hairs about the basal pair of scutellar bristles. Mediotergite shining and intensively brownish yellow.

Coxae and legs entirely ochraceous yellow, with bristles and hairs including row of densely placed short anterodorsal bristles on hind tibiae, yellow to brownish yellow.

Halteres pale ochraceous yellow.

Wings with the usual pattern of the genus; basal band present but does not attain posterior wing margin, forming at apical process of anal cell a large, diffuse, translucent, and dark brown spot, extending over anal vein; costa at humeral cross-vein (*th*) and at tip of subcosta not blackened; anterior half of *th* brownish black; stigma long, about

2.4 times as long as wide at base. First costal section 0.82, second 1.97, third 1.00 and fourth 0.68 mm. long; first section of fourth longitudinal vein (M_1) 1.59, penultimate 0.45, and ultimate 1.54 mm. long; inner cross-vein (*ta*) 0.43, outer (*tp*) 0.84 mm. long, *ta* about as long as distance between cross-veins, and slightly more oblique than *tp*; fifth longitudinal vein, which borders posteriorly discal cell, is but slightly excurved. Anal cell long (1.11 mm.), its apical process (0.45 mm. long) slightly shorter than rest of cell; whole cell almost 2.5 times as long as apical process itself.

Preabdomen rather shining, clear brownish yellow, 2.9 mm. long and 1.7 mm. wide, rather elongate; tergites sparsely covered with dark brownish hairs; each of the third to fifth tergites with pair of relatively small, brownish black lateral spots; pair on fourth tergite is largest and pair on fifth is smallest. Fifth tergite 0.43 mm. long, nearly 1.5 times as long as the fourth.

Epandrium oval, yellow; two pairs of shining black gonapophyses, the posterior pair acute and tiny.

FEMALE: Unknown.

TYPES: Holotype ♂, (USNM 61717), Panamá, El Cermeño, December 16, 1941, J. Zetek.

Tomoplagia carrerai, new species

FIGURES 96,*a-c;* 97,*j;* PLATE 21, FIGURE 9

A very well defined Brazilian species of the *pleuralis* group, which is readily distinguished from all known *Tomoplagia* in having black outer vertical, outer occipital, and genal bristles, and black genal hairs, and in having a pair of black spots on sides of the postalar callosity, between the lower and upper postalar bristles.

MALE: Length 5.1 (4.9) mm.; wing 4.5 (4.5) mm. long and 2.0 (1.8) mm. wide, 2.3 (2.5) times as long as wide.

Head ochraceous yellow, antennae and mouthparts testaceous yellow, excepting brown prementum and labellae. Head 0.77 (0.88) mm. long, 1.38 (1.38) mm. wide, and 1.25 (1.18) mm. high. Frons at vertex 0.73 (0.66), at anterior margin 0.57 (0.54) mm. wide, and in the median line 0.54 (0.52) mm. long, hardly wider at anterior margin than long; unicolored, only the genovertical plate with grayish tinge; ocellar plate among the transparent yellow ocelli is blackish brown. Upper half of occiput testaceous yellow. Oral margin of mesofacial plate raised and prominent.

Postpedicel oval, 0.27 (0.27) mm. long and 0.20 (0.18) mm. wide, 1.35 (1.5) times as long as wide. Seta bare and shining brownish black, except the testaceous yellow basal third; nearly three times as long as postpedicel. The eyes, in profile, 1.6 times as high as wide.

Head bristles somewhat flattened, brownish yellow, except outer vertical, outer occipital, and genal bristles, and hairs on genae, which are black. This is a very unusual character in this genus. Three pairs of incurved lower orbital bristles, all the same length and hardly longer than the considerably thicker posterior pair of recurved upper orbital bristles (*ors*). Anterior pair of *ors* as long as divergent ocellar and outer vertical bristles; the convergent inner vertical bristles are longest and strongest of all. Two to three pairs of well-developed genal bristles present among the black hairs, the latter are only slightly shorter but much weaker than the bristles.

Thorax 2.2 (2.0) mm. long and 1.5 (1.4) mm. wide, ochraceous yellow; mesonotum strikingly vittate and, except the narrow shining ochraceous yellow hind margin, densely covered with reddish brown dusting except for two broad, whitish dusted vittae separated in median line by a reddish brown linear vitta; each of these densely white dusted vittae (in which the dorsocentral and prescutellar bristles are inserted) is broader than the reddish brown dusted lateral vittae, which terminate in the usual black spots situated between the upper postalar and prescutellar bristles; the white dusted vittae are covered with pale yellow and the reddish brown ones with black hairs. On hind part of mesonotum are two pairs of oval black spots, placed in transverse row—the inner pair situated in front of scutellum, and present in most all known species of *Tomoplagia* (it is homologous to the outer pair of black spots in the *atelesta* group); each black spot of the supernumerary outer pair of black spots situated between upper and lower pair of postalar bristles (*pa*), immediately above the lower *pa*; black spot beneath the wing base. Pleura ochraceous yellow, shining, darker below, with four black spots: a horizontal broad vittalike one in the middle third of sternopleura, a narrow vittalike one situated on upper margin of sternopleura before the sternopleural bristle, a large oval one above hind coxa, and a wide stripelike one on lower half of ventral and on inferior margin of dorsal pleurotergite.

Scutellum shining ochraceous yellow, with some black hairs on hind half. Postscutellum shining testaceous yellow, with pair of triangular lateral black spots. Mediotergite in one specimen is entirely dark testaceous yellow, in the other one with two lateral black vittae united with the pair of lateral black spots of postscutellum.

Thoracic bristles brownish yellow except lower postalar pair (*pa*), which in both specimens examined are brownish black, and upper *pa* and the four scutellar bristles, which in one specimen are also brownish black, in the other are brownish yellow; two pairs of mesopleural bristles present, lower one dark brown to brownish black, much weaker than and about half as long as the upper one; dorsocentral bristle pair inserted about middle of distance between transverse suture and the (imaginary) transverse line between supra-alar bristles; apical pair of scutellar bristles convergent and may be crossed apically.

Coxae and legs testaceous yellow, but distitarsi of mid and hind legs slightly darkened, brownish; bristles and hairs of coxae and legs brownish yellow, except posteroventral row of long bristles on forefemora, the two or three preapical dorsal bristles of hind femora, the rather loose anterodorsal row of very short bristles on hind tibiae, and the hairs on hind femora, all of which are brownish black.

Halteres testaceous yellow.

Wings with intensively colored bands; the yellow apical band separated from costa by a hyaline line, ending in a dark brown dot (at

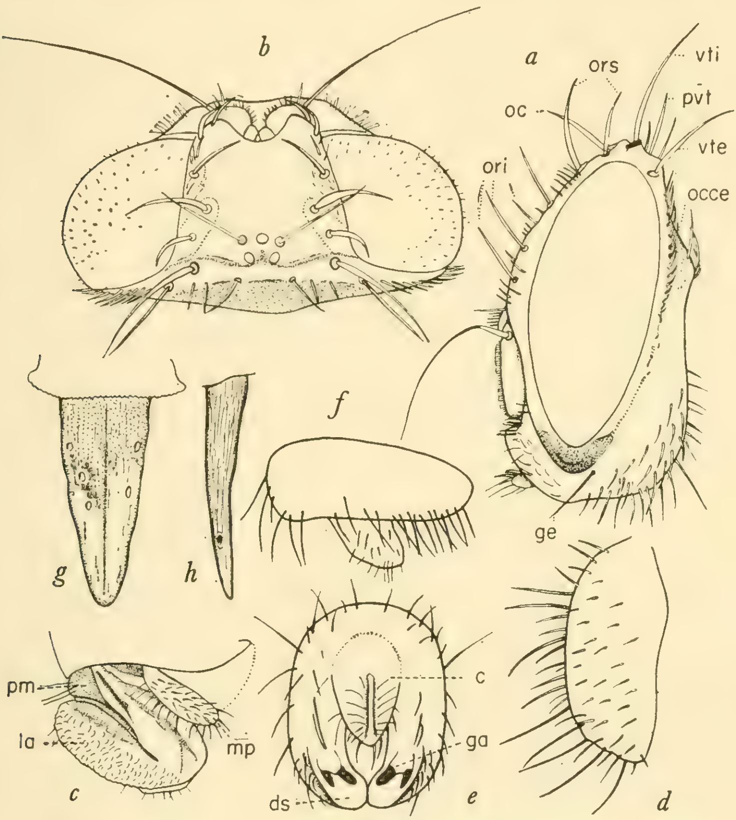

Figure 90.—*Tomoplagia stonei*: *a*, Lateral view of head; *b*, dorsal view of head; *c*, latera view of mouthparts; *d*, right maxillary palpus, superior surface; *e*, dorsal view of epandrium; *f*, lateral view of epandrium; *g*, dorsal view of ovipositor tip; *h*, lateral view of ovipositor tip.

tip of third longitudinal vein); basal band well developed, nearly attaining posterior wing margin, entirely translucent yellowish brown, with apex it extends broadly over petiole of anal cell; in middle of marginal cell a dark brown dot proximal to a hyaline one; the yellow of subapical band pale, bordered with a pale brown line. Stigma 2.6 times as long as wide at base. First costal section 0.68 (0.66), second 1.59 (1.50), third 0.91 (0.77), and fourth 0.59 (0.52) mm. long; first section of the fourth longitudinal vein 1.36 (1.28), penultimate 0.38 (0.36), and the strongly arched ultimate 1.46 (1.48) mm. long; inner cross-vein 0.34 (0.34), outer cross-vein 0.62 (0.52) mm. long; inner slightly shorter than distance between cross-veins; penultimate section of fifth longitudinal vein distinctly excurved. Anal cell with apical process 1.09 (1.02) mm. long; whole anal cell 2 (2.2) times as long as the apical process (0.51 (0.50) mm.); apical process longer than petiole of anal cell.

Preabdomen shining yellowish brown with reddish tinge, in one specimen mostly blackened and covered with appressed short black hairs. It is 1.9 (1.9) mm. long and 1.8 (1.7) mm. wide; each one of second to fifth tergites is marked with a pair of large lateral black spots; on third to fifth tergites, between the mentioned black spots and lateral margin may be present a smaller long-oval spot, sometimes connected with the usual ones; fifth tergite 0.61 (0.63) mm. long, 1.6 times as long as the fourth.

Epandrium testaceous yellow, oval, with relatively long surstyli; two pairs of shining black gonapophyses present, posterior pair slightly shorter than anterior one, and more acute.

Female: Unknown.

Types: Holotype ♂ (Dep. Zool., São Paulo), Brazil, São Paulo, Castelhanos, July 23, 1936, Lange de Morretes. Paratype (FML), same data as holotype.

Tomoplagia costalimai Blanchard (MS.), new species

Figures 98,*e-i;* 102,*o,p;* Plate 22, figure 14

Tomoplagia costalimai (Blanchard in litt.) Hayward, 1941, p. 95 (nomen nudum).
Tomoplagia distincta (Blanchard in litt.) Hayward, 1942, p. 32 (nomen nudum).

The only species without special characters of the aberrant *unifascia* group which may easily be recognized from the key.

Male: Length of body 3.8 mm.; wing 4.5 mm. long and 1.9 mm. broad, nearly 2.4 times as long as broad.

Head entirely testaceous yellow, 0.73 mm. long, 1.28 mm. wide, and 1.09 mm. high; oral margin of mesofacial plate raised and prominent, plate without whitish dusting. Frons at vertex as wide (0.54 mm.) as long in median line, 0.43 mm. wide at anterior margin. Antennae and the narrow, slightly curved maxillary palpi with rounded apex testaceous yellow, labellae yellowish brown. Ocellar plate but slightly raised. Postpedicel 0.25 mm. long and 0.18 mm. wide, nearly 1.4 times as long as wide; seta bare, shining black except for the testaceous yellow basal fourth, approximately 2.5 times as long as postpedicel. Eyes in profile 0.93 mm. high and 0.45 mm. wide, slightly more than twice as high as wide. Inferior part of cerebral plate very slightly raised, invisible in profile. Genae below eyes 0.09, inferior part of postcranium in profile 0.18 mm. broad.

Cephalic bristles brownish yellow, except for the golden shining brown genal bristle. The three pairs of incurved lower orbital bristles are subequal in length and slightly longer than the posterior pair of recurved upper orbital bristles (*ors*); anterior pair of *ors* subequal to outer vertical and ocellar bristles, which are slightly longer than any of these and slightly shorter than the inner vertical bristles.

Thorax with scutellum 1.8 mm. long and 1.5 mm. wide, testaceous yellow; mesonotum, except for the shining hind margin, evenly and densely covered with pale yellow pruinosity and with short appressed pale yellow hairs; there are no pruinose vittae. The usual pair of nearly round black spots present, each one between prescutellar and upper postalar bristles; a black dot behind (and beneath) wing base.

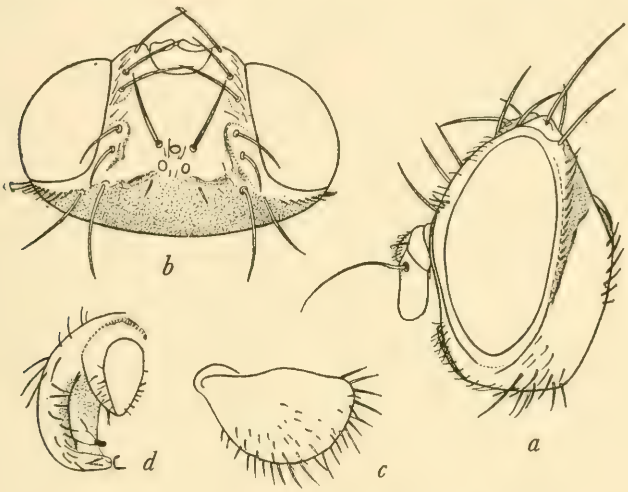

Figure 91.—*Tomoplagia brevipalpis:* *a*, Lateral view of head; *b*, dorsal view of head; *c*, right maxillary palpus, superior surface; *d*, dorsal view of epandrium.

Pleura subshining except for mesopleura and sternopleura. Two black spots on the pleura: a large one above hind coxa and a double one on inferior part of ventral and dorsal pleurotergites. Scutellum shining ochraceous yellow with some yellowish hairs on sides. Median third of postscutellum pale brownish yellow, the lateral thirds black. Mediotergite shining intensive testaceous yellow.

Thoracic bristles brownish yellow; lower mesopleural bristles shorter than the anterior pair; dorsocentral pair inserted approximately in anterior third of distance between transverse suture and supra-alar bristle (*sa*) and more widely placed than the prescutellar pair, which stands in posterior third of distance between *sa* and upper postalar bristles (in female almost halfway between these). Apical pair of scutellar bristles convergent and crossed, considerably shorter than basal pair.

Wings with the general pattern of the genus and with intensive yellow oblique bands; there is a small hyaline dot at tip of second longitudinal vein. Basal band abbreviated and ends in a diffuse dark brown spot at apex of apical process. Stigma approximately 2.6 times as long as broad at base. First costal section 0.64, second 1.45, third 1.00, and fourth 0.54 mm. long. Basal section of the fourth longitudinal vein 1.11, penultimate 0.41, and ultimate 1.50 mm. long. The 0.32-mm. inner cross-vein slightly more oblique than the 0.59-mm. outer one. Anal cell with apical process 0.85 mm. long, cell itself approximately 3.4 times as long as the short (0.27-mm.) apical process.

Halteres testaceous yellow, knob sometimes brownish.

Legs testaceous yellow.

Preabdomen 1.5 mm. long and 1.2 mm. wide, shining testaceous yellow with appressed brownish black hairs and with four pairs of lateral black spots; third to fourth tergites each with one pair, and fifth with two pairs, from which the posterior pair reaches the posterior margin. The 0.57-mm. fifth tergite is approximately 1.3 times as long as the 0.43-mm. fourth.

Postabdomen testaceous yellow; epandrium wide-oval, with normally shaped surstyli; only the anterior pair of the shining black gonapophyses present in this species.

Female: Body 4.6 (4.8) mm. long; wings 4.8 (4.8) mm. long and 2.0 (2.1) mm. broad, 2.4 (2.3) times as long as broad.

Head 0.82 (0.79) mm. long, 1.34 (1.30) mm. wide and 1.07 (1.16) mm. high. Frons at vertex 0.61 (0.59) and at anterior margin 0.50 (0.45) mm. broad, in the median line 0.56 (0.57) mm. long. Postpedicel 0.29 (0.27) mm. long and 0.18 (0.20) mm. wide, 1.6 (1.4) times as long as wide. Eyes in profile 0.91 (0.93) mm. high and 0.48 (0.52) mm. wide, 1.9 (1.8) times as high as wide. Genae below the eye 0.09 (0.09), inferior part of the postcranium in profile 0.24 (0.17) mm. wide. Thorax with scutellum 2.0 (2.0) mm. long and 1.4 (1.5) mm. wide.

Wings similar to those of the male. First costal section 0.71 (0.71), second 1.61 (1.63), third 0.93 (0.98), and fourth 0.57 (0.59) mm. long. Basal section of fourth longitudinal vein 1.17 (1.17), penultimate (median) 0.39 (0.38), and ultimate 1.57 (1.55) mm. long. Inner cross-vein 0.32 (0.33), outer cross-vein 0.61 (0.66) mm. long. Anal cell and apical process, 0.86 (0.86) mm. long, cell itself 2.7 (2.8) times as long as the apical process (0.32 (0.31) mm. long).

Preabdomen 1.6 (1.6) mm. long and 1.5 (1.5) mm. wide. Third to sixth tergites each with a pair of lateral black spots, which are subequal (the pair on the sixth tergite is slightly larger) and oval in shape. Sixth tergite (0.36 (0.30) mm.) slightly longer than fifth (0.32 (0.23) mm.).

Ovipositor sheath shining testaceous yellow, with dark brown apical margin and covered with fine dark brown hairs; it is dorsoventrally flattened in the specimens examined (basally only 0.11

(0.20) mm. long) and approximately as long (0.70 (0.79) mm.) as basally wide (0.70 (0.75) mm.); at apex it is 0.34 (0.38) mm. wide. Middle and apical parts of ovipositor pale testaceous yellow, apical part subshining, translucent and dorsoventrally flattened, in dorsal aspect narrow-lanceolate and slightly narrowed before the tip.

TYPES: Holotype ♂ (Coll. Blanchard), Argentina, Entre Ríos, Concordia, August 1936, trapped among citrus trees, K. J. Hayward No. 3284, "*T. costalimai* n. sp. det. E. E. Blanchard." Allotype ♀ (Coll. Blanchard), Argentina, Tucumán, Tucumán, August 16, 1936, K. J. Hayward, "No. 5. *T. distincta* n. sp. det. E. E. Blanchard." Paratypes: 2 (Coll. Blanchard), with same data as allotype; ♀ (FML), Brazil, "Citrus."

This species was taken in fruit-fly traps among sweet orange trees by Hayward (1941) in the provinces of Entre Ríos, Corrientes, and Misiones, and was reared from sweet orange and guava fruits (Hayward 1942) in Tucumán, Argentina. The types of this species and of *minattai* were kindly submitted for description and inclusion in this paper by Dr. E. E. Blanchard when he learned that a revision of the genus had been planned. The writer preserves the original manuscript names of Blanchard for both species, listed previously in applied entomological papers (Hayward 1941, 1942).

Tomoplagia cressoni, new species

FIGURES 95,*g-k;* 97,*c,d;* PLATE 20, FIGURE 7

This is the same species from southwestern United States, that Cresson (1907, p. 100) mentioned as "*Plagiotoma obliqua* Say" from Alamogordo, New Mexico, and which Hendel (1914, p. 38: "Cresson erwähnt diese Form als *T. obliqua* Say") considered conspecific with the Peruvian *monostigma*. It is closely related to the latter, more closely than to *obliqua* or to the Brazilian *biseriata*, nevertheless it may be distinguished from *monostigma* by the presence of a weak lower mesopleural bristle, by a small brown apical spot on the scutellum, and by the following comparative characters: the black spot on the ventral pleurotergite does not extend to the dorsal; on the second tergite there is always one pair of small pointlike dots, black to brown in color; the sheath of ovipositor is slightly longer than wide at base.

MALE: Length 3.7 (3.6) mm.; wing 3.6 (3.8) mm. long, and 1.5 (1.5) mm. wide, about 2.5 times as long as wide.

Head, together with antennae and mouthparts, entirely pale ochraceous yellow, 0.66 (0.70) mm. long, 1.07 (1.16) mm. wide and 0.98 (0.95) mm. high. Frons at vertex 0.57 (0.52) and at anterior margin 0.38 (0.36) mm. wide, and in the median line 0.48 (0.48) mm. long, shorter than wide at vertex; pale ochraceous yellow, only the genovertical and ocellar plates are slightly infuscated. Oral margin of mesofacial plate is raised and prominent. Postpedicel wide-oval, 0.22 (0.23) mm. long and 0.16 (0.15) mm. wide, 1.3 (1.5) times as long as wide; seta bare shining black, except the thickened basal third, which is ochraceous yellow; slightly more than twice as long as the postpedicel. Eyes in profile 1.7 times as long as wide, very sparsely beset with erect microscopic hairs. Maxillary palpi wide-oval.

The brownish yellow cephalic bristles hardly flattened; the weak posterior pair of the recurved upper orbital bristles (*ors*) the shortest, two-thirds as long as anterior pair; three incurved lower orbital bristles, the anterior slightly longer than the posterior *ors*, the two posterior ones equal to the anterior *ors* and to the outer vertical bristles; ocellar bristles divergent and slightly longer than the latter but the longest of the head bristles are the convergent inner verticals. One pair of relatively short but distinct genal bristles present.

Thorax 1.6 (1.4) mm. long and 1.2 (1.25) mm. wide, pale ochraceous yellow in ground color; mesonotum, except the shining bare posterior margin, evenly and densely covered with testaceous yellow dusting and with very short yellow appressed hairs; only a trace of three linear vittae on mesonotum, darker in color, one on median line and two lateral vittae in the line of the dorsocentrals; in some of the dried specimens these are grayish and more distinct. One pair of rounded black spots present on hind part of mesonotum, each one between the prescutellar and upper orbital bristles. On the whitish dusted pleura there is a single pair of black spots on the inferior margin of the raised ventral pleurotergite, which in the specimens examined does not project into the inferior margin of the dorsal pleurotergite; on sternopleura and above hind coxae there are testaceous yellow spots instead of black ones. Scutellum shining, pale ochraceous yellow or whitish in color, with a brown small apical spot between the apical scutellar bristles, bare, with some short brown hairs at hind margin; postscutellum without black spots, as shining testaceous yellow as the mediotergite.

Thoracic bristles relatively short but strong and brownish yellow. All specimens examined possess two pairs of mesopleural bristles, the upper bristle hardly twice as long as the much weaker lower one; the dorsocentral pair inserted in anterior third of distance between transverse suture and transverse line between the supra-alars.

Coxae and legs pale ochraceous yellow, with brownish yellow bristles and hairs, including the anterodorsal row of rather closely placed short bristles on hind tibiae.

Wing with the general pattern of the genus; the second basal cell hyaline, except for posteroapical part, which is yellow; basal band reduced to a diffuse small spot, transparent light brown, extending slightly over petiole of anal cell. Stigma about three times as long as wide at base. Costa at apex of subcosta not darkened, at most its fracture is bordered with a fine dark brown line. Anterior tip of humeral cross-vein dark brown only on the upper surface of wing; the neighboring part of costa remains yellow. First costal section (stigma) 0.61 (0.66), second 1.25, third 0.68, and fourth 0.45 mm. long; first section of the fourth longitudinal vein 1.25, penultimate 0.29, and ultimate 0.98 mm. long; inner cross-vein slightly shorter (0.27 mm.) than the distance between both cross-veins and nearly parallel to the 0.50-mm.-long outer cross-vein; both cross-veins placed slightly more obliquely than in *monostigma*. Anal cell with apical process 0.68 (0.72) mm. long. Process (0.23 (0.25) mm.) about half as long as the rest of the cell; whole anal cell nearly three times as long as apical process, which latter is slightly shorter than in *monostigma*.

Preabdomen shining ochraceous yellow, opaque, covered with very short brown hairs, 1.6 (1.7) mm. long and 1.4 (1.2) mm. wide; third and fourth tergites each with one pair and fifth tergite with two pairs of lateral black spots, all of which are smaller than in female; second tergite in all specimens examined with pair of pointlike lateral black to brown dots; fifth tergite 0.57 (0.52) mm. long, 1.7 (1.8) times as long as fourth. Sternites and membrane ochraceous to whitish yellow, sternites slightly shining.

Epandrium ochraceous yellow and wide-oval; only one pair of shining black gonapophyses present, posterior pair entirely absent.

Female: Length 4.0 (3.9) mm.; wing 4.1 (4.1) mm. long and 1.8 (1.6) mm. wide, 2.3 (2.5) times as long as wide. Head 0.75 (0.70) mm. long, 1.23 (1.20) mm. wide and 0.95 (0.91) mm. high. Frons at vertex 0.54 (0.52), at anterior margin 0.36 (0.36) mm. wide, and in median line 0.50 (0.48) mm. long. Postpedicel 0.25 (0.25) mm. long and 0.16 (0.16) mm. wide, 1.5 times as long as wide. Thorax, including scutellum, 1.6 (1.5) mm. long and 1.3 (1.3) mm. wide, with the same black markings as in the male.

Wings like those of male; first costal section 0.68 (0.63), second 1.41 (1.34), third 0.75 (0.85), and fourth 0.54 (0.52) mm. long; first section of the fourth longitudinal vein 1.45 (1.38), penultimate (between the cross-veins) 0.34 (0.29), and ultimate 1.02 (0.98) mm. long; inner cross-vein 0.27 (0.27), outer 0.59 (0.50) mm. long, inner slightly shorter than distance between both cross-veins; anal cell 0.72 (0.68) mm. long, including the apical process (0.25 (0.23) mm. long); whole anal cell is 2.9 (3) times as long as apical process itself.

Preabdomen 1.8 (1.7) mm. long and 1.4 (1.4) mm. wide; second to fourth tergites with the same markings as in male, fifth and sixth tergites each with a pair of lateral black spots; these black spots usually larger in female than in male; fifth tergite about as long (0.27 (0.27) mm.) as sixth (0.29 (0.27) mm.).

Sheath of ovipositor in specimens examined slightly flattened dorsoventrally and slightly longer (0.68 (0.73 mm.) than wide at base (0.64 (0.63) mm.); at apex 0.27 (0.27) mm. wide and at the base 0.43

(0.39) mm. high, shining testaceous yellow with a pair of round brown spots at apex, and covered with short brown appressed hairs. Only extreme apex of apical part of ovipositor visible; in the allotype it is more acutely pointed than in *monostigma*, and is translucent testaceous yellow.

TYPES: Holotype ♂ (USMN 61718), California, Ontario, 1940, "ex peach," L. D. Christensen. Allotype ♀, California, Pasadena, J. M. Aldrich. Paratypes: ♂, Arizona, Sedona, June 20, 1938, "foliage," L. D. Christensen; 2 ♀♀, California, Banning, "ex peach," L. D. Christensen. (Holotype, allotype, 2 paratypes in USNM; paratype in FML.)

Tomoplagia deflorata Hering

FIGURES 92; 97,*f;* PLATE 19, FIGURE 3

Tomoplagia deflorata Hering, 1937, p. 296.

Belongs to the *obliqua* group and is readily distinguished from its allies by the black markings, having two little black spots on the pleura, one on inferior part of ventral pleurotergite and a larger one above hind coxa; by the spotless abdomen in the female; and by the unique pair of small black spots on fifth tergite in male.

MALE (First description of male): Length 4.5 (4.4) mm.; wing 4.4 (4.6) mm. long and 2.0 (1.8) mm. wide, 2.2 (2.5) times as long as wide.

Head entirely pale yellowish ochraceous, sometimes infuscated, 0.79 (0.73) mm. long, 1.43 (1.39) mm. wide and 1.13 (1.11) mm. high. Ocelli very clear transparent yellow, nearly whitish. Frons at vertex 0.61 (0.59) and at anterior margin 0.41 (0.36) mm. wide, and in median line slightly longer (0.50 (0.45) mm.) than wide at anterior margin. Oral margin of the impressed mesofacial plate raised and slightly prominent. Postpedicel wide-oval, 0.22 (0.18) mm. long and 0.18 (0.16) mm. wide, only 1.1 (1.2) times as long as wide; seta brownish black, bare and shining, except the thickened basal part, which is brownish yellow, only 1.5 times as long as postpedicel. Eyes in profile slightly more than twice as high as wide, sparsely beset with tiny erect and whitish hairs. Maxillary palpi wide, sickle-shaped.

Head bristles brownish yellow with golden shine, slightly flattened; the weak posterior pair of the recurved upper orbital bristles (*ors*) is shortest, equal in length to the parallel postvertical bristles; anterior pair of *ors* slightly longer than the three pairs of the incurved lower orbital bristles; outer verticals and divergent ocellar bristles about the same length and slightly longer than the anterior *ors;* the relatively short inner verticals the longest of all. One distinct pair of genal bristles present.

Thorax 2.2 (2.0) mm. long and 1.6 (1.6) mm. wide, ochraceous yellow in ground color; mesonotum densely covered with clear brass-yellow dusting and with short and shining appressed hairs of the same color, except on the bare and subshining, narrow posterior part in front of scutellum; on mesonotum only a trace of three linear vittae, these slightly deeper in color than the surrounding, one in median line and two lateral vittae in the line of the dorsocentrals; on the shining hind part of mesonotum only one pair of round black spots, each between the upper postalar and prescutellar bristles, and a pair of round black dots, each beneath base of wing on side of the postalar callosity. On mesonotum are four very small brown circlets at base of dorsocentral and prescutellar bristles.

The long and strong thoracic bristles are brownish yellow with a golden shine. All the examined specimens have two pairs of mesopleural bristles, the lower pair considerably weaker; the dorsocentral

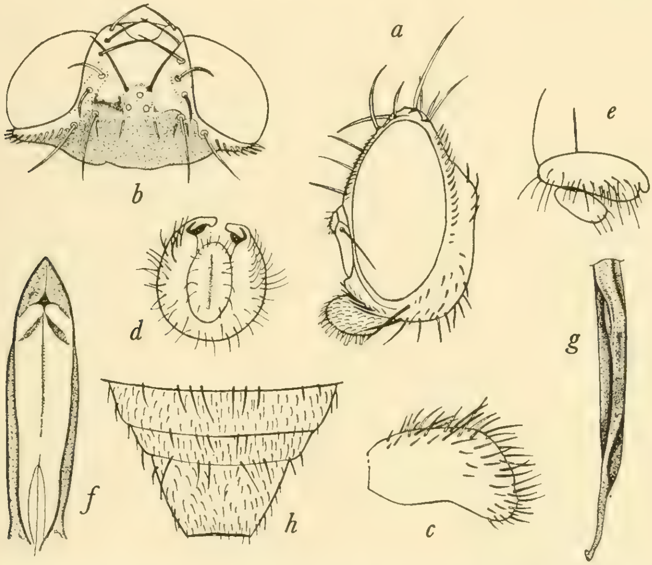

Figure 92.—*Tomoplagia deflorata: a*, Lateral view of head; *b*, dorsal view of head; *c*, right maxillary palpus, inferior surface; *d*, dorsal view of epandrium; *e*, lateral view of epandrium; *f*, ventral view of ovipositor tip; *g*, lateral view of ovipositor tip; *h*, dorsal view of apex of female abdomen.

pair situated near the anterior third of distance between transverse suture and (imaginary) transverse line between the supra-alar bristles; apical pair of scutellar bristles not crossed but nearly parallel or slightly convergent.

On the pale ochraceous pleura always only two pairs of black markings, one on inferior margin of ventral pleurotergite and a larger one above hind coxa, these may be sometimes insignificant but are present in all the examined species. Scutellum transparent pale yellow, subshining, covered with sparse whitish pruinosity and with some hairs between bases of the basal and apical scutellar bristles; postscutellum without black markings; mediotergite shining, transparent bronze colored, in dried specimens with or without irregular, intensely yellow, opaque spots.

Coxae and legs pale ochraceous yellow, except distitarsi of hind legs, and two last tarsomeres of midlegs, which are yellowish brown; bristles and hairs are yellow with brownish tinge, except anterodorsal row of rather closely spaced bristles of hind tibiae, which are slightly darker in color.

Halteres pale ochraceous, nearly whitish in color.

Wing with the usual pattern of the genus, but basal band abbreviated, forming at apical process of the anal cell a diffuse and rounded small translucent brown spot, hardly extending over anal vein; a very short section of costa blackened at tip of subcosta in some of the examined specimens; anterior third to half of humeral cross-vein brownish black. Stigma about 2.3 times as long as wide basally. First costal section 0.70 (0.68), second 1.52 (1.43), third 0.82 (0.86), and fourth 0.52 (0.50) mm. long; first section of the fourth longitudinal vein 1.36 (1.41), penultimate 0.38 (0.43), and ultimate 1.16 (1.09) mm. long; inner cross-vein (*ta*) 0.32 (0.32), outer (*tp*) 0.66 (0.61) mm. long, *ta* slightly shorter than distance between both cross-veins, and almost parallel to *tp;* fifth longitudinal vein which forms the posterior limit of the discoidal cell hardly excurved; the whole anal cell 0.98 (0.88) mm. long, 2.4 (3) times as long as apical process (0.41 (0.27) mm.).

Preabdomen subshining ochraceous yellow, opaque, sometimes infuscated and translucent. Basal double tergite (segments 1+2) covered with pale yellowish, other tergites mostly with dark brown appressed hairs; shape of preabdomen wide-oval, 1.6 (1.5) mm. long and 1.5 (1.4) mm. wide. Only fifth tergite marked with a pair of subquadrate lateral black spots; fifth tergite 0.47 (0.43) mm. long, 1.5 (1.6) times as long as fourth. Sternites, membrane, and postabdomen pale ochraceous yellow.

Epandrium wide-oval, nearly round; two pairs of shining black gonapophyses, posterior pair nearly as long as the anterior but very acute.

Female: Like male. Length 4.5 (5.1) mm.; wings 4.6 (4.5) mm. long and 2.0 (2.0) mm. wide. Head 0.75 (0.85) mm. long, 1.36 (1.31) mm. wide and 1.13 (1.13) mm. high. Frons at vertex 0.59 (0.60), at anterior margin 0.41 (0.40) mm. wide, and in median line 0.48 (0.54) mm. long. Postpedicel 0.20 (0.21) mm. long and 0.16 (0.16) mm. wide, 1.2 (1.3) times as long as wide. Thorax with scutellum 2.2 (2.1) mm. long and 1.6 (1.5) mm. wide, with the same black markings as in male.

Wings like those of male; first costal section 0.65 (0.68), second 1.52 (1.54), third 0.91 (0.79), and fourth 0.50 (0.50) mm. long; first section of the fourth longitudinal vein 1.38 (1.47), penultimate 0.38 (0.36), and ultimate 1.16–1.11 mm. long; inner cross-vein 0.32 (0.34), outer cross-vein 0.61 (0.63) mm. long; anal cell and process 0.82 (0.88) mm. long, apical process 0.22 (0.32) mm. long, whole anal cell 2.7 (3.5) times as long as apical process.

Preabdomen 1.6 (2.2) mm. long (without ovipositor) and 1.5 (1.5) mm. wide, without black markings in all the specimens examined; fifth tergite 0.23 (0.31), sixth 0.18 (0.29) mm. long; fifth tergite slightly longer than, to 1.2 times as long as, sixth.

Sheath of ovipositor in living specimens very probably short conical (length 0.48, basal width 0.70, apical width 0.29, and basal height 0.61 mm.) but in dried specimens is usually flattened (length 0.49, basal width 0.82, apical width 0.36, and basal height 0.23 mm.); about 1.5 times as wide basally as long; shining and brownish yellow in color, evenly covered with fine, yellowish brown, appressed hairs. Apical part of ovipositor lanceolate, with apex pointed.

Species orginally described from Costa Rica.

TYPE: In Hamburg Museum.

SPECIMENS EXAMINED: Panamá: El Cermeño, 28 ♂♂, 26 ♀♀, April 1939, fruit-fly trap, Zetek; ♀, Dec. 5, 1939, fruit-fly trap, Zetek; La Campana, 2 ♂♂, 3 ♀♀, March–April 1938, fruit-fly trap, Zetek; Arraijan, ♂, May 29, 1951, Zetek. Guatemala: Guatemala City, ♀, June 12, 1923, E. G. Smyth; Antigua, ♂, June 12, 1923, E. G. Smyth. (All specimens in USNM.)

Tomoplagia discolor (Loew)

FIGURE 97,*g*; PLATE 20, FIGURE 6

Trypeta discolor Loew, 1862, p. 64.
Tomoplagia discolor (Loew), Hendel, 1914, p. 34.

A single female specimen is at hand from Puerto Rico; it undoubtedly belongs to the well-defined species *discolor* (Loew), with modified wing pattern, although its abdomen is not entirely black. According to the absence of the black spots on the postscutellum, this species may belong to the *obliqua* group.

FEMALE: Length 3.4 mm.; wing 4.0 mm. long and 1.7 mm. wide, 2.3 times as long as wide.

Head entirely pale ochraceous yellow, including antennae and mouthparts; 0.75 mm. long, 1.30 mm. wide, and 1.09 mm. high. Frons at vertex 0.57 and at anterior margin 0.45 mm. wide, and in median line 0.57 mm. long. Postpedicel wide-oval, 0.27 mm. long and 0.23 mm. wide, nearly 1.2 times as long as wide; seta bare, shining black, except the thickened testaceous yellow basal fourth; only about twice as long as postpedicel. Eyes in profile 1.6 times as high as wide. Oral margin of mesofacial plate raised and considerably prominent.

Cephalic bristles brownish yellow, relatively short and somewhat flattened. Four pairs of incurved lower orbital bristles on both sides, the three anterior pairs about equal in length; the posterior pair much weaker and one half as long as the others. Two pairs of recurved upper orbital bristles, the anterior pair slightly longer but much stronger, the posterior pair slightly shorter and weaker than the anterior pairs of *ori*. The convergent inner vertical bristles (*vti*) almost as long but much stronger than the ocellars. The divergent outer vertical pair the longest of the head bristles, slightly longer but weaker than the *vti*, an exceptional character. A distinct pair of genal bristles present.

Thorax 1.8 mm. long and 1.4 mm. wide; mesonotum uniformly testaceous yellow, densely covered with short appressed brownish yellow hairs, except for shining posterior margin behind prescutellar bristles. Only one pair of black spots, each between the upper postalar and prescutellar bristles. Pleura pale ochraceous yellow, with lower region more testaceous yellow, without black spots, except a pointlike dot beneath base of wing; on inferior part of ventral pleurotergite above hind coxa and below bristle on sternopleura only reddish yellow spots present. Postscutellum and mediotergite shining testaceous yellow, opaque, without black spots. If we do not consider the modified wing pattern, this species belongs to the *obliqua* group. Scutellum shining ochraceous yellow with some brownish hairs at hind margin. Postscutellum entirely yellow.

Thoracic bristles brownish yellow; only the upper mesopleural bristle present and well developed; the posterior notopleural bristle much weaker than, and nearly half as long as, anterior; dorsocentral bristle inserted in anterior third of distance between transverse suture and supra-alar bristle; the apical pair of scutellar bristles convergent and crossed.

Coxae and legs without exceptional characters, ochraceous yellow, with bristles and hairs (including the anterodorsal row of rather loosely placed, relatively short bristles of hind tibiae) yellow.

Halteres ochraceous yellow.

Wings with the general pattern of the genus, but with apical band at anterior margin of wing separated at apex from first posterior cell, which is broadly connected with the next (subapical) band; the black dot of humeral cross-vein absent; second basal cell almost entirely hyaline; only basal part of basal band represented, forming a small diffuse transparent light brown spot on each side of anal vein; very characteristic is an opaque dark brown V-shaped marking in marginal cell above stigma, marking bifurcation of subapical and median bands; stigma 2.4 times as long as wide basally. First costal section 0.59, second 1.27, third 0.66, and fourth 0.34 mm. long; first section of the fourth longitudinal vein 1.18, penultimate 0.33, and ultimate 1.00 mm.

long; inner cross-vein (0.23 mm. long) is considerably shorter than distance between both cross-veins and is much more oblique than the 0.54-mm.-long, convex outer cross-vein. Anal cell and its 0.23-mm. apical process 0.73 mm. long, the whole anal cell being 3.2 times as long as the apical process.

Preabdomen covered with brownish appressed hairs, subshining and bicolored in the specimen examined; basal tergites (first to third) and lateral margins of fourth and fifth tergites ochraceous yellow, apical part black; 1.25 mm. long and 0.9 mm. wide; third and fourth tergites shortest; fifth tergite shorter (0.25 mm.) than sixth (0.32 mm.). Sternites and major part of membrane ochraceous yellow, only apical part of membrane black.

Sheath of ovipositor flattened, 0.70 mm. long, at base 0.68, at apex 0.29 mm. wide, basally 0.14 mm. high; nearly as wide at base as long; dark brown with yellowish tinge, except below on both sides of apical part, where there are testaceous yellow triangles separated by a rather wide dark median vitta.

Species originally described from Cuba.

TYPE:

SPECIMEN EXAMINED: Puerto Rico: Mayagüez, ♀ July, J. W. Ballock, "trap in guava tree, P. R. No. 1511" (in USNM).

Tomoplagia fiebrigi Hendel

FIGURES 98,*j-o;* 102,*j,k;* PLATE 22, FIGURE 15

Tomoplagia fiebrigi Hendel, 1914, p. 40.

A well-defined species with special characters, distinguished from all the other species by the presence of a median row of black spots between the usual lateral ones on the preabdomen.

MALE: Length of body 3.2 (4.0) mm.; wing 3.3 (4.0) mm. long and 1.3 (1.7) mm. broad, 2.3 (2.5) times as long as broad.

Head ochraceous yellow, frontal vitta testaceous yellow, frontal plates grayish and sparsely whitish dusted; 0.73 (0.80) mm. long, 1.18 (1.34) mm. wide and 0.91 (1.08) mm. high; ocellar plate scarcely raised.

Postpedicel short-oval, 0.20 (0.22) mm. long and 0.16 (0.19) mm. wide, only 1.2 (1.1) times as long as wide. Seta bare, shining black, except for the testaceous yellow, thickened basal fourth, almost 2.5 times as long as postpedicel. Frons at vertex 0.54 (0.61) and at anterior margin 0.41 (0.48) mm. broad, and at median 0.54 (0.59) mm. long. Antennae and mouthparts testaceous yellow. Inferior part of cerebral plate slightly raised. Eyes in profile 0.77 (0.91) mm. high and 0.50 (0.48) mm. wide, 1.5 (1.9) times as high as wide. Genae below eyes very narrow (0.07 (0.09) mm.), inferior part of postcranium in profile 0.16 (0.25) mm. wide.

Cephalic bristles brownish yellow; the usual garniture present. The genal bristle not very distinct.

Thorax with scutellum 1.5 (1.8) mm. long and 1.1 (1.4) mm. wide, testaceous yellow; mesonotum sparsely covered with whitish pruinosity and with appressed short yellowish hairs, except for the narrow shining hind margin; in the whitish pruinosity there are three indistinct pale brownish yellow vittae, one on median line and two laterals between prescutellar and dorsocentral bristles, ending in the usual pair of lateral black spots; these yellowish brown dusted vittae slightly broader than space between them. On sides of mesonotum only one black dot present behind wing base. Pleura sparsely white dusted, only region between and around sternopleural and pteropleural bristles fully shining, and mesopleura (anepisternite) dusted with testaceous yellow and subshining. Pleura characteristically marked with black in this species; postscutellum (except for a small anteromedian yellow dot), entire mediotergite and dorsal pleurotergite, ventral pleurotergite (except for superior margin), and adjacent lower hind part of pteropleuron (anepimeron) coherently black. Sometimes inferior third of pteropleuron black. Metapleura above hind coxa extensively black; this large black spot is separated from the above-mentioned black region by a testaceous yellow, narrow, horizontal vitta which begins at the haltera base, extending over superior margin of metapleura and of sternopleuron; the same metapleural black spot separated from the entirely black sternopleuron (katepisternite) by the testaceous yellow midcoxa.

Thoracic bristles brownish yellow and somewhat flattened; lower mesopleural bristle more than two-thirds as long as upper; posterior notopleural bristle but slightly shorter than anterior. Dorsocentral bristle pair placed near trasverse suture, in the anterior fourth of distance between suture and supra-alar bristle (*sa*); slightly more widely spaced than prescutellar pair, which is inserted approximately in hind third of distance between upper postalar and *sa* bristles.

Coxae and legs entirely testaceous yellow.

Wings with the usual pattern of the genus. Stigma 2.7 (2.9) times as long as broad at the base. First costal section 0.45 (0.54), second 0.95 (1.16), third 0.68 (0.82), and fourth 0.41 (0.50) mm. long. Basal section of the fourth longitudinal vein (M_1) 0.75 (1.02), penultimate (between both cross-veins) 0.24 (0.34), and ultimate 1.11 (1.20) mm. long. Inner cross-vein (0.20 (0.27) mm.) slightly more obliquely placed than outer (0.43 (0.53) mm.). Anal cell with the apical process together 0.54 (0.63) mm. long, and 3.8 (3.9) times as long as apical process (0.14 (0.16) mm.).

Halteres testaceous yellow.

Preabdomen 1.4 (1.6) mm. long and 1.2 (1.5) mm. wide, shining testaceous yellow, covered with appressed brownish yellow hairs; the black markings are very characteristic for this species. Third and fourth tergites each with three black spots, one median and two laterals extremely variable in size; the lateral spots situated near lateral margin of tergites, and median spot always reaches anterior margin; in one specimen fourth tergite is mostly black, the three black spots being separated only by two linear vittae. Fifth tergite with a pair of rounded subtriangular large black spots separated by a testaceous yellow narrow median vitta. Fifth tergite 1.8 (1.7) times as long (0.45 (0.59) mm.) as the fourth (0.25 (0.34) mm.). Intersclerital membrane and sternite testaceous yellow, with or without black parts.

Postabdomen testaceous yellow; epandrium oval with normally shaped surstyli and with two pairs of shining black gonapophyses subequal in length but anterior pair much thicker than posterior.

FEMALE: Like male. Body 4.1 (4.2) mm. long; wings 3.9 (3.9) mm. long and 1.6 (1.6) mm. broad, 2.4 times as long as broad.

Head 0.80 (0.80) mm. long, 1.32 (1.36) mm. wide, and 1.04 (1.11) mm. high. Frons at vertex 0.59 (0.57) and at anterior margin 0.45 (0.43) mm. wide, and in the median line 0.59 (0.54) mm. long. Postpedicel 0.20 (0.21) mm. long and 0.18 (0.19) mm. wide, only 1.1 times as long as wide. Eyes in profile 0.86 (0.73) mm. high and 0.52 (0.57) mm. wide, 1.6 (1.3) times as high as wide. Genae below eyes 0.08 (0.09) and inferior part of postcranium in profile 0.13 (0.13) mm. wide.

Thorax with scutellum 1.7 (1.8) mm. long and 1.4 (1.4) mm. wide, with the same characters as in male.

Wings like those of male. First costal section 0.57 (0.50), second 1.11 (1.09), third 0.75 (0.73), and fourth 0.50 (0.45) mm. long. Basal section of the fourth vein 0.98 (0.88), penultimate 0.29—0.35, and ultimate 1.29 (1.20) mm. long. Inner cross-vein 0.27 (0.25), outer 0.53 (0.50) mm. long. Anal cell with apical process 0.68 (0.68) mm. long, the whole cell 3.2 (3.4) times as long as entire apical process (0.18 (0.20) mm.).

Preabdomen 1.6 (1.6) mm. long and 1.5 (1.5) mm. wide. Third to fifth tergites each with three black spots, which are variable in size and shape; lateral spots are near lateral margin and usually long-oval in shape, median spots may be as large as, or considerably larger than, lateral spots, in shape transverse-oval to rhomboid. On sixth tergite a pair of lateral black spots, less widely spaced than those on anterior tergites, sometimes a small triangular median spot present, reaching anterior margin of the tergite. In some specimens the median black spots form an almost uninterrupted vitta. Sixth tergite (0.29 (0.38) mm.) slightly longer than fifth (0.25 (0.27) mm.).

Sheath of ovipositor usually dorsoventrally flattened (at base only 0.14 (0.16) mm. high) and entirely shining testaceous yellow, covered with appressed fine brownish yellow hairs; it is 0.52 (0.61) mm. long, at the base 0.73 (0.73) and at the apex 0.36 (0.38) mm. wide. In one specimen sheath is perfectly conical, without lateral edges; this was 0.77 mm. long, at the base 0.66, at the apex 0.34 mm. wide and in profile 0.57 mm. high at the base; very probably this is the original form of the ovipositor sheath. In some specimens apex of sheath is bordered with lighter or darker yellowish brown.

Apical part of ovipositor shining, translucent, testaceous yellow, wide lanceolate in dorsal aspect; apex with tiny dorsal hook.

Type locality: San Bernardino in Paraguay.

Types: In Natural History Museum, Vienna, and in the Hungarian National Museum, Budapest.

Specimens examined: Argentina: Córdoba, Sierra Córdoba, ♂, 3 ♀♀, January 5–14, Bridarolli, and Santa Fé, Piquete, ♂, January 15, 1930, Bridarolli (all in Coll. Colegio Máximo de San José, San Miguel); Corrientes, San Roque, ♀, February 1920, J. Bosq, "*T. dorsofasciata* n. sp. det. E. E. Blanchard" (Coll. Blanchard); Chaco, Colonia Benítez, ♂, December 7, 1949, R. Goldbach, Jujuy, Sierra Zapla, ♂, January 30, 1949, M. L. Aczél, Formosa, Pirane, ♀, December 29–31, 1948, R. Golbach; and Tucumán, El Naranjito, ♀, February 3, 1947, Ares (all in FML).

Tomoplagia formosa, new species

Figures 98,*p-s;* 102,*v;* Plate 23, figure 16

Similar to *reimoseri*, differing in the characters given in the key (p. 329).

Female: Length of body 4.5 mm.; wing 4.3 mm. long and 1.9 mm. wide, almost 2.3 times as long as wide.

Head testaceous yellow, except upper half of frons darker and mesofacial plate whitish dusted ochraceous yellow; 0.85 mm. long, 1.34 mm. wide and 1.13 mm. high. Ocellar plate only very slightly raised. Frons at vertex 0.61 and at anterior margin 0.41 mm. broad, and medially 0.60 mm. long, approximately as long as broad at vertex. Antennae and mouthparts testaceous yellow; maxillary palpi not curved, long-oval with widely rounded apex. Oral margin of mesofacial plate raised and considerably prominent. Postpedicel long oval, 0.27 mm. long and 0.18 mm. wide, 1.5 times as long as wide; setae shining black except for testaceous yellow basal fifth, and more than twice as long as postpedicel. Inferior part of cerebral plate only slightly raised. Eyes in profile 1.32 mm. high and 0.70 mm. wide, nearly 1.9 times as high as wide; inferior part of postcranium in profile 0.23, genae below eyes 0.11 mm. wide.

Cephalic bristles brownish yellow and somewhat flattened; the usual garniture present and the relation in length almost the usual, but in the specimen examined outer verticals much longer than ocellar and anterior pair of recurved upper orbital bristles. Genal bristle short but distinct by the brownish black color.

Thorax with scutellum 2.0 mm. long and 1.5 mm. wide, testaceous yellow in ground color; mesonotum covered with silky whitish pruinosity and with appressed thickish pale yellow hairs, except for posterior margin which is shining; in the dusting there are no vittae present. The usual pair of oval black spots relatively large, each situated between prescutellar and upper postalar bristles; a minute black dot behind and beneath wing base. Pleura shining, only inferior part of sternopleuron (katepisternite) sparsely dusted with whitish pruinosity; they are marked with three black spots as in *reimoseri* but the double one on inferior part of dorsal pleurotergite is as wide as on ventral. Scutellum shining testaceous yellow with some minute yellowish hairs at sides. Median part of postscutellum yellow, whitish dusted; lateral parts black, which continues in a pair of large lateral long-oval black spots on the shining yellowish red mediotergite.

Thoracic bristles brownish yellow and somewhat flattened; inferior mesopleural bristle but slightly shorter than superior; posterior notopleural bristle slightly shorter than anterior; dorsocentral pair inserted approximately in, or slightly before, anterior third of distance between transverse suture and supra-alar bristle, spaced slightly farther apart than prescutellar pair, which stands approximately in posterior fourth of distance between upper postalar and supra-alar bristles. Apical pair of scutellar bristles almost parallel and slightly shorter than basal pair.

Coxae and legs entirely testaceous yellow, without special characters.

Wings with the usual pattern of the genus; tip of humeral cross-vein brownish black; costa blackened at tip of humeral cross-vein and at tip of subcosta. Basal band abbreviated and terminated in a small diffuse brown cloud at tip of apical process of anal cell. Subcostal cell (stigma) 2.9 times as long as basally broad. First section of costa 0.63, second 1.25, third 0.80, and fourth 0.63 mm. long; basal section of fourth longitudinal vein 1.02 penultimate 0.38, and ultimate 1.36 mm. long. Inner cross-vein 0.30 mm. long and almost parallel to outer cross-vein (0.61 mm.). Anal cell with 0.34-mm. apical process 0.85 mm. long, the whole cell exactly 2.5 times as long as the entire apical process.

Halteres testaceous yellow with brownish knob.

Preabdomen 1.7 mm. long and 1.6 mm. wide, ground color subshining testaceous yellow, covered with appressed brownish yellow hairs. Third to sixth tergite each with pair of lateral black spots; black spots of third to fifth tergites small, rounded or long-oval, and placed in two parallel longitudinal rows, unusually near lateral margins of corresponding tergites; black spots on sixth tergite larger and considerably closer placed than anterior pairs. Sixth tergite slightly longer than fifth (0.25 mm.), 0.34 mm. long and nearly 1.3 times as long as fifth. Intersclerital membrane and sternites dark testaceous yellow.

Sheath of ovipositor dorsoventrally flattened (basally 0.20 mm. high in profile), entirely shining dark testaceous yellow and covered with appressed minute brownish yellow hairs; longer than in *punctata*, as long (0.91 mm.) as width of base, at the apex 0.41 mm. long. The median and the shining translucent apical part of ovipositor testaceous yellow; apical part dorsoventrally flattened, its shape in dorsal aspect long-oval, gradually tapering to a narrow, rounded tip.

MALE: Unknown.

TYPES: Holotype ♀ (FML), Argentina, Formosa, Misión Laishi, December 13–15, 1948, R. Golbach.

Tomoplagia heringi, new species

FIGURES 99,*c-e;* 102,*s;* PLATE 23, FIGURE 17

Similar to *reimoseri* in general aspect, but mesonotum is marked with three linear golden-yellow vittae and the ovipositor differs.

FEMALE: Length of body 4.0 mm.; wing 4.1 mm. long and 2.0 mm. broad, twice as long as broad.

Head pale ochraceous yellow, postcranium mostly testaceous yellow; 0.73 mm. long, 1.27 mm. wide, and 1.09 mm. high. Frons at vertex 0.57 and at anterior margin 0.43 mm. broad, and in median line 0.50 mm. long. Inferior part of cerebral plate slightly raised. Ocellar plate in this species strongly raised, with reddish oscelli. Oral margin of mesofacial plate raised and slightly prominent. Antennae and mouthparts testaceous yellow, only labella brown; maxillary palpi slightly curved, as in *reimoseri*, but much broader with blunt tip. Postpedicel broad-oval, 0.25 mm. long and 0.16 mm. wide, approximately 1.6 times as long as wide; seta bare shining black except for the thickened ochraceous yellow basal part. Inferior part of postcranium in profile (0.11 mm.) and genae below eyes relatively narrow. Eyes in profile 0.88 mm. high and 0.50 mm. wide, almost 1.6 times as high as wide.

Cephalic bristles brownish yellow.

Thorax with scutellum 1.8 mm. long and 1.3 mm. wide, pale ochraceous to testaceous yellow; mesonotum with the same pruinose pattern as in *punctata*, that is to say the mesonotum, except for the very narrow, shining hind margin, is covered with silky whitish dusting and with very short and somewhat thickish whitish yellow hairs; in the silky whitish pruinosity are three linear vittae of pale golden yellow dusting, a median vitta and two in the line of the dorsocentral bristles; on each side of mesonotum a broad vitta dusted with the same color. On the hind margin of mesonotum the usual pair of lateral black spots, in this species relatively large; a black dot behind wing base. Pleura shining, except for the whitish pruinose mesopleuron (anepisternite) and sternopleuron (katepisternite), with three black markings—a broad horizontal black vitta crossing sternopleuron and broader than the yellow vitta above it on upper margin, a large black spot above hind coxa, and on inferior part of pleurotergites a double one, very broad, on ventral pleurotergite (occupying lower two-thirds) and much narrower on dorsal. Scutellum shining pale ochraceous yellow with some short black hairs on sides; middle third of postscutellum pale testaceous yellow, lateral thirds black. Mediotergite entirely shining, intensive, testaceous yellow.

Thoracic bristles brownish yellow and somewhat flattened; two mesopleural bristles present on both sides, but inferior very weak and shorter than half of superior bristle. Posterior notopleural bristle two-thirds as long as anterior but much weaker. Dorsocentral pair inserted in anterior third of distance between transverse suture and supra-alar bristle, spaced slightly wider than prescutellar pair, which stands in posterior third of distance between upper postalar and supra-alar bristle. Apical pair of scutellar bristles distinctly shorter than basal pair and convergent.

Coxae and legs entirely testaceous yellow.

Wings with the general pattern of the genus; apical half of humeral cross-vein brownish black on upper surface of wing; costa slightly darkened only at tip of subcosta; basal band very abbreviated, ending in an indistinct brownish cloud. Subcostal cell (stigma) approximately 2.4 times as long as basally broad. First costal section (stigma) 0.63, second 1.29, third 0.75, and fourth 0.59 mm. long. Basal section of the fourth longitudinal vein 1.09, penultimate (or median) 0.45, and ultimate 1.23 mm. long. Inner cross-vein 0.34 mm. long and more obliquely situated than the 0.59-mm. outer cross-vein. Anal cell 0.85 mm. long, including apical process (0.38 mm. long); the whole cell is approximately 2.2 times as long as the apical process itself.

Halteres entirely testaceous yellow.

Preabdomen 1.3 mm. long and 1.2 mm. wide, shining testaceous yellow, covered with appressed short black hairs; second to sixth tergites each with a pair of lateral black spots; black spots on second tergite small, on other tergites large, all slightly transverse-oval in shape except for rounded spots on the 0.34-mm. sixth tergite. The 0.27-mm. fifth tergite is slightly shorter than sixth.

Ovipositor sheath shining testaceous yellow, covered with appressed minute black hairs, apical margin with pair of small brown lateral dots Sheath considerably shorter (0.52 mm.) than basally broad (0.77 mm.) and dorsoventrally strongly flattened; at apex 0.36 mm. wide and at base only 0.16 mm. high in profile. Apical part of ovipositor testaceous yellow, translucent with silky lustre, long-triangular in shape with narrowly rounded normal tip.

Male: Unknown.

Types: Holotype ♀ (USNM 61719), Paraguay, Villarica, May 1939, F. Schade.

Tomoplagia incompleta (Williston)

Figures 99,*h-m;* 102,*l,m;* Plate 22, figure 12

Trypeta incompleta Williston, 1896, p. 378.
Tomoplagia incompleta (Williston), Hendel, 1914, p. 35.

Easily distinguishable by the modified wing pattern, in which respect it is very similar to *argentiniensis;* by the black markings of the fifth abdominal tergite of male it seems to belong to the *unifascia* group.

Male: Length of body 3.8 (4.1) mm.; wing 3.4 (3.7) mm. long and 1.5 (1.6) mm. broad, approximately 2.3 times as long as broad.

Head pale ochraceous yellow except for the densely white pruinose mesofacial plate and genae which are brownish below eyes; 0.68 (0.67) mm. long, 1.02 (1.17) mm. wide, and 0.88 (0.86) mm. high. Frons at vertex 0.50 (0.50) and at anterior margin 0.36 (0.37) mm. broad, and medially 0.43 (0.43) mm. long; ocellar plate very slightly raised. Antennae ochraceous to testaceous yellow, maxillary palpi whitish yellow, slightly curved and with widely rounded apex; labella testaceous yellow. Postpedicel long-oval, 0.25 (0.26) mm. long and 0.16 (0.16) mm. wide, 1.5 (1.6) times as long as wide; seta bare, shining black, except for the testaceous yellow, thickened basal fourth, more than twice as long as postpedicel. Eyes in profile 0.77 (0.77) mm. high and 0.48 (0.46) mm. wide, 1.6 (1.7) times as high as wide. Inferior margin of cerebral plate only slightly raised, invisible in profile. Genae below eyes 0.08 (0.07), inferior part of postcranium in profile 0.17 (0.19) mm. wide.

Cephalic bristles brownish yellow; the usual garniture present. Anterior pair of lower orbital bristles (*ori*) considerably reduced in male, while in female only slightly shorter than posterior pairs; in male subequal to posterior pair of upper orbital bristles (*ors*) or slightly longer; the two posterior pairs of *ori* are subequal in length to anterior pair of *ors;* outer vertical bristles slightly longer than these and subequal to ocellar pair. Genal bristle brownish black, indistinct among the genal hairs of the same color.

Thorax with scutellum 1.5 (1.6) mm. long and 1.3 (1.4) mm. wide, ochraceous to testaceous yellow in ground color; mesonotum, except for the shining hind margin, sparsely and evenly covered with white pruinosity and very short appressed hairs; no dusted vittae present. The usual pair of brownish black spots marks the hind region of mesonotum; behind wing base a pointlike black dot. Pleura shining, except for the finely whitish pruinose mesopleuron (anepisternite) and sternopleuron (katepisternite). The double black spot on inferior part of pleurotergites always present, sometimes yellowish brown; the smaller black spot above hind coxa sometimes absent. Scutellum ochraceous yellow, shining, with some minute appressed brownish yellow hairs on sides. The large median part of postscutellum yellow, lateral parts brownish black to yellowish brown, postscutellum, rarely, may be entirely yellow. Mediotergite shining and usually wholly intensive testaceous yellow, but sometimes on hind region a pair of large lateral dark spots, yellowish brown to brownish black.

Thoracic bristles brownish yellow; inferior mesopleural bristle slightly shorter than superior; posterior notopleural bristle usually only two-thirds as long as and much weaker than anterior. Dorsocentral pair (*dc*) in male inserted in anterior fifth to fourth, in female approximately in anterior third, of distance between transverse suture and supra-alar bristles (*sa*); *dc* bristles more widely spaced than prescutellar pair which stands approximately halfway between *sa* and upper postalar (*pa*) bristles (in male slightly nearer *pa*). Apical pair of scutellar bristles shorter and weaker than basal pair, parallel to slightly convergent.

Wings with characteristically modified pattern as in *argentiniensis;* subapical band is completely absent, except for a brown spot on tip of fourth longitudinal vein. Antebasal band not bordered with brown, yellow with brown tip, much paler than in *argentiniensis;* costa blackened at tip of humeral cross-vein and at tip of subcosta. Basal band abbreviated and terminated in a translucent brown cloud at tip of apical process of anal cell. Stigma (subcostal cell) long, approximately 3.0 (3.2) times as long as basally broad. First costal section 0.52 (0.54), second 1.02 (1.03), third 0.61 (0.77), and fourth 0.43 (0.48) mm. long. Basal section of the fourth longitudinal vein 0.76 (1.00), penultimate (or median) 0.29 (0.25), and ultimate 1.16 (1.30) mm. long, nearly straight. Inner cross-vein (0.23 (0.27) mm.) parallel to outer cross-vein (0.48 (0.57) mm.). Anal cell with apical process 0.66 (0.76) mm. long, 2.2 (2.4) times as long as apical process (0.30 (0.32) mm.)

Halteres entirely testaceous yellow but the knob sometimes brownish.

Coxae, with legs, testaceous yellow.

Preabdomen 1.7 (1.9) mm. long and 1.2 (1.3) mm. wide, shining ochraceous to testaceous yellow, with golden, shining, appressed, brownish black hairs. Third to fourth tergites each with one pair and fifth tergite with two pairs of lateral black spots. Black spots on fourth tergite and basal pair of fifth tergite usually large and subequal; black spots on third tergite are generally as small as apical pair of fifth tergite, sometimes they are only brown to yellowish brown in color, exceptionally may be absent. Fifth tergite unusually long (0.61 (0.73) mm.), 2.2 (2.0) times as long as the fourth (0.27 (0.36) mm.).

Postabdomen testaceous yellow; epandrium very specialized, long oval, without cercal emargination; surstyli bifid, shining and transparent testaceous yellow, dorsal lobes terminating in long, yellowish brown spines which are very probably homologous to the anterior pair of gonapophyses. These all are exceptional characters in this genus.

FEMALE: Like male. Body 3.6 (3.8) mm. long (without ovipositor); wings 4.1 (4.6) mm. long and 1.6 (1.9) mm. broad, 2.5 (2.4) times as long as broad.

Head 0.71 (0.79) mm. long, 1.18 (1.32) mm. wide, and 1.00 (1.09) mm. high. Frons at vertex 0.52 (0.57), at anterior margin 0.39 (0.40) mm. broad and in median line 0.47 (0.51) mm. long. Postpedicel 0.27 (0.26) mm. long and 0.16 (0.16) mm. wide, 1.7 (1.6) times as long as wide. Eyes in profile 0.82 (0.91) mm. high and 0.50 (0.54) mm. wide, 1.6 (1.7) times as high as wide (or long). Genae below eyes 0.09 (0.09) and inferior part of postcranium in profile 0.13 (0.13) mm. wide. Thorax with scutellum 1.7 (1.9) mm. long and 1.3 (1.5) mm. wide, with the same characters as in male.

Wings like those of male; first costal section 0.63 (0.64), second 1.25 (1.27), third 0.85 (0.86), and fourth 0.52 (0.54) mm. long. Basal section of fourth longitudinal vein 1.00 (1.04), penultimate (between both cross-veins) 0.32 (0.28), and ultimate 1.38 (1.43) mm. long. Inner cross-vein 0.29 (0.32), outer cross-vein 0.59 (0.61) mm. long. Anal cell with apical process 0.79 (0.82) mm. long, approximately 2.5 times as long as the apical process (0.32 (0.32) mm. long).

Preabdomen 1.4 (1.4) mm. long and 1.4 (1.3) mm. wide, with two rows of four lateral black spots that converge towards ovipositor sheath; third to sixth tergites each marked with pair of lateral black spots. Black spots on fourth and fifth tergites usually the largest, black spots on third tergite smaller than that of sixth. Exceptionally, black spots on third tergite may be completely absent. Sixth tergite (0.28 (0.28) mm.) slightly longer than fifth (0.21 (0.22) mm.) in all specimens examined.

Ovipositor sheath entirely shining testaceous yellow, covered with fine yellowish to dark brown hairs; strongly flattened dorsoventrally (at the base only 0.16 (0.18) mm. high in profile) and slightly longer (0.91 (0.93) mm.) than width (0.80 (0.86) mm.) at base, at apex only 0.36 (0.35) mm. wide. Apical part of ovipositor dorsoventrally flattened, subshining and translucent testaceous yellow; in dorsal aspect short lanceolate and slightly narrowed before tip.

TYPE: ?

TYPE LOCALITY: St. Vincent Island, British West Indies. Also recorded from Paraguay (Hendel).

Specimens examined: Argentina: Misiones, Loreto, ♀, December 30, 1929, and Uberaba, ♀, June 16, 1936, R. Mundell, (both in coll. Blanchard); Córdoba, Sierra Córdoba, ♂, January 1, 1938, Bridarolli, (in coll. Dr. Williner); Tucumán, Villa Padre Monti, 38 ♂♂, 33♀♀, January 17–February 7, 1948, R. Golbach; Jujuy, Palpalá, ♂, ♀, January 12–18, 1949, M. C. Aczél; Chaco, Colonia Benítez, ♂, December 7, 1949, R. Golbach; Misiones, Iguazú, ♀, January 30–February 13, 1947, Hayward, Willink, and Golbach (all in FML); Catamarca, Catamarca, ♀, May 31, 1927, M. Kisliuk, "No 782, on chrysanthemum"; Puerto Rico: Maricao, ♂, December 19, 1935, H. L. Dozier, "P. R. 199," Mayagüez, ♂, January 21, 1936, J. W. Baher, "1502, trap in rose apple tree." St. Kitts: Stapleton, ♂ August 10, 1931, Kisliuk and Cooley, "K. & C. St. Kitts No. 32, on guava" (in USNM).

The specimens from the Antilles were much smaller in size than those from the Argentine but no structural differences were to be found.

Tomoplagia kelloggi, new species

Figures 99,*a*,*b*; 102,*g*; Plate 23, figure 18

The writer received the type specimen of this medium sized species as *atimeta* Hendel from the U. S. National Museum, but it doubtlessly represents a well-characterized new species which has an entirely different aggregate of characters than *atimeta* except for the large opaque black spot on the anal vein, a common character for both species. It may be easily distinguished from all known species by the characters given in the key (p. 329).

Male: Length 4.7 mm.; wing 5.3 mm. long and 2.1 mm. wide, 2.5 times as long as wide.

Head entirely testaceous yellow, 0.86 mm. long, 1.36 mm. wide and 1.13 mm. high. Eyes in profile obliquely situated, 0.85 mm. high and 0.57 mm. wide, 1.5 times as high as wide; genae below eyes 0.18 and inferior part of postcranium 0.25 mm. wide, both relatively wide. Ocellar plate behind posterior ocelli with small black dot. Inferior part of cerebral plate raised. Oral margin of the impressed mesofacial plate raised and prominent. Frons at vertex 0.61 and at anterior margin 0.52 mm. broad, broader than one eye and medially as long (0.52 mm.) as broad at anterior margin. Antennae and mouthparts reddish testaceous yellow, except for the reddish brown labella; maxillary palpi wide sickle-shaped. Postpedicel wide-oval, 0.25 mm. long and 0.18 mm. wide, as wide as genae below eyes and 1.4 times as long as wide; seta bare, shining blackish, except for the testaceous yellow basal third; more than three times as long as postpedicel.

The major part of the cephalic bristles lacking; the three incurved lower orbital bristles are brownish yellow, the outer occipital (=

postocular) cilia golden shining brownish black; the missing outer vertical and perhaps the anterior pair of the recurved upper orbital bristles are most probably also brownish black. Genal bristle and the majority of the genal hairs are brownish black with a golden lustre.

Thorax with scutellum relatively long, 2.0 mm. long and 1.4 mm. wide, reddish testaceous yellow in ground color; mesonotum, except for the bare and shining posterior margin in front of scutellum, evenly covered with yellowish dusting and golden shining appressed short hairs; no pruinose vittae of different color, but both sides of mesonotum above wing base and behind transverse suture up to line of dorsocentrals covered with black hairs longer and thinner than the whitish hairs. Only the usual pair of oval black spots present on hind region of mesonotum, each between prescutellar and upper postalar bristles. In the specimen examined the small black dot behind (and beneath) wing base absent. Sternopleuron (katepisternite) almost entirely shining black, except for the narrow yellow superior and hind margins; on the reddish yellow pleura are the following black markings: a large black spot above hind coxa and a long vittalike spot on inferior part of pleurotergites. Scutellum, postscutellum, and mediotergite shining dark testaceous yellow, without black or dark spots.

Thoracic bristles dark brownish yellow. Only superior mesopleural bristle present on both sides; dorsocentral pair inserted anterior third of distance between transverse suture and supra-alar bristle and more widely spaced than prescutellar pair. The hind notopleural bristle only two-thirds as long as the fore.

Coxae and legs testaceous yellow, only tips of femora and tarsi are darker.

Wings with the general pattern of the genus but basal band represented only by a round, large, opaque, brownish black spot situated on apical part of anal cell and on both sides of $Cu_2 + An_2$ vein, and bisected in two halves by a hyaline line that borders from behind the brownish black anal vein. Costa blackened at the almost entirely black humeral cross-vein and darkened at tip of subcosta. Stigma 2.5 times as long as broad at base. First costal section 0.27, second 1.66, third 0.95, and fourth 0.52 mm. long. Basal section of the fourth longitudinal vein (M_1) 1.36, penultimate 0.48, and ultimate 1.66 mm. long. Inner cross-vein more obliquely placed than the unusually oblique outer cross-vein (*tp*) and slightly shorter than the penultimate section of M_1 (0.36 mm.); *tp* 0.61 mm. long. Discoidal cell peculiarly shaped, since the fifth longitudinal vein is strongly excurved; second basal cell mostly yellow with a small oval hyaline dot in the anteromedian part of cell. Anal cell with apical process 0.86 mm. long, 2.3 times as long as the (0.37-mm.-long) apical process. Halteres dark testaceous yellow.

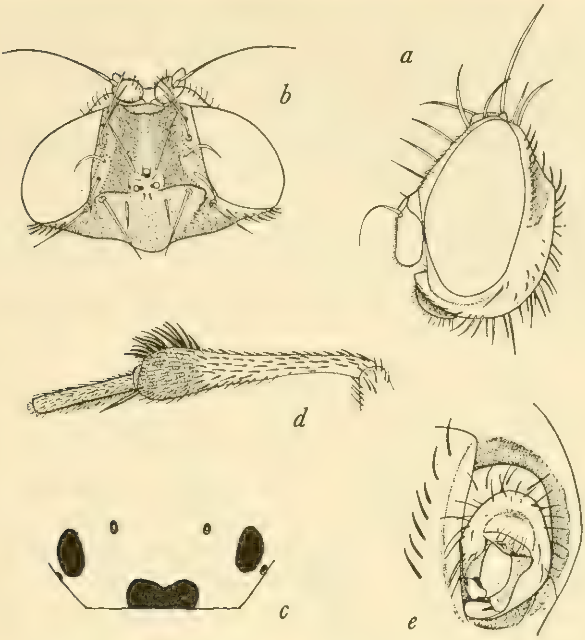

FIGURE 93.—*Tomoplagia pseudopenicillata: a,* lateral view of head; *b,* dorsal view of head; *c,* markings on hind margin of mesonotum; *d,* anterior view of midtibia; *e,* dorsal view of epandrium.

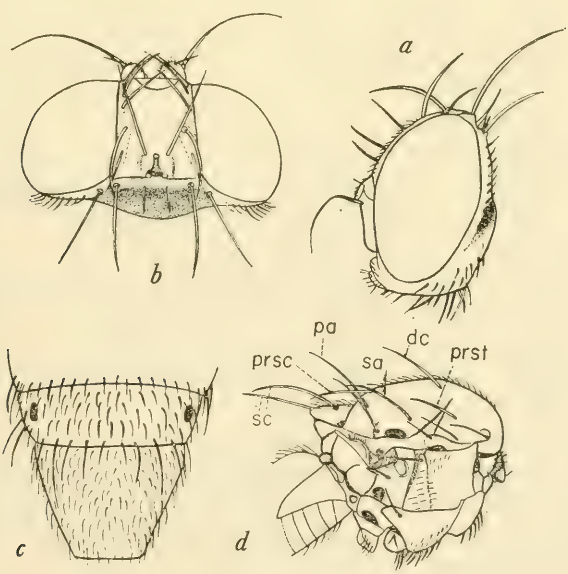

FIGURE 94.—*Tomoplagia propleuralis: a,* lateral view of head; *b,* dorsal view of head; *c,* dorsal view of apex of female abdomen; *d,* lateral view of thorax.

Preabdomen shining reddish testaceous yellow, covered with appressed fine black hairs, 1.7 mm. long and 1.8 mm. wide. In the type specimen are four pairs of lateral black spots, second to fourth tergites each with a large rounded pair (on second tergite they are smaller than the others), and fifth tergite with a pair of narrow vittalike spots that do not attain the hind margin; fifth tergite 1.7 times as long (0.59 mm.) as fourth (0.34 mm.).

Postabdomen dark testaceous yellow; epandrium oval with brown cerci and normally shaped surstyli.

Types: Holotype ♂ (USNM 61720), Perú, Río Charape, September 15, C. H. Townsend.

Tomoplagia minattai Blanchard (MS.), new species

Figures 99,*f*,*g*; 102,*i*; Plate 24, figure 19

A very distinct large species with special characters; similar to *tripunctata* Hendel, but differs from all known species by having on sides of the mesonotum only the pair of long-oval black spots, each above the wing base (below the supra-alar bristle).

Female: Length of body 6.0 mm.; wing 6.2 mm. long and 2.8 mm. broad, 2.2 times as long as broad.

Head 1.07 mm. long, 1.75 mm. wide, and 1.52 mm. high, testaceous yellow with brown markings, symmetrical on both sides of inferior part of postcranium. Frons at vertex 0.80 and at anterior margin 0.59 mm. broad, and in median line 0.66 mm. long; parafacial plates, which widen considerably towards antennae, and a median vitta, including the slightly raised ocellar plate, distinctly silky white pruinose, much narrower than the bare testaceous-yellow vittalike lateral parts of the frontal vitta. Antennae and the almost straight subtriangular maxillary palpi testaceous yellow, labella yellowish brown. Oral margin of mesofacial plate raised and considerably prominent. Postpedicel long-oval, 0.32 mm. long and 0.22 mm. wide, approximately 2.5 times as long as wide; setae bare, shining black, except for the testaceous yellow basal sixth, approximately 2.5 times as long as postpedicel. Inferior part of cerebral plate raised. Eyes in profile 1.32 mm. high and 0.70 mm. wide (or long), nearly 1.9 times as high as wide. Inferior part of postcranium in profile 0.27, genae below eyes 0.13 mm. wide.

Cephalic bristles brownish yellow and somewhat flattened; considering the insertion points, the usual garniture present but almost all the bristles of the type specimen are absent. No distinct genal bristle; the short hairs on genae and on inferior part of postcranium shining brownish black.

Thorax with scutellum 3.0 mm. long and 2.0 mm. wide, testaceous yellow in ground color; mesonotum covered with whitish pruinosity and with appressed short yellowish hairs except for the bare and shining narrow hind margin; some erect blackish hairs around the usual black spots on the hind region and three yellowish brown-dusted golden shining vittae, one in median line and two on dorsocentral line; the two whitish dusted vittalike interspaces between them are narrower than these; the lateral brown vittae terminate posteriorly in the usual black wide oval spots and are narrower than the whitish dusted lateral sides of the mesonotum. A long oval black dot above wing base (below supra-alar bristle) on both sides of the type specimen, and a subtriangular spot behind (beneath) wing base. Pleura shining, except the sparsely whitish pruinose, subshining mesopleuron and

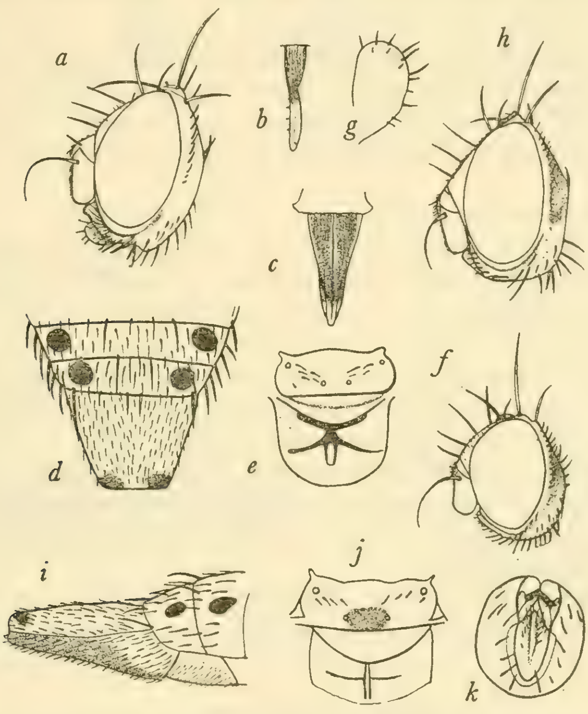

FIGURE 95.—*Tomoplagia monostigma: a*, lateral view of head; *b*, lateral view of ovipositor tip; *c*, dorsal view of ovipositor tip; *d*, dorsal view of apex of female abdomen; *e*, scutellum, postscutellum, and mediotergite. *T. minuta: f*, lateral view of head. *T. cressoni: g*, right maxillary palpus, superior surface; *h*, lateral view of head; *i*, lateral view of apex of female abdomen; *j*, scutellum, postscutellum, and mediotergite; *k*, dorsal view of epandrium.

sternopleuron; pleura marked with two of the most common black spots; one large spot on sternopleuron below bristle and a double spot occupying lower half of ventral pleurotergite, extending over inferior part of dorsal. Scutellum shining translucent ochraceous yellow with some brownish black hairs on sides. The large median region of post-scutellum testaceous yellow, whitish dusted, the small lateral parts black. Mediotergite shining, intensive testaceous yellow.

Thoracic bristles brownish yellow and somewhat flattened; lower mesopleural bristle slightly shorter and weaker than upper; posterior notopleural bristle considerably shorter and weaker than anterior. Dorsocentral pair inserted nearer supra-alar bristle than transverse suture, approximately in distal two-fifths of distance between them. Apical pair of scutellar bristles only slightly shorter than basal pair.

Coxae and legs entirely testaceous yellow.

Wings with the usual pattern of genus. Apical half of humeral cross-vein (*th*) black; costa not blackened at tip of *th* and subcosta. Basal band abbreviated and ending in a subtriangular, nearly opaque, dark brown spot at apex of apical process. First costal section 1.04, second 1.73; third 1.23, and fourth 0.82 mm. long. Basal section of fourth longitudinal vein 1.48, penultimate (median) 0.41, and ultimate 1.88 mm. long, strongly curved. Inner cross-vein 0.43 mm. long and nearly parallel to the 0.86-mm.-long outer cross-vein. Whole anal cell 1.23 mm. long, 3.0 times as long as the apical process (0.41 mm. long).

Halteres ochraceous yellow.

Preabdomen 2.4 mm. long and 2.6 mm. wide, yellowish brown, except for the wide yellow hind margins of second to fifth tergites; sixth tergite with narrow hind margin; preabdomen covered with very short brownish black hairs. Third to sixth tergites each marked with pair of lateral black spots, irregular in shape. Sixth tergite 0.41 mm. long, slightly longer than the fifth (0.35 mm.). Intersclerotal membrane pale yellow, sternites testaceous yellow.

The dorsoventrally flattened ovipositor sheath entirely ochraceous yellow, opaque, densely covered with fine yellow hairs; wider at base (1.11 mm.) than long (0.80 mm.), apically 0.48 mm. wide and basally 0.22 mm. high in profile.

Types: Holotype ♀ (Coll. Blanchard), Argentina, Entre Ríos, Concordia, November 1947, Ismael Minatta. Named in honor of the collector.

Tomoplagia minuta Hering

Figures 95,*f*; 97,*h*; Plate 21, figure 10

Tomoplagia minuta Hering, 1938, p. 187.

This species pertains to the *obliqua*-group and it is the smallest of all; it may be easily distinguished from its allies (*monostigma* and *cressoni*) as indicated in the key, and from *biseriata* (Loew) by the mostly hyaline coloration of the second basal cell of the wing.

Male: Length 2.8 mm.; wing 3.1 mm. long and 1.3 mm. wide, nearly 2.4 times as long as wide.

Head pale ochraceous yellow, 0.52 mm. long, 0.96 mm. wide, and 0.68 mm. high; antennae and mouthparts testaceous yellow. Frons without darker vittae, genovertical plate hardly infuscated; at vertex 0.43, at anterior margin 0.27 mm. wide, and in median line 0.38 mm. long, slightly shorter than wide at vertex. Occiput (postcranium) apparently brownish yellow, because it is translucent except for narrow inferior part around posterior part of oral margin, which is opaque and pale ochraceous yellow. Ocelli clear transparent yellow. Oral margin of mesofacial plate raised and but very slightly prominent. Postpedicel wide-oval, 0.19 mm. long and 0.13 mm. wide, about 1.4 times as long as wide; seta bare and shining black except the slightly

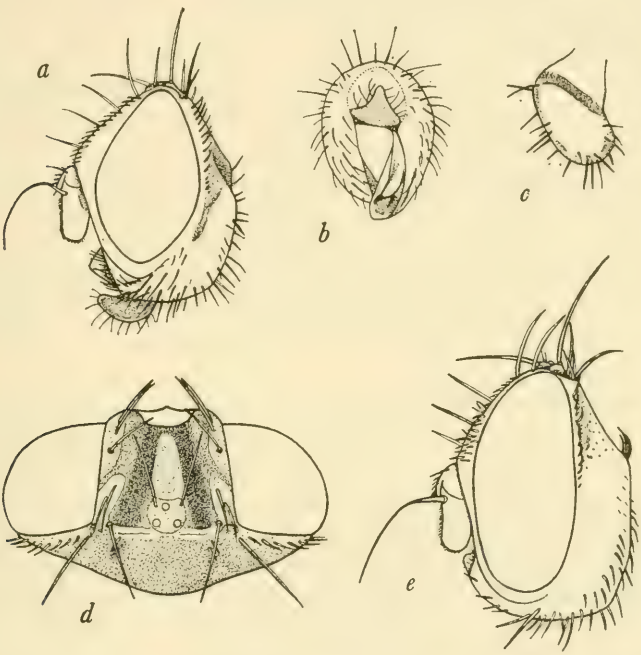

FIGURE 96.—*Tomoplagia carrerai:* *a*, lateral view of head; *b*, dorsal view of epandrium; *c*, left maxillary palpus, inferior view. *T. trivittata:* *d*, dorsal view of head; *e*, lateral view of head.

thickened, brownish yellow basal fourth; about 2.5 times as long as postpedicel. Eyes, in profile, only 1.4 times as high as wide. Maxillary palpi wide-oval.

Head bristles brownish yellow; the weak posterior pair of the recurved upper orbital bristles (*ors*) and the anterior pair of the incurved lower orbital bristles (*ori*) the shortest; the two posterior pairs of *ori* about as long as the anterior pair of *ors*, and slightly shorter than the outer vertical bristles (*vte*); ocellar bristles slightly longer than *vte*, but much shorter than inner vertical ones. One pair of weak, hardly distinguishable genal bristles.

Thorax 1.3 mm. long and 0.9 mm. wide, ochraceous yellow in ground color; mesonotum evenly covered with testaceous yellow dusting and with short appressed yellow hairs, except the bare and shining narrow translucent posterior margin; on mesonotum only a trace of three linear vittae: one on median line and two lateral vittae on line of dorsocentrals visible only from behind as a slightly darker color. On hind part of mesonotum one pair of rounded black spots present, each one between upper postalar and prescutellar bristles. The pleura sparsely covered with ochraceous yellow dusting in front of mesopleural bristles and bare and shining in their rear, with only one narrow stripe-like dark spot on inferior margin of ventral pleurotergite, which in the specimen examined is yellowish brown.

Scutellum shining and translucent, ochraceous yellow, with some sparse brown hairs on hind margin. Postscutellum without black spots, slightly lighter than the brownish yellow, shining mediotergite.

The yellowish brown thoracic bristles somewhat flattened; two pairs of mesopleural bristles present, the lower one much weaker and about half as long as upper one; dorsocentral pair placed almost in suture; apical pair of scutellar bristles parallel.

Coxae and legs ochraceous yellow, except the blackish brown distitarsi of mid and hind legs; bristles and hairs brownish yellow, including anterodorsal row of short bristles on hind tibiae.

Halteres ochraceous yellow.

Wings with characteristic pattern of the genus; it is characteristic of the species that the remainder of basal band is concentrated, at apical process of anal cell, in a small opaque blackish brown spot which does not extend over anal vein. Stigma about 2.5 times as long as wide basally. First costal section 0.45, second 1.07, third 0.68, and fourth 0.41 mm. long; first section of the fourth longitudinal vein 1.04, penultimate 0.20, and very slightly arched ultimate 0.85 mm. long; inner cross-vein (*ta*) 0.24 and outer (*tp*) 0.39 mm. long; *ta* slightly longer than distance between cross-veins, and more obliquely situated than *tp;* penultimate section of fifth longitudinal vein, which limits discoidal cell, slightly but distinctly excurved. Anal cell with 0.16-mm.-long apical process 0.52 mm. (whole anal cell 3.2 times as long as the apical process).

Preabdomen shining testaceous yellow, covered with brownish yellow appressed hairs, 0.9 mm. long and 1.0 mm. wide, wider than long; each one of third to fifth tergites marked with a pair of rounded black spots; fifth tergite 0.33 mm. long, 1.5 times as long as fourth.

Epandrium testaceous yellow, wide-oval and very small.

Species originally described from Brazil (Nova Teutonia).

Type: In the collection of Dr. Martin Hering (Berlin).

Specimens examined: Brazil: São Paulo, Salesópolis, ♂, 850 m., October 21, 1940, Travassos, Travassos filho, and Rabello (in Dep. Zool., São Paulo).

Tomoplagia monostigma Hendel

FIGURES 95,*a-e;* 97,*i;* PLATE 20, FIGURE 8

Tomoplagia monostigma Hendel, 1914, p. 38.

This species of the *obliqua* group is very similar to *cressoni*, but may be easily distinguished from the latter by the following comparative characters: only the upper mesopleural bristle is present; the apical brown spot is always absent on the scutellum; the black spot on the inferior part of ventral pleurotergite is always more or less projecting into the neighboring parts of the dorsal pleurotergite; and the second abdominal tergite is spotless.

FEMALE: Length 3.5 (3.6) mm.; wing 4.0 (4.0) mm. long and 1.75 (1.66) mm. wide, 2.3 (2.5) times as long as wide.

Head, including antennae and mouthparts, pale ochraceous yellow, 0.66 (0.57) mm. long, 1.11 (1.09) mm. wide, and 0.91 (0.93) mm. high. Frons at vertex 0.50 (0.48), at anterior margin 0.32 (0.32) mm. wide, and in median line 0.41 (0.41) mm. long. Oral margin of mesofacial plate raised and as prominent as in *cressoni*. Postpedicel wide-oval, 0.22 (0.23) mm. long and 0.16 (0.16) mm. wide, 1.4 times as long as wide. Seta bare, shining black, except the thickened basal fourth, which is testaceous yellow, about 2.5 times as long as postpedicel. Eyes in profile 1.7 times as long as wide.

Head bristles as in *cressoni*.

Thorax 1.6 (1.6) mm. long and 1.2 (1.1) mm. wide, pale ochraceous yellow in ground color; mesonotum covered with brass-yellow dusting and with very short appressed hairs, except the bare and shining translucent hind margin; only a trace of three linear vittae, slightly darker, present on mesonotum, as in *cressoni*. On the shining hind part of mesonotum the pair of usual black spots, each one between upper postalar and prescutellar bristles; one pair of pointlike small dots, each beneath wing base. Pleura pale ochraceous yellow with only one black spot on inferior part of ventral pleurotergite projecting, in all specimens examined, into the neighboring parts of the dorsal pleurotergite. Scutellum shining translucent ochraceous or whitish yellow, without small brown apical spot in all the specimens examined; postscutellum and mediotergite as in *cressoni*.

Thoracic bristles as in *cressoni*, but only upper pair of mesopleural bristles present; dorsocentral pair placed in anterior fourth to third of distance between suture and transverse line between supra-alars.

Wing with very similar pattern to that of *cressoni*,; but a more or less short stretch of costa at apex of subcosta (distal to fracture) blackish brown; anterior tip of humeral cross-vein dark to blackish brown on both surfaces of wing, the brown often extends to the neighboring parts of costa. Subcostal cell considerably narrower than in *cressoni.* First costal section 0.61 (0.63), second 1.25 (1.32), third 0.80 (0.77), and fourth 0.50 (0.49) mm. long; first section of the fourth longitudinal vein (M_1) 1.34 (1.36), penultimate 0.27 (0.30), and ultimate 1.18 (1.25) mm. long; inner cross-vein (*ta*) 0.32 (0.30), outer 0.50 (0.54) mm. long, *ta* as long as or slightly longer than distance (penultimate section of M_1) between cross-veins; anal cell with apical process 0.72 (0.72) mm. long, whole cell only 2.5 times as long as the apical process (0.29 (0.28) mm.), which is longer than in *cressoni.*

Halteres ochraceous yellow.

Coxae and legs ochraceous yellow with brownish yellow bristles and hairs, including anterodorsal row of short bristles on hind tibiae.

Preabdomen 1.6 (1.4) mm. long and 1.4 (1.3) mm. wide, with coloration and black markings as in *cressoni*, but second tergite in all specimens examined spotless; fifth tergite about as long as sixth (0.20 (0.25) mm.).

Sheath of ovipositor in specimens examined, strongly flattened dorsoventrally and slightly wider at base (0.73 (0.77) mm.) than long (0.57 (0.59) mm.); at apex wider than in *cressoni* (0.34 0.34) mm.), and basally only 0.14 (0.11) mm. high, shining testaceous yellow, with pair of round brown dots at apex as in *cressoni.* Apical part of ovipositor is translucent testaceous yellow, dorsoventrally flattened and acutely lanceolate.

Species originally described from Perú.

Type: In the Dresden Museum.

Specimens examined: Perú; Tingo María, Varias-Aguaytía, 2 ♀♀, September 6–7, 1944, Hambleton; San Bartolomé ♀, July 19, 1932, E. Wille (all in USNM).

Tomoplagia ovalipalpis, new species

Figures 100,*a-e;* 102,*w;* Plate 24, figure 20

Belongs to the *pleuralis–reimoseri* group and may easily be distinguished from the allied species by the broad-oval maxillary palpi and other characters given in the key (p. 329).

Female: Length of body 4.2 mm.; wing 4.9 mm. long and 2.1 mm. broad, 2.3 times as long as broad.

Head testaceous yellow, postcranium brownish yellow; 0.77 mm. long, 1.43 mm. wide and 1.20 mm. high, almost twice as wide as long. Frons at vertex 0.61, at anterior margin 0.45 mm. broad, and at median line 0.57 mm. long, broader than one eye. Oral margin of mesofacial plate raised and prominent. Inferior part of cerebral plate slightly raised. Antennae testaceous yellow, mouthparts brownish yellow, except for the testaceous yellow narrow basal part of the broad-oval, straight maxillary palpi. Postpedicel wide-oval, 0.25 mm. long and 0.18 mm. wide, 1.4 times as long as wide; seta bare, shining black except for the thickened testaceous yellow basal fifth;

three times as long as postpedicel. Eyes in profile 1.00 mm. high and 0.52 mm. wide (or long), almost twice as high as wide. Genae below eyes 0.07 mm., inferior region of postcranium 0.11 mm. wide, both relatively narrow.

Cephalic bristles brownish yellow, only genal bristle brown; three incurved lower orbital bristles present, anterior shorter than posterior two and subequal in length to posterior pair of recurved upper orbital

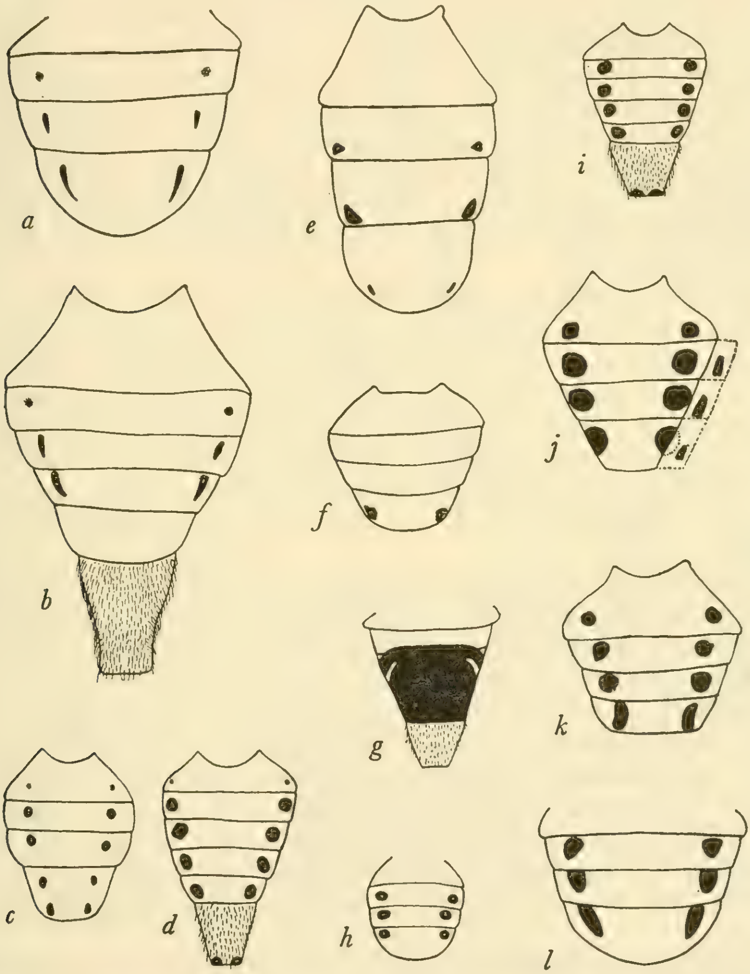

FIGURE 97.—*Tomoplagia stonei:* dorsal view of abdomen: *a*, Male; *b*, female. *T. cressoni;* dorsal view of abdomen: *c*, Male; *d*, female. *T. brevipalpis: e*, Dorsal view of male abdomen. *T. deflorata: f*, Dorsal view of male abdomen. *T. discolor: g*, Dorsal view of female abdomen. *T. minuta: h*, Dorsal view of male abdomen. *T. monostigma: i*, Dorsal view of female abdomen. *T. carrerai: j*, Dorsal view of male abdomen. *T. pseudopenicillata: k*, Dorsal view of male abdomen. *T. trivittata: l*, Dorsal view of male abdomen.

bristles (*ors*) but weaker; anterior pair of *ors* longer than these and subequal in length to the strongly divergent outer vertical and to the ocellar bristles.

Thorax 2 mm. long and 1.5 mm. wide, testaceous yellow in ground color; mesonotum evenly covered with pale golden yellow dusting and with short appressed pale yellow hairs, except for the bare and shining very narrow hind margin; three structural linear vittae in the dusting of mesonotum, one median and two lateral in line of dorsocentral bristles which are visible only from behind. Only the usual pair of black spots present on hind region of mesonotum, each between the prescutellar and upper postalar bristles; behind (and beneath) wing base a small black dot. The commonest three black spots are present on the pleura: one below sternopleural bristle on katepisternum, a large spot above hind coxa, and a double one on inferior region of pleurotergites. Scutellum shining yellow, with some appressed pale yellow hairs on sides. Postscutellum yellow, with a pair of large triangular lateral black spots; mediotergite shining, intensive reddish yellow.

Thoracic bristles brownish yellow and long. Inferior mesopleural bristle only slightly weaker than superior; dorsocentral pair placed in anterior third of distance between transverse suture and supra-alar bristles and slightly farther apart than prescutellar pair, which is situated far before the level of upper postalar bristles. Apical pair of scutellar bristles parallel and slightly shorter than basal pair.

Coxae and legs testaceous yellow, except for the last two tarsomeres of midlegs and distitarsus of hind legs, all of which are dark brown.

Wings with the general pattern of the genus; costa blackened at tip of humeral cross-vein and at tip of subcosta; a hyaline dot present in apical band at apex of second longitudinal vein (R_{2+3}). Basal band abbreviated, ending in an oval-shaped translucent brown cloud at tip of anal cell. Subcostal cell (stigma) 2.3 times as long as basally broad. First costal section 0.68, second 1.70, third 0.91, and fourth 0.54 mm. long. Basal section of the fourth longitudinal vein 1.20, penultimate 0.48, and ultimate 1.48 mm. long. Inner cross-vein 0.33 mm. long, distinctly shorter than the penultimate section of M_1 and more obliquely situated than the 0.63-mm.-long outer cross-vein. Anal cell 1.02 mm. long, 2.5 times as long as the apical process (0.45 mm. long).

Preabdomen without ovipositor 1.7 mm. long and 1.7 mm. wide, shining testaceous yellow with appressed brownish black hairs; only second to fourth tergites each with pair of rounded black spots, the pair on third tergite wider spaced than posterior pair, the circular black spots on second tergite very small. Fifth tergite (0.27 mm.) distinctly (approximately 1.3 times) longer than sixth (0.20 mm.).

Halteres dark testaceous yellow with a brown knob.

Ovipositor sheath entirely shining reddish yellow, sparsely covered with appressed fine black hairs, slightly flattened dorsoventrally and with lateral edges; shorter (0.54 mm.) than basally wide (0.73 mm.) and almost as long as wide at base (0.57 mm. in profile); at tip 0.34 mm. wide. Membranous median part (rasper) and strongly chitinized apical part testaceous yellow, the latter translucent and shining.

Types: Holotype ♀ (in Dep. Zool. São Paulo), Brazil, São Paulo, Itanhaém, November 1948, E. Rabello.

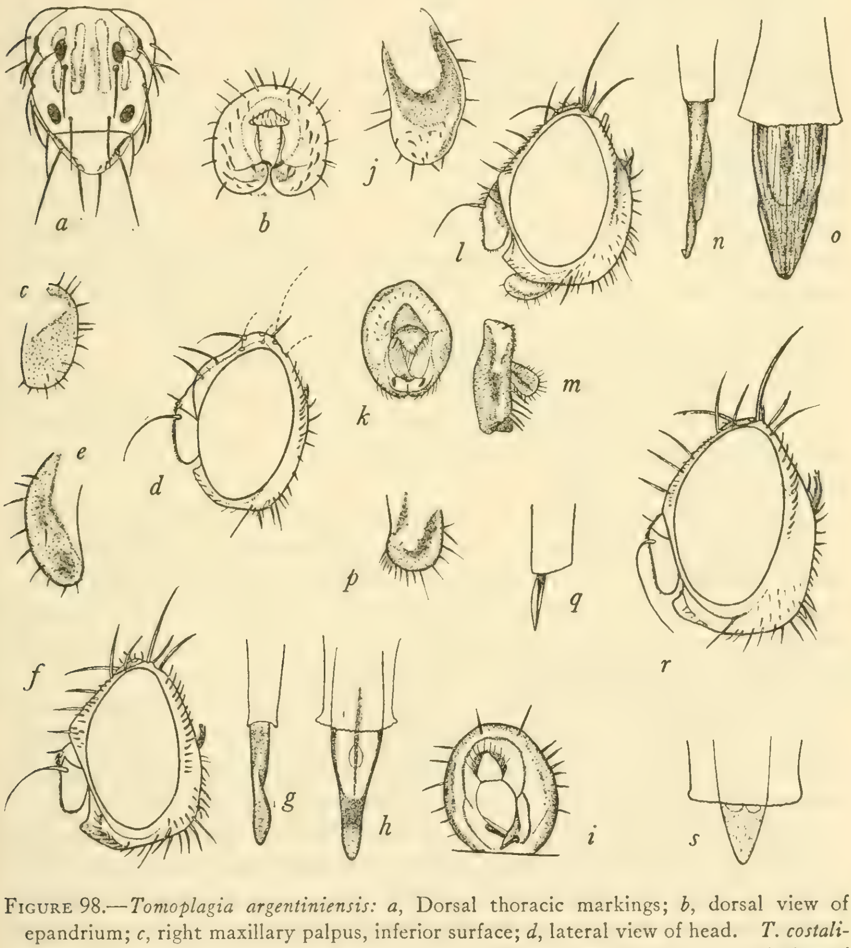

Figure 98.—*Tomoplagia argentiniensis: a*, Dorsal thoracic markings; *b*, dorsal view of epandrium; *c*, right maxillary palpus, inferior surface; *d*, lateral view of head. *T. costalimai: e*, Left maxillary palpus, inferior surface; *f*, lateral view of head; *g*, lateral view of ovipositor tip; *h*, dorsal view of ovipositor tip; *i*, dorsal view of epandrium. *T. fiebrigi: j*, Left maxillary palpus, superior surface; *k*, dorsal view of epandrium. *l*, Lateral view of head; *m*, lateral view of epandrium; *n*, lateral view of ovipositor tip; *o*, dorsal view of ovipositor tip. *T. formosa: p*, Left maxillary palpus, superior surface; *q*, lateral view of ovipositor tip; *r*, lateral view of head; *s*, dorsal view of ovipositor tip.

***Tomoplagia phaedra* Hendel**

FIGURES 100,*h-l;* 102,*c,d;* PLATE 24, FIGURE 21

Tomoplagia phaedra Hendel, 1914, p. 38.
Tomoplagia tucumana (Blanchard in litt.) Hayward, 1942, p. 32 (nomen nudum).
Tomoplagia bosqi (Blanchard in litt.).

A well-defined large species easily distinguishable by the characters given in the key.

MALE: Length of body 5.1 (6.3) mm.; wing 5.0 (5.2) mm. long and 2.2 (2.1) mm. broad, 2.3 (2.5) times as long as broad.

Head entirely testaceous yellow, 1.04 (1.11) mm. long, 1.71 (1.88) mm. wide and 1.52 (1.63) mm. high. Antennae and mouthparts testaceous yellow, antennae paler. Frons at vertex 0.86 (0.98) and at anterior margin 0.66 (0.75) mm. broad, and in median line 0.80 (0.82) mm. long, without white pruinosity. Ocellar plate slightly raised, vertex on both sides of ocellar plate considerably raised. Postpedicel long-oval, 0.27 (0.32) mm. long and 0.22 (0.20) mm. wide, 1.4 (1.6) times as long as wide; apical half of seta shining black, basal half testaceous yellow; seta approximately three times as long as postpedicel. Oral margin of mesofacial plate raised and prominent. Maxillary palpi wide oval, almost straight, with widely rounded tip. Inferior part of cerebral plate very slightly raised, invisible in profile. Eyes in profile 1.18 (1.27) mm. high and 0.59 (0.67) mm. wide, 2.0 (1.9) times as high as wide. Genae below eyes (0.20 (0.26) mm.) and inferior region of postcranium in profile (0.43 (0.29) mm.) are relatively wide.

Cephalic bristles yellow to brownish yellow; anterior of the three incurved orbital bristles (*ori*) as long as posterior of the recurved upper orbital bristles (*ors*); posterior pairs or *ori*, anterior pair of *ors*, ocellar pair and outer postvertical bristles are longer than the aforementioned and subequal in length; inner postvertical pair usually but slightly longer than these. Genal bristle indistinct.

Thorax with scutellum 2.5 (2.7) mm. long and 1.8 (2.0) mm. wide, testaceous yellow; mesonotum evenly and densely covered with yellow dusting and with very short appressed yellow hairs, except for the very narrow, shining hind margin; no dusted vittae of different color present. Only the usual pair of wide-oval, almost circular, black spots present on hind region of mesonotum; sides of mesonotum with three black spots: a short vittalike one beneath posterior notopleural bristle, a large half-circle spot above wing base, and a pointlike dot behind (and beneath) wing base. Pleura shining except for the mesopleuron and sternopleuron, the major part of which is covered with fine whitish pruinosity. Pleura marked on lower hind part of pteropleuron (anepimeron), with only one brownish black to brownish yellow spot which is quite variable in size and sometimes completely absent. Scutellum subshining testaceous yellow with some scattered brownish yellow appressed hairs at sides. Median part of postscutellum yellow, lateral parts black to brown, continuing in a pair of lateral spots of the same color on the shining testaceous yellow mediotergite (as in *formosa*).

Thoracic bristles brownish yellow; inferior mesopleural bristle two-thirds as long as superior and much weaker; posterior notopleural bristle almost as long as anterior. Dorsocentral pair inserted in male slightly before line of supra-alars, approximately in posterior fourth

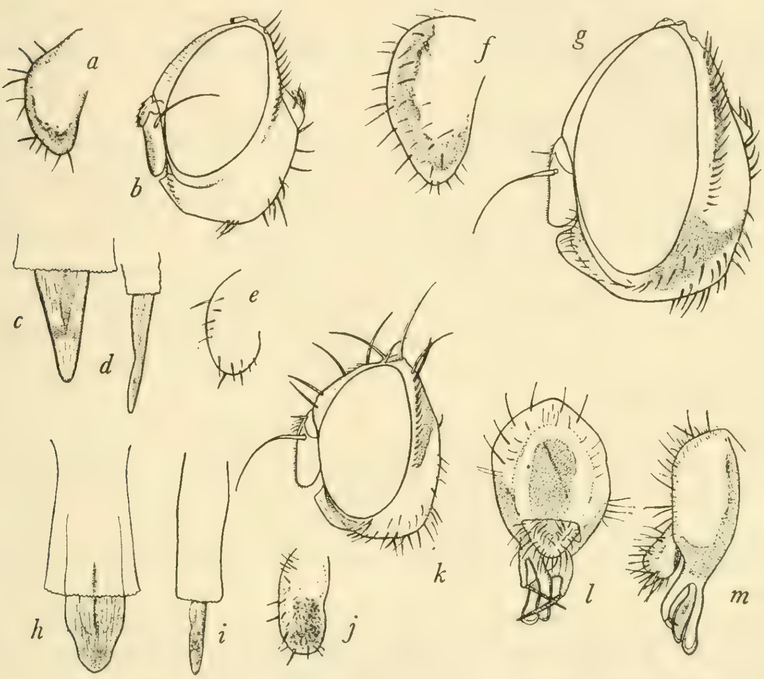

FIGURE 99.—*Tomoplagia kelloggi: a*, Left maxillary palpus, inferior surface; *b*, lateral view of head. *T. heringi: c*, Dorsal view of ovipositor tip; *d*, lateral view of ovipositor tip; *e*, left maxillary palpus, inferior surface. *T. minattai: f*, Left maxillary palpus, inferior surface; *g*, lateral view of head. *T. incompleta: h*, Dorsal view of ovipositor tip; *i*, lateral view of ovipositor tip; *j*, left maxillary palpus, inferior surface; *k*, lateral view of head; *l*, dorsal view of epandrium; *m*, lateral view of epandrium.

of distance between transverse suture and supra-alar (*sa*) bristle, and in female placed on a level with *sa* bristles or slightly behind. Dorsocentral bristles slightly wider spaced, and shorter than prescutellar pair, which stands but slightly before level of upper postalar bristles. Apical pair of scutellar bristles convergent and almost as long as the divergent basal pair.

Coxae and legs entirely testaceous yellow, anteroventral row of short yellow bristles on hind tibiae indistinct, especially in male.

Wings with the general pattern of the genus, but the yellow bands are only indistincly bordered with brown and are sometimes very pale as in *rudolphi*. Basal band abbreviated, ending in a small pale brown cloud at apex of apical process of anal cell. Tip of humeral cross-vein brownish black. Subcostal cell (stigma) approximately 2.8 (2.9) times as long as basally broad. First section of costa 0.70 (0.75), second 1.59 (1.75), third 0.95 (0.85), and fourth 0.61 (0.59) mm. long. Basal section of fourth longitudinal vein 1.27 (1.34), penultimate (between both cross-veins) 0.29 (0.32), and ultimate 1.85 (1.66) mm. long. Inner cross-vein 0.36 (0.36) mm. long and slightly more oblique than outer cross-vein (0.68 (0.73) mm. long). Anal cell with apical process 0.93 (1.13) mm. long, 2.0 (2.6) times as long as apical process (0.48 (0.41) mm.).

Halteres testaceous yellow.

Preabdomen 2.2 (2.9) mm. long and 2.0 (2.2) mm. wide, faintly shining testaceous yellow in ground color, covered with dark brown, golden shining hairs. In all male specimens examined only the fifth tergite is marked with a pair of lateral brownish black spots, which are variable in size, usually very small, and in one specimen represented by pointlike yellowish brown dots; very probably they may be wholly absent. The fifth tergite (0.59 (0.82) mm.) is 1.5 (1.7) times as long as fourth (0.34 (0.56) mm.); intrasclerital membrane and sternites testaceous yellow.

Postabdomen testaceous yellow, relatively small; epandrium wide-oval, nearly round with normally shaped surstyli. Gonapophyses shining black, posterior pair very reduced.

Female: Like male. Length of body 5.1 (7.0) mm.; wing 5.0 (6.3) mm. long and 1.9 (2.6) mm. broad, 2.6 (2.4) times as long as broad.

Head 0.95 (1.36) mm. long, 1.66 (2.13) mm. wide, and 1.48 (1.88) mm. high. Frons at vertex 0.80 (1.18) and at anterior margin 0.57 (0.68) mm. broad, and in median line 0.68 (1.00) mm. long. Post-pedicel 0.34 (0.34) mm. long and 0.22 (0.25) mm. wide, approximately 1.4 (1.5) times as long as wide. Eyes in profile 1.13 (1.43) mm. high and 0.61 (0.73) mm. wide, 1.9 times as high as wide. Genae below eyes 0.16 (0.29) and inferior region of postcranium in profile 0.33 (0.48) mm. wide. Thorax with scutellum 2.3 (3.1) mm. long and 1.7 (2.3) mm. wide, with the same characters as in male.

Wings like those of male. First costal section 0.68 (0.82), second 1.63 (2.04), third 0.85 (0.95), and fourth 0.59 (0.75) mm. long. Basal section of fourth vein 1.27 (1.59), median or penultimate 0.31 (0.32), ultimate 1.48 (1.77) mm. long. Inner cross-vein 0.36 (0.50), outer cross-vein 0.63 (0.86) mm. long. Anal cell together with apical process 0.95 (1.43) mm long, 2.5 (2.7) times as long as apical process (0.38 (0.52) mm.).

Preabdomen 2.1 (2.6) mm. long and 1.6 (2.4) mm. wide. Sixth tergite always with pair of long oval lateral black to brownish black spots; fifth tergite usually with pair of dark lateral spots variable in size and in color from blurred yellowish brown small dots to long-oval black spots as large as that on sixth tergite (*tucumana* Blanchard in litt.) but sometimes entirely absent; on fourth tergite a pair of lateral dark spots or dots also rarely present, yellowish brown to blackish brown (*bosqi* Blanchard in litt.). Fifth tergite approximately as long (0.34 (0.43) mm.) as sixth (0.38 (0.43) mm.).

Ovipositor sheath slightly flattened dorsoventrally (at base, in profile 0.57 (0.45) mm. high), shining testaceous yellow and covered with golden shining appressed brown hairs, with apex usually darker (in *bosqi* brown); slightly shorter (0.70 (0.91) mm.) than basally wide (0.82 (1.18) mm.) and at apex 0.48 (0.57) mm. wide. Median part of ovipositor (rasper) darker in color than sheath, with unusually long rasper-tooth; apical part subshining, translucent, testaceous yellow from wide-oval base tapering into a long and narrow apical region, with blunt apex in dorsal aspect, with acute tip in lateral aspect.

TYPE: In Dresden Museum.

TYPE LOCALITY: Rosalinda, Río Urumbaba, Perú.

SPECIMENS EXAMINED: Argentina: Corrientes, San Roque, 2♀♀, February 1920, J. Bosq, "*T. phaedra* Hendel, det. E. E. Blanchard" and "*T. bosqi* n. sp., det E. E. Blanchard," and Tucumán, Tucumán, ♀, K. J. Hayward, "*T. tucumana* n. sp. det. E. E. Blanchard" (all in coll. Blanchard); Santa Fé, Piquete, ♂, January 4, 1928, Bridarolli (in Colegio Máximo de San José, San Miguel), and Santa Fé, Villa Ana, 2 ♂♂, February 1–18, 1946, Hayward and Willink, Misiones, Iguazú, ♀, January 30–March 13, 1945, Hayward, Willink and Golbach (all in FML).

Dr. Hayward (1942) reared this species, together with *Anastrepha* species, from sweet orange and guava fruits in Tucumán.

Tomoplagia pleuralis **Hendel**

FIGURES 100,*f,g;* 102,*h;* PLATE 25, FIGURE 22

Tomoplagia pleuralis Hendel, 1914, p. 39.

The writer examined some Argentine specimens and an Ecuadorian speciman of a species which traces to *pleuralis* in Hendel's key to the species of *Tomoplagia* but did not wholly agree with the original description. A typical male from the U. S. National Museum, when compared with the specimens in question, does not show any structural difference. Therefore it is very probable that the pleural black spots of this species are variable in size. It differs from allied species of the *pleuralis-reimoseri* group by the characters given in the key (p. 329). The drawings and the first number of all measures in the redescription of the male belong to the typical Peruvian specimen, and the second numbers to the smaller Ecuadorian specimen.

Male: Length of body 3.5 (3.0) mm.; wing 3.9 (3.3) mm. long and 1.6 (1.4) mm. wide, 2.4 (2.3) times as long as wide.

Head entirely testaceous yellow, 0.59 (0.52) mm. long, 1.04 (0.93) mm. wide and 0.79 (0.72) mm. high. Frons at vertex 0.45 (0.43) and at anterior margin 0.36 (0.29) mm. broad, at median line 0.43 (0.36) mm. long. A minute black point at interior margin of each ocellus. Oral margin of mesofacial plate raised and slightly prominent. Inferior region of cerebral plate raised and in profile slightly prominent. Antennae and mouthparts testaceous yellow, maxillary palpi slightly curved, with broadly rounded apex. Postpedicel broad oval, 0.20 (0.18) mm. long and 0.15 (0.14) mm. wide, about 1.3 times as long as wide; seta bare, shining black, except for the yellow basal fourth; seta 2.5 times as long as postpedicel. Eyes in profile 0.68 (0.59) mm. high and 0.34 (0.38) mm. wide, 2.0 (1.6) times as high as wide; inferior region of postcranium in profile 0.17 (0.11), genae below eyes 0.07 (0.07) mm. wide.

Cephalic bristles brownish yellow; three incurved lower orbital bristles (*ori*), anterior pair slightly shorter; two recurved upper orbital bristles, anterior subequal to, posterior shorter than, *ori*. The divergent outer vertical bristles subequal to the divergent and proclined ocellar bristles in length, and longer than *ori;* inner vertical bristles slightly reclined and convergent.

Thorax 1.6 (1.4) mm. long and 1.2 (1.0) mm. wide, testaceous yellow in ground color; mesonotum evenly covered with pale brass-yellow dusting and with pale yellow thickish and short appressed hairs, except for the bare and shining posterior margin; mesonotum without structural, or pruinose, vittae of different color. Only the usual pair of lateral black spots present on hind region of mesonotum; behind (and beneath) wing base a black point. Mesopleuron (anepisternum) shining in all specimens examined; sternopleuron in the typical specimen shining black, except for the narrow upper margin; in the Ecuadorian specimen a longish, triangular, shining black spot below sternopleural bristle on hind margin of sternopleuron; in both specimens a long-oval spot above hind coxa and another spot on inferior region of pleurotergites (at the haltere base), both brownish black. Scutellum shining yellow with some appressed brown hairs on sides; postscutellum yellow with a pair of triangular lateral black spots; metanotum shining reddish yellow with some blackish markings irregular in shape.

Thoracic bristles brownish yellow; only upper mesopleural bristle present in all specimens. The hind notopleural bristle only half as long as forebristle and much weaker; dorsocentral pair situated in anterior fourth of distance between transverse suture and supra-alar bristle and slightly wider spaced than prescutellar pair, which is inserted far before line of upper postalar bristles.

Coxae and legs entirely testaceous yellow.

Wings with the general pattern of the genus; oblique bands intensive yellow distally bordered with dark brown. Second basal cell mostly

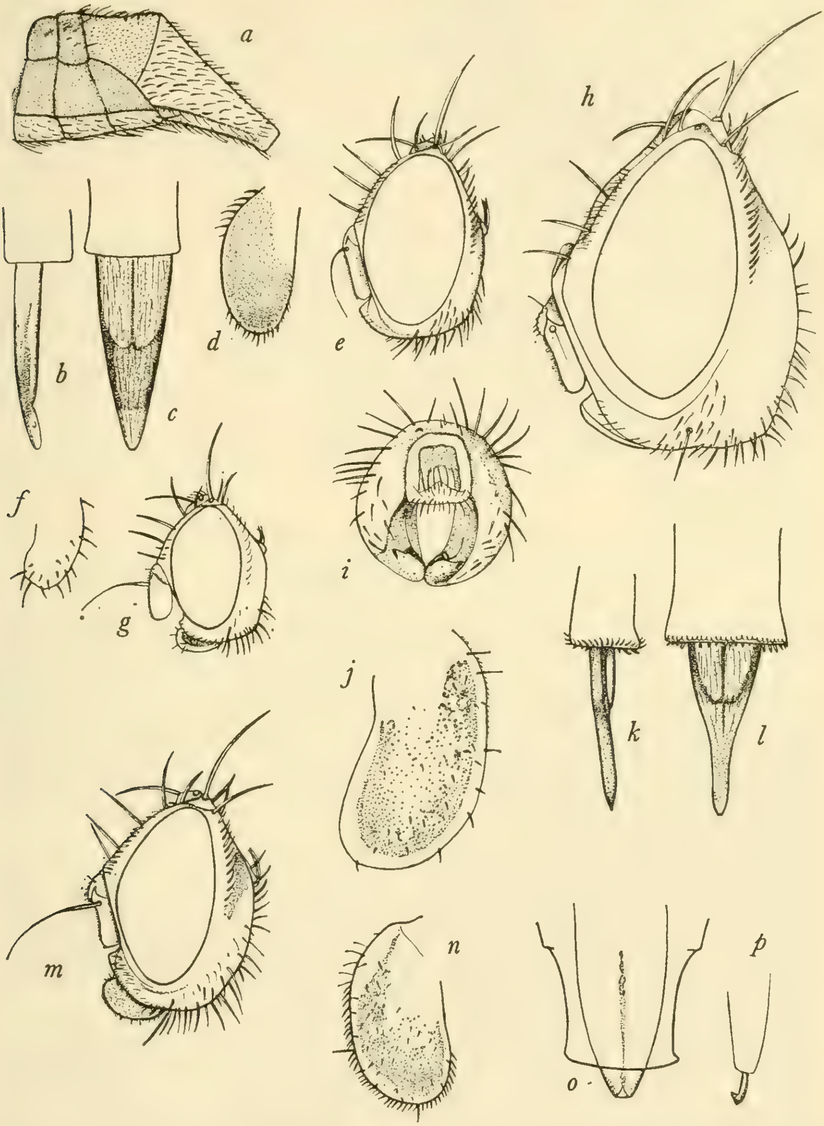

FIGURE 100.—*Tomoplagia ovalipalpis: a*, Lateral view of female postabdomen; *b*, lateral view of ovipositor tip; *c*, dorsal view of ovipositor tip; *d*, left maxillary palpus, inferior surface; *e*, lateral view of head. *T. pleuralis: f*, Right maxillary palpus, inferior surface; *g*, lateral view of head. *T. phaedra: h*, Lateral view of head; *i*, dorsal view of epandrium; *j*, left maxillary palpus, superior surface; *k*, lateral view of ovipositor tip; *l*, dorsal view of ovipositor tip. *T. punctata: m*, Lateral view of head; *n*, right maxillary palpus, superior surface; *o*, dorsal view of ovipositor tip; *p*, lateral view of ovipositor tip.

hyaline. Subcostal cell (stigma) 2.7 (2.6) times as long as basally broad. First costal section (stigma) 0.57 (0.52), second 1.34 (1.04), third 0.77 (0.68), and fourth 0.48 (0.39) mm. long; basal section of the fourth longitudinal vein 1.02 (0.86), penultimate 0.29 (0.23), and ultimate 1.33 (1.09) mm. long. Inner cross-vein 0.16 (0.22) mm. long, very obliquely placed and exactly parallel to outer cross-vein (0.54 (0.45) mm.). Fifth longitudinal vein, which posteriorly delimits discoidal cell, only slightly excurved. Anal cell with apical process 0.73 (0.54) mm. long, approximately 2.7 times as long as the short (0.27 (0.20) mm.) apical process.

Halteres testaceous yellow.

Preabdomen 1.4 (1.2) mm. long and 1.3 (1.3) mm. wide, shining testaceous yellow, covered with appressed fine black hairs and marked with three pairs of lateral black spots: third to fifth tergites each with a pair; the black spots on third and fourth tergites transverse-oval and the pair on the fifth is long and vittalike, crossing the tergite from anterior to posterior margin. Fifth tergite 1.7 times as long (0.43 (0.41) mm.) as the fourth (0.25 (0.23) mm.).

Postabdomen testaceous yellow; epandrium oval with normally shaped surstyli.

Female: Like male; length of body 3.2 (3.8) mm., wing 3.1 (3.6) mm. long and 1.4 (1.5) mm. broad, 2.2 (2.4) times as long as broad.

Head 0.64 (0.70) mm. long, 1.04 (1.16) mm. wide, and 0.82 (0.91) mm. high. Frons at vertex 0.45 (0.50) and at anterior margin 0.36 (0.43) mm. broad, and medially 0.43 (0.45) mm. long. Postpedicel 0.25 (0.24) mm. long and 0.15 (0.16) mm. wide, 1.7 (1.5) times as long as wide. The three black points, each at the interior margin of the ocelli, present only in the specimen from Sierra Córdoba. Eye in profile 0.68 (0.75) mm. high and 0.41 (0.45) mm. wide, 1.6 (1.7) times as high as wide. Genae below eyes 0.07 (0.07), inferior region of postcranium in profile 0.16 (0.17) mm. wide.

Thorax with scutellum 1.4 (1.5) mm. long and 1.0 (1.1) mm. wide, with the same markings as in the Ecuadorian male, except for the black markings on sternopleuron: the black spot smaller in the Argentine females, which have additionally the upper margin of pleura bordered with a vittalike, narrow, short, brownish black marking.

Wings like those of male; brown basal band is paler and more abbreviated than in typical male specimen. First costal section 0.55 (0.57), second 0.98 (1.09), third 0.63 (0.73), and fourth 0.50 (0.50) mm. long. Basal section of fourth longitudinal vein 0.73 (0.88), median (penultimate) 0.27 (0.25), and ultimate 1.09 (1.18) mm. long. Inner cross-vein 0.25 (0.27) mm. long and more obliquely situated that the outer cross-vein (0.45 (0.48) mm.), which is placed almost at right angles to costa. Anal cell with apical process 0.57 (0.63) mm. long, whole cell 3.1 (2.7) times as long as the apical process itself (0.18 (0.23) mm.).

Preabdomen 1.3 (1.5) mm. long and 1.2 (1.3) mm. wide, with five pairs of lateral black spots; second to sixth tergites each with one pair of transverse-oval spots, the two longitudinal rows of black spots convergent towards the ovipositor. Fifth tergite (0.23 (0.25) mm.) slightly longer than the sixth (0.18 (0.23) mm.).

Ovipositor sheath in the specimens examined strongly flattened dorsoventrally, entirely shining testaceous yellow and covered with very short and fine, appressed, brownish yellow hairs, slightly shorter (0.52 (0.54) mm.) than basally wide (0.57 (0.63) mm.), at apex only 0.30 (0.32) mm. wide and basally in profile 0.16 (0.18) mm. high.

TYPE: In Hungarian National Museum, Budapest.

TYPE LOCALITY: Callanga, Río Charape, Perú.

SPECIMENS EXAMINED: Perú: Río Charape, ♂, September 12, C. H. Townsend. Ecuador: Hacienda Parish, ♂, 1914, J. M. Aldrich, (both USNM). Argentina: Corrientes, Corrientes, ♀, October 1938, D'Angelo, (in coll. Blanchard); ♀, Córdoba, Sierra Córdoba, January 1938, Bridarolli, (in coll. Colegio Máximo de San José, San Miguel); Chaco, Colonia Benítez, ♀, December 3, 1949, R. Golbach (in FML).

Tomoplagia propleuralis, new species

FIGURE 94; PLATE 20, FIGURE 5

A medium-sized, very well defined species, readily distinguished from all known species by the modified wing pattern (the apical band being separated entirely from the others) and by the absence of the pair of lateral black spots between the upper postalar and prescutellar bristles, on the hind part of the mesonotum. This species is the only known *Tomoplagia* which has a short linear black vitta on the propleura, above the anterior spiracle. Unfortunately the only specimen has become wet by some greasy liquid, thus the ground color and the morphological characters can be noted but the pruinosity is obscured.

FEMALE: Length 4 mm.; wing 4.5 mm. long and 1.6 mm. wide, relatively narrow, 2.8 times as long as wide.

Head testaceous yellow, 0.73 mm. long, 1.43 mm. wide, and 1.13 mm. high. Frons at vertex 0.48, at anterior margin 0.36 mm. wide, and in median line 0.54 mm. long, relatively narrow, since it is considerably longer than wide at vertex. Antennae and mouthparts testaceous yellow; postpedicel wide-oval, 0.27 mm. long and 0.20 mm. wide, 1.35 times as long as wide; seta bare, shining black, except the thickened transparent yellow basal third, about three times as long as postpedicel. Eyes in profile 1.6 times as high as wide, very sparsely beset with microscopically short fine erect and whitish hairs; oral margin of the impressed mesofacial plate raised and slightly prominent.

Head bristles brownish yellow and somewhat flattened; three pairs of incurved lower orbital bristles (*ori*), anterior pair much shorter and weaker than the others, and but slightly longer and stronger than posterior pair of recurved upper orbital bristles (*ors*); the distance between posterior and middle pairs of *ori* nearly twice as long as between anterior and middle pairs; anterior pair of *ors* subequal to outer verticals; ocellar pair is slightly longer than these, but considerably shorter than inner vertical bristles. A pair of distinct genal bristles.

Thorax 2.0 mm. long and 1.5 mm. wide, testaceous yellow in ground color (mesonotum is darker), except for the characteristic black spots; mesonotum densely covered with short dark yellow appressed hairs. The usual pair of lateral black spots between upper postalar and prescutellar bristles is in this species wholly absent. There is a pointlike black dot beneath base of wing, below postalar callosity. On the sides of mesonotum the characteristic black spots of the *phaedra* group: one horizontal short vitta below posterior notopleural bristle, and one larger oval black spot on side of mesonotum above wing base. On pleura four black spots: a horizontal linear vitta on propleura attaining upper margin of anterior spiracle, a curved stripe on inferior margin of ventral and dorsal pleurotergites, an oval one on metapleura above hind coxa, and another one on lower hind corner of pteropleura; none on sternopleura.

The long and strong thoracic bristles are brownish yellow; only upper mesopleural bristle present and well developed; posterior notopleural bristle considerably shorter and weaker than anterior; dorsocentral bristle inserted in anterior sixth of the distance between transverse suture and (imaginary) transverse line between supra-alar bristles; apical pair of scutellar bristles well developed, slightly convergent and crossed at apex.

Scutellum covered with yellow appressed hairs, except on the basicentral area. Postscutellum entirely testaceous yellow, without black spots. Mediotergite subshining, intensive dark testaceous yellow in ground color.

Coxae and legs without exceptional characters, entirely testaceous yellow with bristles and hairs of the same color, including anterodorsal row of rather closely spaced bristles of hind tibiae.

Halteres testaceous yellow.

Wing with the slightly modified pattern of the genus: apical band entirely separated from the others in both wings of the type specimen; basal band almost entirely absent, subbasal band entirely yellow and not attaining posterior wing margin; second basal cell almost entirely hyaline; costa darkened only above basal part of subcostal cell (*Csc*=stigma), which is rather narrow, 2.6 times as long as wide basally. The second longitudinal vein almost straight, ultimate section of third (R_{4+5}) and fourth longitudinal veins (M_1) only slightly curved. First costal section 0.63, second 1.70, third 0.66, and fourth

0.51 mm. long; first section of M_1 1.36, penultimate 0.38, and ultimate 1.25 mm. long; inner cross-vein oblique and shorter than distance between both cross-veins; outer cross-vein 0.54 mm. long and hardly oblique at all; fifth longitudinal vein, which limits the discoidal cell, perfectly straight. Anal cell with 0.25-mm. apical process 0.75 mm. long, latter half as long as rest of anal cell.

Preabdomen in the specimen examined darkened, yellowish brown with reddish tinge, and covered with appressed brownish yellow hairs. Preabdomen 1.8 mm. long by 1.4 mm. wide. Sixth tergite marked only with a pair of small and oval lateral black spots. Sixth tergite slightly longer (0.34 mm.) than the fifth (0.32 mm.).

Sheath of ovipositor flattened in the type specimen, 0.63 mm. long, at base 0.85 and at apex 0.38 mm. wide, and basally 0.38 mm. high; about 1.3 times as wide at base as long; shining dark testaceous yellow and evenly covered with appressed, short, fine, brownish yellow hairs.

MALE: Unknown.

TYPE: Holotype ♀ (USNM 61721), Puerto Rico, Petri Finca, Adjuntas, flying, August 17, 1932, R. G. Oakley No. 5573.

Tomoplagia pseudopenicillata, new species

FIGURES 93; 97,*k*; PLATE 19, FIGURE 4

Hendel (1914, p. 39) described his Peruvian species *penicillata* as a member of the *pleuralis* group. The characters of the male given by Hendel, in the very short original description and in his key to the species of *Tomoplagia*, agree completely with the characters of one male specimen in the material of the U. S. National Museum from southern Brazil. This Brazilian specimen, however, belongs to the *atimeta* group, having three brownish black spots on the subshining and bare hind margin of the mesonotum: the usual lateral pair, and one double spot at the middle, with posterior margin distinctly attaining the scutellar suture. Since *penicillata* Hendel has not been discussed by other authors after the first description, there is a possibility that the Brazilian specimen does not represent a species distinct from *penicillata*, if the absence of median black spot is not a constant character in the latter. Nevertheless, taking into consideration the mentioned character which Hendel thought important and which is regarded generally as constant structural character, furthermore the geographical distance, in order to avoid confusion which may be caused by two distinct kind of *penicillata*, the writer prefers, although unwillingly, to describe the Brazilian specimen as a new species. The comparison of the type specimen of the *penicillata* Hendel in the Hungarian National Museum with the description given below, or with Peruvian material, will be necessary to settle definitely the status of *pseudopenicillata*.

Male: Length 4.9 mm.; wing 5.0 mm. long and 2.2 mm. wide, 2.3 times as long as wide.

Head testaceous yellow except the yellowish white lunula, 0.82 mm. long, 1.54 mm. wide, and 1.13 mm. high. Frons at vertex 0.63 and at anterior margin 0.45 mm. wide, and in median line 0.48 mm. long, 1.3 times as wide at vertex as long and but slightly longer than wide at anterior margin; *pseudopenicillata* and *trivittata* (Lutz and Lima) are the only known species in having two intensive testaceous yellow longitudinal strips on the frons, forming a V-shaped marking (frontal vitta intensive testaceous yellow except for a long triangular stripe in front of ocellar plate, the apex attaining the lunula, which is as covered with shining white dusting, as the ocellar, genovertical, parafacial, and mesofacial plates). Oral margin raised and considerably prominent. Antennae and mouthparts testaceous yellow, postpedicel wide-oval, 0.25 mm. long and 0.18 mm. wide, 1.4 times as long as wide; seta bare shining black except the thickened basal third, which is translucent testaceous yellow; seta about three times as long as postpedicel. Eyes in profile nearly two times as high as wide, very sparsely beset with tiny erect and whitish hairs.

Cephalic bristles brownish yellow and somewhat flattened; three pairs of incurved lower orbital bristles; anterior pair shorter and weaker. Two pairs of strong recurved upper orbital bristles, posterior pair slightly shorter, anterior pair about as long as the divergent ocellar bristles; inner vertical pair longest of all, strongly convergent, outer verticals shorter and divergent. One pair of brown genal bristles present.

Thorax 2.2 mm. long and 1.6 mm. wide, ochraceous yellow in ground color; mesonotum densely covered, except for bare and shining narrow posterior margin, with whitish dusting and short whitish appressed hairs; mesonotum with five distinct vittae of clear brass-yellow pruinosity: three middle ones almost linear (one in median line and two in line of dorsocentrals), and two lateral ones slightly wider than these and connected with vittae on dorsocentral line at its anterior origin and on transverse suture, bordering thus a whitish triangle and ending in the lateral black spots near hind margin. The usual pair of lateral black spots present on hind margin of mesonotum, each one between upper *pa* and *prsc* bristles, and between and behind these a double one, posteriorly limited by scutellar suture; one pair of black dots, each one beneath the base of wing, below postalar callosity. On mesonotum are tiny and shining transparent testaceous-yellow circles at bases of the dorsocentral and prescutellar bristles, the others clear yellow.

Thoracic bristles long and strong, brownish yellow with golden shine; two pairs of mesopleural bristles present, lower pair slightly shorter;

dorsocentral pair inserted halfway between transverse suture and (imaginary) transverse line between supraalar bristles; apical pair of scutellar bristles nearly parallel, not crossed; ochraceous-yellow pleura with three black markings: a double one on inferior margin of ventral and dorsal pleurotergites, a large one above hind coxa, and a triangular spot, the largest, on upper hind part of sternopleura, divided in two by a yellow horizontal line in which stands the sternopleural (*st*) bristle.

Scutellum subshining, opaque, ochraceous yellow and covered, except for center, with whitish, nearly erect hairs; postscutellum with a pair of triangular brownish black lateral spots; mediotergite shining, and intensively testaceous yellow.

Coxae and legs testaceous yellow except two last tarsomeres of mid and hind legs, which are yellowish brown; apical third of mid-tibiae strongly dilated and anteroposteriorly compressed, with dorsal bunch of about 20 strong and relatively short black bristles; bristles and hairs of coxae and legs pale to testaceous yellow except antero-dorsal row of rather closely spaced yellowish brown bristles.

Halteres ochraceous yellow.

Wing with the usual pattern of the genus; basal band does not attain posterior wing margin; at apical process of anal cell forming a very obliterate spot, transparent brownish yellow; costa not blackened at humeral cross-vein or at tip of subcosta; stigma 2.2 times as long as wide at base; first costal section 0.77, second 1.82, third 0.95, and fourth 0.54 mm. long; first section of the fourth longitudinal vein 1.54, penultimate 0.52, and ultimate 1.82 mm. long; inner cross-vein (*ta*) 0.36, outer (*tp*) 0.77 mm. long, *ta* considerably shorter than distance between cross-veins, and slightly more oblique than *tp;* anal cell with 0.43-mm.-long apical process 1.00 mm. long, apical process slightly shorter than rest of cell (whole cell is 2.3 times as long as process).

Preabdomen shining testaceous yellow, covered with brownish yellow hairs, those on basal double tergite (1.42) paler; 2.1 mm. long and 1.8 mm. wide. Second to fourth tergites each with a pair of large lateral black spots, fifth with a pair of rather wide and slightly curved lateral black vittae. The fifth tergite (0.45 mm. long) is about 1.3 times as long as fourth. Sternites and membrane testaceous yellow except basal part, which is ochraceous yellow. Postabdomen testaceous yellow. Epandrium wide-oval, in the specimen examined asymmetrical (very probably by the drying process); the two pairs of gonapophyses shining black, posterior pair shorter than anterior, thin and acute.

FEMALE: Unknown.

TYPE: Holotype ♂ (USNM 61722), Brazil, near São Paulo, 1932, Kisliuk and Cooley No. 278.

***Tomoplagia punctata*, new species**

FIGURES 100,*m-p;* 102,*t,u;* PLATE 25, FIGURE 23

This median-sized species is similar to *stonei* in having unusually large, shining dark brown insertion points of the dorsocentral and prescutellar bristles on the mesonotum, but is easily distinguished from *stonei* by the characters given in the key.

MALE: Length 4.5 mm.; wing 4.4 mm. long and 1.8 mm. broad, 2.4 times as long as broad.

Head 0.68 mm. long, 1.43 mm. wide and 1.16 mm. high, pale ochraceous yellow except for the testaceous yellow frontal vitta; ocellar, genovertical, parafacial, and mesofacial plates with fine white pruinosity but no distinct vittae on frons. Antennae and maxillary palpi ochraceous yellow, labella yellowish brown. Ocellar plate considerably raised; oral margin of mesofacial plate raised and prominent. Inferior region of cerebral plate slightly raised. Maxillary palpi broad-oval, not curved, with widely rounded apex. Postpedicel very broad-oval, 0.21 mm. long and 0.18 mm. wide, about 1.1 times as long as wide. Seta bare, shining black except for the testaceous yellow, thickened third, almost three times as long as postpedicel. Eyes in profile 0.91 mm. high and 0.54 mm. wide, nearly 1.7 times as high as wide. Inferior region of postcranium in profile 0.20 and genae below eyes 0.14 mm. wide.

Cephalic bristles pale brownish yellow; the usual garniture present and the relation in length among them is the same as in *reimoseri*, only the genal bristle is distinct.

Thorax with scutellum 2.1 mm. long and only 1.3 mm. wide, predominantly ochraceous yellow; mesonotum with the same pruinose pattern as in *heringi:* densely covered with silky whitish dusting and, except for the shining narrow hind margin, rather thick short whitish hairs; in the whitish pruinosity three light golden yellow vittae, slightly wider than in *heringi*, one on median line and two in lines of dorsocentral pair, on both sides of mesonotum before transverse suture a broad and short vitta reaching to insertion point of the presutural bristles. The chitin insertion circlets at base of dorsocentral and prescutellar bristles unusually large and shining dark brown, which is a distinct character of this species. The usual pair of black oval spots present on hind region of mesonotum, and the usual black dot behind (and beneath) wing base. Pleura shining except for the mesopleuron and "hypopleura" (katepimeron), and marked with the same three spots as in *reimoseri*. Scutellum shining ochraceous yellow, with some dark brown scattered hairs on sides. The larger median part of postscutellum yellow, whitish pruinose, lateral parts black. Mediotergite shining testaceous yellow.

Thoracic bristles pale brownish yellow, somewhat flattened; inferior mesopleural bristle only slightly shorter than superior; posterior notopleural bristle shorter and weaker than anterior. Dorsocentral pair placed close to transverse suture, approximately in anterior fourth of distance between suture and supra-alar bristles (*sa*); slightly more widely spaced than prescutellars (*prsc=acr*) which stands in posterior third of distance between *sa* and upper postalar bristles. Apical pair of scutellar bristles convergent and sometimes crossing, slightly shorter than basal pair.

Coxae and legs entirely testaceous yellow.

Wings with the general pattern of the genus. Tip of humeral cross-vein brownish black. Basal band abbreviated and ending in a diffuse small brown cloud at tip of apical process of anal cell. Subcostal cell (stigma) 2.5 to 2.8 times as long as basally broad. First section of costa (stigma) 0.60, second 1.43, third 0.82, and fourth 0.57 mm. long. Basal section of fourth longitudinal vein 1.32, penultimate (median) 0.41, and ultimate 1.36 mm. long. Inner cross-vein 0.32 mm. long and slightly more obliquely placed than the 0.59-mm.-long outer one. Whole anal cell 0.93 mm. long, 2.6 times as long as apical process (0.36 mm.).

Haltera ochraceous yellow.

Preabdomen 1.6 mm. long and 1.6 mm. wide, subshining testaceous yellow, covered with appressed brownish yellow hairs. Third to fifth tergites each with a pair of large rounded black spots, larger than in *reimoseri;* the pairs on third and fourth tergites nearly equal, widely spaced but pair on fifth tergite less so and reaching posterior margin. Fifth tergite (0.54 mm.) 1.7 times as long as fourth (0.32 mm.).

Postabdomen testaceous yellow; epandrium oval with apex hidden beneath fifth sternite. Membrane mostly black, sternites mostly testaceous yellow.

FEMALE: Like male. Length of body (without ovipositor) 4.6 (4.9) mm.; wing 4.5 (4.6) mm. long and 2.1 (2.0) mm. broad, 2.1 (2.3) times as long as broad.

Head 0.85 (0.82) mm. long, 1.41 (1.48) mm. wide, and 1.25 (1.30) mm. high. Frons at vertex 0.66 (0.70) and at anterior margin 0.48 (0.50) mm. long, and on median line 0.53 (0.54) mm. long. Postpedicel 0.25 (0.25) mm. long and 0.17 (0.16) mm. wide, 1.4 (1.5) times as long as wide. Eyes in profile 0.91 (1.00) mm. high and 0.61 (0.57) mm. wide, 1.5 (1.7) times as high as wide. Genae below eyes 0.13 (0.13), inferior region of postcranium in profile 0.16 (0.17) mm. wide.

Thorax with scutellum 1.9 (2.1) mm. long and 1.5 (1.6) mm. wide, with the same dusted pattern, black spots, etc. as in male.

Wings like those of male. First costal section 0.68 (0.73) second 1.43 (1.45), third 0.82 (0.86), and fourth 0.59 (0.61) mm. long. Basal section of fourth longitudinal vein (M_1) 1.04 (1.20), penultimate 0.41 (0.41), and ultimate 1.34 (1.38) mm. long. Inner cross-vein (*ta*) 0.32 (0.34) and outer cross-vein 0.63 (0.63) mm. long, *ta* always slightly shorter than penultimate section of M_1. Anal cell with apical process 0.95 (0.98) mm. long, approximately 2.6 times length of process (0.36 (0.38) mm.).

Preabdomen 1.9 (2.0) mm. long and 1.6 (1.7) mm. wide. Third to fifth tergites each with a pair of relatively large lateral black spots, and sixth, in all specimens examined, with a small, sometimes point-like, brownish black to yellowish brown dot, which may occasionally be completely absent. Fifth tergite approximately as long (0.27 (0.35) mm.) as the sixth (0.27 (0.33) mm.).

Ovipositor sheath dorsoventrally strongly flattened (at base only 0.11 (0.18) mm. high in profile) and entirely shining testaceous yellow, evenly covered with appressed minute brownish yellow hairs; nearly as long (0.63 (0.67) mm.) as wide at base (0.75 (0.79) mm.) and much longer than wide at apex (0.43 (0.43) mm.). Median and apical parts of ovipositor testaceous yellow, apical shining and translucent, long-oval in shape, with a distinct dorsal hook at the apex.

Types: Holotype ♂ (FML), Argentina, Misiones, Iguazú, January 30–March 13, Hayward, Willink, and Golbach. Allotype ♀, 3 ♀♀ paratypes, with same data. (One paratype in USNM 61724.)

Tomoplagia reimoseri Hendel

Figures 101,*i-m;* 102,*q,r;* Plate 25, figure 24

Tomoplagia reimoseri Hendel, 1914, p. 39.

This seems to be a common medium-sized species in northern Argentine, southern Brazil, and Paraguay; it belongs to the *pleuralis-reimoseri* group, differing from the allied species by the characters given in the key.

Male: Length of body 4.0 (4.3) mm.; wing 4.2 (4.5) mm. long and 1.8 (1.9) mm. broad, slightly more than 2.3 times as long as broad.

Head, antennae, and maxillary palpi testaceous yellow, only labella brown; 0.70 (0.73) mm. long, 1.27 (1.34) mm. wide and 1.02 (1.11) mm. high. Frons at vertex 0.59 (0.57) mm., at anterior margin 0.41 (0.39) mm. wide and on median line 0.50 (0.50) mm. long. Ocellar plate slightly raised and covered with many scalelike whitish hairs; ocelli transparent golden yellow. Oral margin of mesofacial plate raised and prominent. Inferior region of cerebral plate only slightly raised. Maxillary palpi broad, sickle-shaped, tapering into a pointed tip. Postpedicel very broad-oval, 0.20 (0.20) mm. long and 0.16 (0.18) mm. wide, only 1.1 (1.2) times as long as wide; seta bare, shining black except for the thickened basal third, which is testaceous yellow; approximately 3 times as long as postpedicel. Eyes in profile 0.87 (0.91) mm. high and 0.48 (0.49) mm. wide, approximately 1.8 times as high as wide; inferior region of postcranium in profile 0.18 (0.18), genae below eye 0.09 (0.08) mm. wide, both are relatively narrow.

Cephalic bristles brownish yellow and somewhat flattened; three pairs of incurved lower orbital bristles, relatively short, anterior pair slightly shorter than posteriors and not longer than posterior pair of recurved upper orbital bristles (*ors*). Genal bristle not very distinct. Anterior pair of *ors* subequal to outer vertical and ocellar bristles.

Thorax with scutellum 1.9 (2.0) mm. long and 1.5 (1.6) mm. wide, testaceous to ochraceous yellow in ground color; mesonotum densely covered with pale brass-yellow pruinosity and short appressed yellowish hairs, thickish and shining except for the shining narrow hind margin; no vittae of differently colored dusting, but three linear structural vittae, visible only from behind, in darker color: one on median line and two on lines of dorsocentral bristles. On hind region of mesonotum the usual pair of lateral black spots, each between prescutellar and upper postalar bristles, and a small black dot behind (and beneath) wing base. In a single male specimen (from Corrientes) the partly obliterated remains of a median pair of black spots between the usual pair, which are pale brown in color and nearer to scutellar suture than the usual spots, distance between them approximately equal to its diameter. Pleura shining, except the whitish dusted mesopleuron (anepisternite) and sternopleuron (katepisternite); marked with three black spots: a shining and oval one on sternopleuron below bristle (in some specimens it is brownish yellow), a large one above hind coxa on metapleura, and on inferior margin of pleurotergites a double one which is almost always wider on dorsal pleurotergite. Scutellum shining ochraceous yellow with some yellowish hairs on sides. Median region of postscutellum yellow, the lateral ones black. Mediotergite shining intensive dark testaceous yellow.

Thoracic bristles brownish yellow and somewhat flattened; inferior mesopleural bristle three-fourths as long as, and much weaker than, superior; posterior notopleural bristle slightly to considerably weaker, shorter than anterior. Dorsocentral pair situated approximately in anterior third of distance between transverse suture and supra-alar bristles (*sa*) and only slightly wider spaced than prescutellar pair, which stands approximately in posterior third of distance between *sa* and upper postalar bristles. Apical pair of scutellar bristles only slightly shorter than basal pair and slightly divergent.

Coxae and legs testaceous yellow, distitarsi of mid and hind legs usually darkened.

Wings with the characteristic pattern of the genus; tip of humeral cross-vein brownish black, costa blackened only at tip of subcosta. Basal band abbreviated, ending in a diffuse transparent brown cloud distad to anal vein. Subcostal cell (stigma) 2.0 (2.9) times as long as basally broad. First costal section 0.73 (0.66), second 1.34 (1.50), third 0.77 (0.77), and fourth 0.50 (0.48) mm. long. Basal section of the fourth longitudinal vein 1.07 (1.13), median (penultimate) 0.34 (0.34), and ultimate 1.27 (1.43) mm. long. Inner cross-vein 0.34 (0.34) mm. long and slightly more obliquely placed than the outer cross-vein (0.59 (0.63) mm.). Whole anal cell 0.85 (0.95) mm. long, approximately 2.6 times as long as the apical process (0.32 (0.36) mm.).

Halteres ochraceous to testaceous yellow.

Preabdomen 1.6 (1.7) mm. long and 1.2 (1.6) mm. wide, shining testaceous yellow and covered with golden shining appressed brownish yellow hairs. Third to fifth tergites each with a pair of lateral black spots, placed in nearly parallel longitudinal rows, only the pair on the third tergite slightly wider spaced than the others; black spots of third tergite usually rounded, those on fifth tergite largest and long-oval but never reaching anterior or posterior margins. Fifth tergite in this species short, only 1.2 (1.3) times as long as fourth (fifth 0.43 (0.45), fourth 0.35 (0.34) mm.).

Postabdomen testaceous yellow; epandrium wide-oval with normally shaped surstyli and with two pairs of shining black gonapophyses; posterior pair nearly as long as anterior, but much slender.

Female: Like male. Length of body 4.2 (4.1) mm.; wing 4.1 (4.0) mm. long and 1.9 (2.2) mm. broad, 2.1 (2.2) times as long as broad.

Head 0.70 (0.71) mm. long, 1.32 (1.58) mm. wide, and 1.07 (1.07) mm. high. Frons at vertex 0.57 (0.57) mm. and at anterior margin 0.38 (0.38) mm. broad, and medianly (from lunula to vertex) 0.57 (0.54) mm. long. Postpedicel 0.23 (0.22) mm. long and 0.19 (0.16) mm. wide, approximately 1.2 (1.3) times as long as wide. Eyes in profile 0.86 (0.91) mm. high and 0.48 (0.46) mm. wide (long), 1.8 (2.0) times as high as wide. Genae below eyes 0.07 (0.07) and the inferior region of postcranium in profile 0.18 (0.19) mm. wide.

Thorax with scutellum 2.0 (1.9) mm. long and 1.5 (1.4) mm. wide, with the same black markings as in male.

Wings like that of male; first costal section 0.66 (0.59), second 1.38 (1.38), third 0.75 (0.77), and fourth 0.50 (0.48) mm. long. Basal section of fourth longitudinal vein (M_1) 1.04 (1.09), median (penultimate) 0.32 (0.34), and ultimate 1.36 (1.36) mm. long. Inner cross-vein (*ta*) 0.32 (0.32) mm. long and slightly more obliquely placed than the outer cross-vein (0.63 (0.63) mm. long); *ta* approximately as long as median section of M_1 (between both cross-veins). Whole anal cell 0.86 (0.84) mm. long, 2.4 (2.2) times as long as the apical process (0.36 (0.38) mm.).

Preabdomen without ovipositor 1.5 (1.5) mm. long and 1.7 (1.6) mm. wide. Third to fifth tergites each with a pair of lateral black spots, the pair on second tergite slightly wider spaced than the others; all three pairs of rounded spots may be equally large or may be unequal, in the latter case the spots on fifth tergite are largest and those on the third smallest. On sixth tergite a pair of small lateral black dots may exceptionally be present. Fifth tergite approximately as long (0.23 (0.25) mm.) as the sixth (0.25 (0.24) mm.).

Ovipositor sheath very short, trapezium-shaped, dorsoventrally strongly flattened and entirely shining testaceous yellow, covered with appressed minute brownish yellow hairs; much shorter (0.41 (0.41) mm.) than wide at base (0.73 (0.70) mm.), and approximately as long as apically wide (0.41 (0.41) mm.); at base only 0.16 (0.20) mm. high in profile. Median part of ovipositor (rasper) testaceous yellow, apical part shining and translucent testaceous yellow, long-oval with rounded tip and with a distinct small dorsal hook at the apex.

Species originally described from Paraguay (San Bernardino) and Trinidad (Port of Spain).

TYPES: In Vienna Museum and Hungarian National Museum, Budapest.

SPECIMENS EXAMINED: Brazil: São Paulo, Ipiranga, ♂, October 1937, F. Lane, Pôrto Cabral, 2 ♂♂, April 1–25, 1944, Travassos Filho, M. Carrera, and E. Dente, Batatais, ♂, June 1945, Pereira, and Irapolis, ♀, May 1947, F. Lane (all in Dep. Zool., São Paulo); near São Paulo, ♀, 1932, Kisliuk and Cooley No. 263 (in USNM); Santa Catarina, Nova Teutonia, ♂, ♀, March 17–23, 1938, F. Plausmann, "*T. reimoseri* Hend., det. M. Hering" (in coll. Aczél), and 2 ♂♂, 2 ♀♀, November 1, 1950, F. Plaumann (in Naturhistorisches Museum, Basel). Argentina: Misiones, Pindapoy, ♂, J. M. Bosq, "*T. jonasi* (Lutz and Lima) det. E. E. Blanchard," Corrientes, Corrientes, 3 ♂♂, 2 ♀♀, April 1938, D'Angelo (all in coll. Blanchard); Misiones, Puerto Bemberg, 13 ♂♂, 13 ♀♀, and Iguazú, 44 ♂♂, 32 ♀♀, January 30–March 14, 1945, Hayward, Willink, and Golbach (all in FML). Venezuela, Carabobo, Valle Seco, ♂, 2 ♀♀, January 1940, P. Anduze, (in USNM). Paraguay, Villarica, May and June 1939, 2 ♀♀, F. Schade (in USNM).

Tomoplagia rudolphi (Lutz and Lima)

FIGURES 101,*a-d;* 102,*a,b;* PLATE 26, FIGURE 25

Plagiotoma biseriata Ihering (not Loew), 1912, p. 14.
Plagiotoma rudolphi Lutz and Lima (new name), 1918, p. 10.
Tomoplagia rudolphi (Lutz and Lima), Lima, 1934, p. 116.

One of the largest species of the genus which belongs to the *atelestaphaedra* group. There is no doubt that *T. vernoniae* Hering is but a synonym to this species because the original description of *vernoniae* entirely agrees with the examined *rudolphi* specimens, and Hering apparently did not know this species ("von der schon bekannten cecidogenen Art an *Vernonia*, *T. rudolphi* ist sie sogleich durch die ganz gelbe

Cb_2 zu unterscheiden") which has the second basal cell (Cb_2) entirely yellow. In any case the wing photograph published by Dr. A. da Costa Lima does not demonstrate this character.

It may be easily distinguished from the other species by the characters given in the key, and principally by the arrowhead-shaped apical part of the ovipositor.

MALE: Length of body 7.7 mm.; wing 7.3 mm. long and 2.6 mm. wide, 2.8 times as long as wide.

Head entirely testaceous yellow, 1.29 mm. long, 2.31 mm. wide, and 2.07 mm. high, considerably wider and higher than long. Frons at vertex 1.18, at anterior margin 1.00 mm. broad and medianly 1.02 mm. long, about as long as broad at anterior margin and twice as broad as one eye. Oral margin of mesofacial plate raised and prominent. Cerebral plate on occiput not raised. Antennae and mouthparts testaceous yellow except for the dark brown labella; apical part of broad-oval maxillary palpi slightly darkened. Postpedicel broad-oval, dorsally convex, 0.34 mm. long and 0.25 mm. wide, more than 1.3 times as long as wide; seta bare, dark brown with golden lustre except for thickened basal third, which is dark testaceous yellow; three times as long as postpedicel. Eyes in profile 1.95 mm. high and 0.79 mm. wide (long), more than 2.4 times as high as wide and 5.7 times as high as genae, bare. Genae below eyes relatively broad (0.34 mm.), nearly as broad as inferior region of postcranium in profile (0.36 mm.).

Cephalic bristles brownish yellow and somewhat flattened: three pairs of incurved lower orbital bristles (*ori*), anterior pair only slightly shorter; the divergent outer ventral pair and anterior pair of the recurved upper orbital bristles (*ors*) subequal to *ori*, ocellar pair slightly longer. Posterior pair of *ors* shorter, and the slightly convergent inner vertical pair much longer than *ori*.

Thorax with scutellum 3.3 mm. long and 2.6 mm. wide, testaceous yellow in ground color; mesonotum evenly covered with light yellow dusting and golden shining appressed short hairs, except for the bare and shining narrow posterior margin; in the specimens examined no dusted vittae of different color. The usual pair of oval black spots present on hind margin of mesonotum, and between them in all the specimens examined a pair of smaller rounded black spots situated nearer to scutellar suture than the lateral spots. On the sides of mesonotum three black spots: the largest spot above wing base, a short vittalike one below posterior notopleural bristle, and a smaller one behind wing base; all these spots black to dark brown. Pleura with no black spots.

Thoracic bristles long, brownish yellow with golden lustre. Two pairs of nearly equal, long mesopleural bristles; dorsocentral (*dc*) pair inserted in line with supra-alars or slightly before them. Prescutellar pair nearly as widely spaced as *dc* pair and placed nearly in line with upper postalar pair. Scutellum faintly shining, and covered with fine whitish pruinosity, on sides with some appressed brownish yellow hairs. Postscutellum entirely yellow, whitish pruinose, without

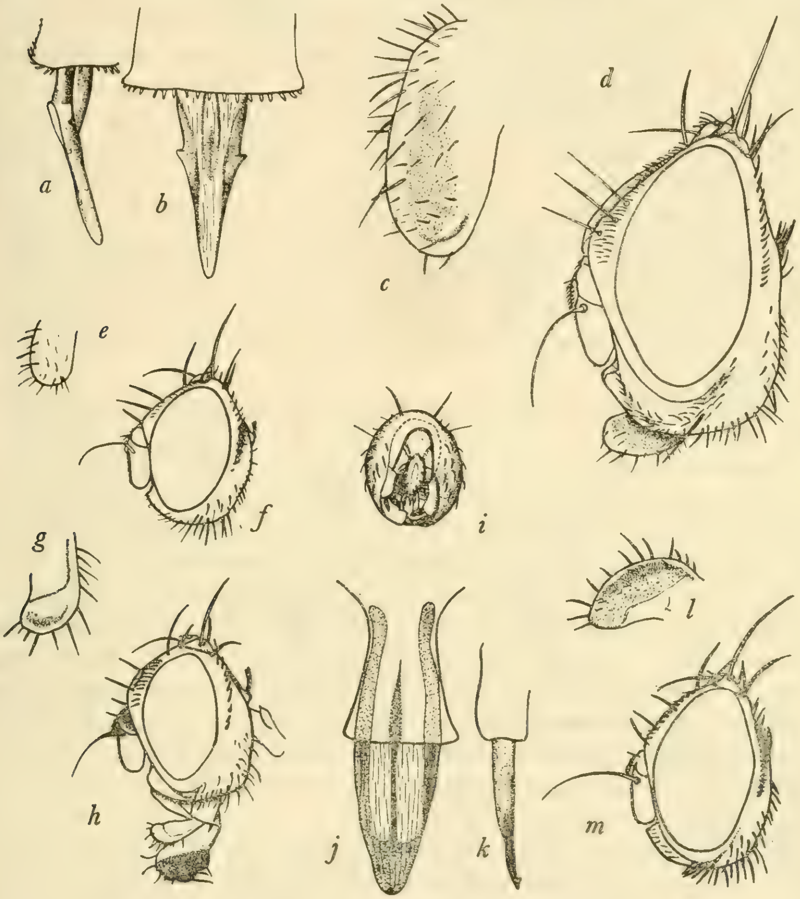

FIGURE 101.—*Tomoplagia rudolphi:* *a*, Lateral view of ovipositor tip; *b*, dorsal view of ovipositor tip; *c*, right maxillary palpus, superior surface; *d*, lateral view of head. *T. salesopolitana:* *e*, Left maxillary palpus, inferior surface; *f*, lateral view of head. *T. unifascia:* *g*, Left maxillary palpus, superior surface; *h*, lateral view of head. *T. reimoseri:* *i*, Dorsal view of epandrium; *j*, dorsal view of ovipositor tip; *k*, lateral view of ovipositor tip; *l*, right maxillary palpus, superior surface; *m*, lateral view of head.

lateral black spots. Mediotergite shining dark testaceous yellow, sometimes with irregular brownish markings.

Coxae and legs testaceous yellow.

Halteres testaceous yellow, the knob brownish.

Wings with the usual pattern of the genus but the bands intense yellow without dark brown distal borders, only the median band has a vestige of a dark border. Tips of apical, subapical, and median bands brownish; subapical band sometimes very pale. Basal band abbreviated, does not reach posterior wing margin and does not end in a dark brown spot or cloud. Costa not blackened at tip of humeral cross-vein nor at tip of subcosta. Subcostal cell (stigma) 2.5 (♀♀ 3.0) times as long as broad at base. First costal section 1.07, second 2.11, third 1.25, and fourth 0.79 mm. long; basal section of fourth longitudinal vein (M_1) 2.02, median (penultimate) 0.45, and ultimate 2.17 mm. long. Inner cross-vein more obliquely placed than outer (*tp*) and as long as the penultimate section of M_1 (0.45 mm.); *tp* 0.95 mm. long. Whole anal cell 1.38 mm. long, 2.9 times as long as apical process (0.48 mm.).

Preabdomen moderately shining, testaceous yellow, covered with appressed yellowish and blackish hairs, 3.8 mm. long and 2.9 mm. wide. In the specimen examined only the fourth tergite with a pair of small blackish brown lateral spots. The 0.91-mm.-long fifth tergite approximately 1.5 times as long as fourth (0.59 mm.). Sternites and membrane testaceous yellow.

Postabdomen brownish yellow; epandrium wide oval (Costa Lima 1934, fig. 1).

Female: Like male. Length of body 6.6 (7.4) mm.; wing 6.7 (7.8) mm. long and 2.5 (2.8) mm. wide, 2.7 (2.8) times as long as wide. Head 1.18 (1.41) mm. long, 2.09 (2.50) mm. wide, and 1.80 (2.18) mm. high. Frons at vertex 1.03 (1.23), and at anterior margin 0.82 (0.98) mm. broad, and medianly 0.91 (1.02) mm. long. Postpedicel 0.32 (0.40) mm. long and 0.22 (0.25) mm. wide, 1.5 (1.6) times as long as wide. Eyes in profile 1.36 (1.63) mm. high and 0.77 (0.79) mm. long, 1.7 (2.0) times as high as long (wide) and 4.3 (4.7) times as high as genae. Genae below eyes 0.29 (0.37) mm. wide, nearly as wide as inferior region of postcranium in profile (0.32 (0.45) mm.).

Thorax with scutellum 3.0 (3.8) mm. long and 2.2 (2.7) mm. wide, with the same characters as in male.

Wings like that of male; first costal section 0.85 (1.07), second 2.23 (2.62), third 1.14 (1.34) and fourth 0.75 (0.79) mm. long. Basal section of fourth longitudinal vein (M_1) 2.02 (2.27), penultimate 0.45 (0.50), and ultimate 2.09 (2.34) mm. long. Inner cross-vein (*ta*) 0.43 (0.52), outer 0.93 (0.95) mm. long; *ta* approximately as long as penultimate section of M_1. Whole anal cell 1.34 (1.66) mm. long, 2.7 (2.8) times as long as apical process (0.50 (0.57) mm.).

Preabdomen 2.4 (2.6) mm. long and 2.8 (2.9) mm. wide, wider than long; fourth to sixth tergites each with a pair of small lateral rounded blackish brown spots; the pair on fifth tergite usually larger than the others; third tergite sometimes also marked with a pair of small lateral spots, usually lighter in color that the others. Fifth tergite slightly shorter (0.36 (0.34) mm.) than the sixth (0.41 (0.43) mm.).

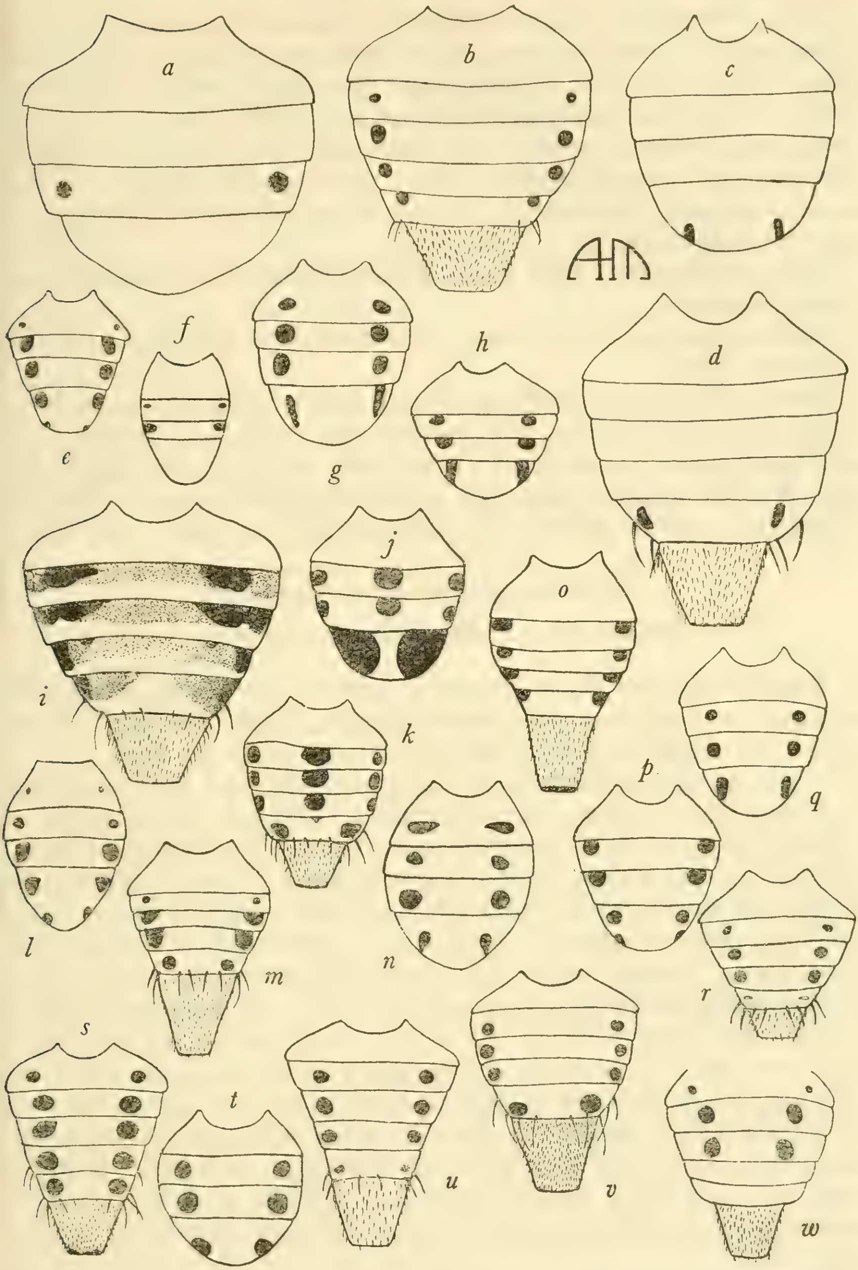

FIGURE 102.—Dorsal markings of abdomen: *Tomoplagia rudolphi: a*, Male; *b*, female: *T. phaedra: c*, Male; *d*, female. *e*, *T. unifascia*, male. *f*, *T. salesopolitana*, male. *g*, *T. kelloggi*, male. *h*, *T. pleuralis*, male. *i*, *T. minattai*, female. *T. fiebrigi: j*, Male; *k*, female. *T. incompleta: l*, Male; *m*, female. *n*, *T. argentiniensis*, male. *T. costalimai: o*, Female; *p*, male. *T. reimoseri: q*, Male; *r*, female. *s*, *T. heringi*, female. *T. punctata: t*, Male; *u*, female. *v*, *T. formosa*, female. *w*, *T. ovalipalpis*, female.

Ovipositor sheath in the specimens examined strongly flattened dorsoventrally, much shorter (0.79 (0.93) mm.) than basally wide (1.34 (1.34) mm.), and slightly longer than apically wide (0.68 (0.70) mm.); at base only 0.30 (0.30) mm. high in profile; entirely subshining testaceous yellow, covered with fine and short appressed hairs. Median part (rasper) reddish yellow; the arrowhead-shaped shining and translucent, testaceous yellow apical part of ovipositor is characteristic for this species.

TYPE: In Museum of São Paulo and in the Instituto Oswaldo Cruz, Rio de Janeiro.

TYPE LOCALITY: The States of São Paulo and Rio de Janiero in southern Brazil.

SPECIMENS EXAMINED: Brazil: Rio de Janeiro, Tinheiro, ♂, ♀, June 27, 1940, P. A. Araujo "De cecidias em caule de *Vernonia. T. rudolphi* Lutz & Lima, det. C. Lima, 8480 and 8482 col. ENA." (in coll. Escuela de Agronomía, Rio de Janeiro); São Paulo, ♀, May (in USNM); Paraná, Curitiba, ♀, December 1940, Claretiáno (in FML).

Tomoplagia salesopolitana, new species

FIGURES 101,*e,f;* 102,*f;* PLATE 26, FIGURE 26

A small species of the *obliqua-monostigma-minuta* group, similar to *minuta*, differing from this species by the black markings of the abdominal tergites and by other characters given in the key.

MALE: Length of the body 4.0 (3.8) mm.; wing 4.0 (3.7) mm. long and 1.6 (1.5) mm. broad, approximately 2.5 times as long as broad.

Head pale testaceous to ochraceous yellow, 0.68 (0.66) mm. long, 1.09 (1.04) mm. wide and 0.91 (0.88) mm. high. Frons at vertex 0.50 (0.48) and at anterior margin 0.36 (0.36) mm. broad, and on median line 0.45 (0.45) mm. long. Oral margin of mesofacial plate raised and prominent. Inferior margin of cerebral plate slightly raised. Antennae and mouthparts pale testaceous yellow, maxillary palpi almost straight and long-oval in shape. Postpedicel broad-oval, 0.23 (0.20) mm. long and 0.17 (0.15) mm. broad, slightly more than 1.3 times as long as broad; seta bare, shining black except for the thickened testaceous yellow basal fifth; about 2.5 times as long as postpedicel or slightly longer. Eyes in profile 0.77 (0.73) mm. high and 0.43 (0.41 mm. long (or wide), 1.8 times as high as wide. Inferior region of postcranium in profile 0.12 (0.16) genae below eyes only 0.05 (0.06) mm. wide.

Cephalic bristles pale brownish yellow; the usual garniture present. Anterior pair of the incurved lower orbital bristles (*ori*) shorter and weaker than the two posterior pairs and subequal to the posterior pair of recurved upper orbital bristles (*ors*); the two posterior *ori* subequal to the anterior *ors*, and the slightly longer ocellar bristles are subequal to the outer vertical bristles. Genal bristle distinct, brown with golden lustre.

Thorax with scutellum 1.7 (1.6) mm. long and 1.3 (1.1) mm. wide, pale testaceous to ochraceous yellow in ground color; mesonotum evenly covered with pale, testaceous yellow dusting and shining pale yellow appressed short hairs except for the very narrow hind margin, which is bare and shining; there are no structural or dusted vittae present. On the hind region of the mesonotum the usual pair of lateral black spots present, in this species they are small; beneath (and behind) wing base a small brownish black dot. Pleura without black spot. Scutellum whitish dusted, only linear basal border shining. Postscutellum and metanotum intensive testaceous yellow, shining, without black spots.

Thoracic bristles brownish yellow; only the upper pair of mesopleural bristles present; hind notopleural bristle only half as long as and much weaker than fore pair. Dorsocentral pair placed in transverse suture or slightly behind, more widely spaced than prescutellar pair, which is inserted far before level of upper postalar bristles close to level of supra-alar pair. Apical pair of scutellar bristles crossed and considerably shorter than basal.

Coxae and legs pale testaceous yellow, only distitarsi of mid and hind legs dark brown.

Wings with the general pattern of the genus; it is characteristic of this species that the yellow basal band is abbreviated, ending in a subquadrangular semiopaque dark brown spot distad to anal vein, at tip of apical process of anal cell. Subcostal cell (stigma) 2.2 (2.3) times as long as basally broad. First costal section (stigma) 0.57 (0.50), second 1.38 (1.34), third 0.79 (0.70), and fourth 0.52 (0.45) mm. long. Basal section of the fourth longitudinal vein 1.13 (1.02), median (penultimate, between the cross-veins) 0.32 (0.27), and ultimate 1.30 (1.11) mm. long. Inner cross-vein 0.27 (0.26) mm. long and more obliquely placed than the outer cross-vein (0.51 (0.43) mm.). Entire anal cell 0.59 (0.59) mm. long, 2.6 (3.1) times as long as apical process (0.23 (0.19) mm.)

Halteres pale ochraceous yellow.

Preabdomen 1.7 (1.7) mm. long and 1.3 (1.2) mm. wide, long-oval testaceous yellow with appressed fine brownish yellow hairs and with only two pairs of lateral black spots; third to fourth tergites each with pair of small lateral black spots, equally widely spaced. Fifth tergite (0.41 (0.41) mm.) very long, 2.3 (2.5) times as long as the fourth (0.18 (0.16) mm.).

Postabdomen testaceous yellow; epandrium long-oval, with normally shaped surstyli. Apparently only the anterior pair of the shining black gonapophyses present.

FEMALE: Unknown.

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TYPES: Holotype ♂, Brazil, São Paulo, Salesópolis, August 14, 1947, Rabello, Travassos Filho, and J. Lane. Paratype ♂, Brazil, Salesópolis, September 9, 1949, Travassos, Travassos Filho, and Rabello, ♂ Brazil, São Paulo, Campo de Jordão, January 23, 1936, F. Lane. (Holotype and paratype in Dep. Zool., São Paulo, paratype in FML.)

Tomoplagia stonei, new species

FIGURES 90; 97,*a*,*b*; PLATE 19, FIGURE 1

A large well-defined species of the *pleuralis* group with the same general characters as all other *Tomoplagia* species but differing from them in having small and shining brownish black insertion circlets on the thorax at bases of the presutural, dorsocentral, supra-alar, postalar, prescutellar, and scutellar bristles. It seems to be closely related to *arsinoe* Hering (Colombia) and to *punctata*, new species (Argentina).

MALE: Length 6.7 (7.3) mm.; wing 7.5 (8.1) mm. long and 3.1 (3.3) mm. wide, always longer than body and nearly 2.5 times as long as wide.

Head 1.09 (1.13) mm. long, 1.91 (2.07) mm. wide, and 1.77 (1.93) mm. high, pale ochraceous yellow; frons homogeneously pale ochraceous yellow, only genovertical and ocellar plates slightly grayish, parafacial plate below eyes brownish yellow; ocelli transparent clear yellow; frons at vertex 0.86 (0.88) and at anterior margin 0.56 (0.66) mm. wide, and in median line 0.70 (0.85) mm. long, shorter than wide at vertex; mesofacial plate impressed as in all other species; oral margin raised and considerably prominent. Antennae, maxillary palpi, and mouthparts pale ochraceous yellow; postpedicel oval, 0.38 (0.50) mm. long and 0.18 (0.25) mm. wide, 2 (2.2) times as long as wide, sometimes darkened; seta nearly three times as long as postpedicel, bare and shining black except the thickened basal parts, which are brownish yellow. Eyes in profile more than twice as high as wide, sparsely beset with tiny erect whitish hairs.

All head bristles as brownish yellow as the thoracic bristles and somewhat flattened. Three pairs of incurved lower orbital bristles present, posterior pair always slightly longer than anterior ones and subequal to posterior pair of recurved upper orbital bristles (*ors*); anterior pair of *ors* slightly longer than these and about as long as the strongly divergent ocellar bristles; as usual in Tephritidae, the inner verticals are the longest of all head bristles, slightly longer than the outer ones. A distinct genal bristle.

Thorax pale ochraceous yellow in ground color, 3.1 (3.4) mm. long and 2.3 (2.4) mm. wide; mesonotum densely covered with pale ochraceous yellow dusting and short pale appressed hairs except the narrow bare posterior part in front of scutellum, which is as subshining and sparsely whitish dusted as scutellum; in the dusting of mesonotum are three vittae, golden yellow dusted and equally narrow, one in median line and two lateral ones in dorsocentral line; the pale ochraceous yellow dusted space between two golden yellow vittae twice as broad as one vitta. Only one pair of oval black spots, each between upper postalar and prescutellar bristles; a pair of round black spots, each beneath the base of wing and below postalar callosity. This is the only known species with small but very distinct shining brownish black circlets on mesonotum at bases of the presutural, dorsocentral, supra-alar, postalar, prescutellar, and scutellar bristles. In *punctata* only the dorsocentral and prescutellar bristles are inserted on shining dark brown circlets.

Thoracic bristles long and strong, brownish yellow and somewhat flattened; apical pair of scutellar bristles crossed; two pairs of long mesopleural bristles, inferior slightly shorter than superior; dorsocentral pair inserted about half way between transverse suture and supra-alar bristle.

On pleura only two small black dots present, a round one on sternopleura below sternopleural bristle and an oval one on inferior margin of ventral pleurotergite at base of haltere; the latter may be absent, principally in male. Sometimes there is a smaller black or brown dot above hind coxa. Scutellum pale ochraceous yellow, with narrow basal part subshining and with apical two-thirds sparsely covered with yellow appressed hairs. Each side of postscutellum with a triangular black marking. Mediotergite (metanotum of authors) shining and intensively brownish yellow with reddish tinge.

Coxae and legs entirely ochraceous to testaceous yellow, with bristles and hairs ochraceous yellow except for a row of densely spaced anterodorsal bristles and a row of much weaker posterodorsal bristles, and, between these, two rows of hairs on hind tibiae brownish black.

Halteres pale ochraceous yellow.

Wing with the usual pattern of the genus; base of subapical band very narrow; basal band present, forming at apical process of anal cell a diffuse translucent dark brown spot, which extends over anal vein; costa at humeral cross-vein (*th*) and at termination of subcosta not blackened, a small blackish brown dot on anterior termination of *th*, and almost linear borders of the same color at tip of subcosta (auxiliary vein). Stigma (=subcostal cell) long, nearly 2.8 times as long as wide basally. First costal section 1.13 (1.13), second 2.61 (2.73), third 1.36 (1.32), and fourth 0.75 (0.82) mm. long; first section of the fourth vein (M_1) 2.38 (2.45), penultimate section (between the cross-veins) 0.54 (0.59), and ultimate section 1.93 (2.0) mm. long; inner cross-vein (*ta*) 0.59 (0.66), outer cross-vein (*tp*) 1.13 (1.18) mm. long, *ta* slightly longer than distance between cross-veins (=penultimate section of M_1), and much more obliquely situated than *tp;* fifth longitudinal (M_3+Cu_1) vein which limits posteriorly the discoidal cell hardly excurved; anal cell very long (1.82 (1.86) mm.), its apical process (0.95 (1.00) mm.) slightly longer than rest of cell, and considerably longer than petiole (Cu_2+An_2); the whole anal cell only 1.8 times as long as the apical process.

Preabdomen subshining pale ochraceous to testaceous yellow, covered with pale yellowish and brownish hairs, 2.6 (3.0) mm. long and on the second tergite 1.8 (2.1) mm. wide; fourth and fifth tergites each with a pair of vittalike lateral black marks, and third tergite with a pair of lateral small dots, black to pale brown. Fifth tergite 0.81 (0.91) mm. long, 1.7 times as long as fourth. Sternites, membrane, and postabdomen of same color as tergites.

Epandrium oval; two pairs of gonapophyses ("claspers" of authors) shining black, posterior pair smaller.

Female: Like male. Length 5.8 (7.3) mm., wings 7.4 (8.1) mm. long and 3.2 (3.5) mm. wide. Head 1.13 (1.18) mm. long, 1.98 (2.11) mm. wide, and 1.86 (1.93) mm. high. Frons at vertex 0.88 (0.95) and at anterior margin 0.63 (0.68) mm. wide, and in median line 0.80 (0.93) mm. long. Postpedicel 0.48 (0.50) mm. long and 0.23 (0.23) mm. wide. Thorax with scutellum 3.2 (3.4) mm. long and 2.4 (2.5) mm. wide, with the same black markings as in male.

Wings like that of male; first costal section 1.13 (1.29), second 2.61 (2.86), third 1.38 (1.38), and fourth 0.80 (0.86) mm. long; first section of the fourth longitudinal vein (M_1) (proximal to *ta*) 1.88 (2.16), penultimate 0.57 (0.63), and ultimate 2.43 (2.61) mm. long; inner cross-vein (*ta*) 0.57 (0.70), outer 1.62 (1.29) mm. long; anal cell 1.86 (1.86) mm. long, including apical process (1.02 (1.02) mm.), apical process is longer than half the whole cell length.

Preabdomen 2.2 (3.0) mm. long and 2.4 (2.6) mm. wide with the same black markings as in male but sixth tergite without black marks; fifth tergite 0.32 (0.43), sixth 0.43 (0.61) mm. long, longer than the fifth.

Sheath of ovipositor 1.29 (1.45) mm. long, in some specimens dorsoventrally flattened (first numbers), in others subcylindrical, shining and translucent testaceous yellow, evenly covered with fine golden shining brownish hairs; more than twice as wide at base (1.20 (1.11) mm.) as at apex (0.52 (0.45) mm.), slightly longer than basally wide. Apical part of ovipositor (ovipositor of Benjamin) dorsoventrally flattened, rather wide with rounded tip, translucent reddish yellow.

Types: Holotype ♂ (USNM 61717) and allotype ♀, Panamá, El Cermeno, April 1939, J. Zetek, No. 4382A. Paratypes: 7 ♂♂ and 8 ♀♀, with same data as type; ♂ same locality, May 10, 1940, J. Zetek "No. 4560, Fruit-fly trap," ♂ same locality, April 28, 1940, J. Zetek; ♀ La Campana, April 13, 1938, J. Zetek, "No. 5522." (Holotype, allotype, and 13 paratypes in USNM, 6 paratypes in FML.)

Observation: In all specimens examined the fourth longitudinal vein (M_1) is loosely setulose from the base only to the inner cross-vein (*ta*) on both surfaces of the wing.

Tomoplagia trivittata **(Lutz and Lima)**

Figure 96,*d,e;* 97,*e;* Plate 21, figure 11

Plagiotoma trivittata Lutz and Lima, 1914, p. 10.
Tomoplagia trivittata (Lutz and Lima), Lima, 1934, p. 118.

The writer has two specimens of this well-defined species of the *pleuralis* group, originally described from Brazil, which differs from its allies by having two testaceous yellow vittae on the frons as well as by other characters. The Argentine specimen differs slightly from the Brazilian, e. g., the Argentine specimen has the same wing pattern as figured by Costa Lima (1934, pl. 1, fig. 3) and nearly parallel vittae on the frons; the Brazilian specimen is larger in size, its wing pattern is slightly different, and the testaceous yellow vittae are more converging towards anterior margin of the frons, forming a V-shaped marking. It will be necessary to study more specimens, especially reared material, in order to settle the status of the Brazilian male specimen described here. This may represent a variety or a subspecies.

Male: Length 5.5 mm.; wing 5.7 mm. long and 2.6 mm. wide, 2.2 times as long as wide.

Head pale ochraceous yellow, 1.02 mm. long, 1.68 mm. wide, and 1.43 mm. high. Frons at vertex 0.73 and at anterior margin 0.59 mm. wide, and in median line 0.66 mm. long, wider at vertex than long, with a testaceous yellow V-shaped marking on frontal vitta; ocellar, genovertical, parafacial and mesofacial plates, and a wedge-shaped longitudinal stripe on middle of frontal vitta (in front of ocelli) densely covered with whitish dusting. Oral margin of mesofacial plate raised and prominent. Antennae and mouthparts testaceous yellow, except the yellowish brown labellae; postpedicel 0.27 mm. long and 0.20 mm. wide, 1.3 times as long as wide, with bare shining black seta (only basal seventh testaceous yellow), three times as long as the postpedicel. Eyes, in profile, very high, 2.1 times as high as wide, very sparsely beset with tiny hairs, erect and whitish.

The brownish yellow head bristles somewhat flattened; three pairs of incurved lower orbital bristles, anterior pair slightly shorter; two pairs of recurved upper orbital bristles longer and stronger than lower orbitals, posterior pair about as long as the divergent outer vertical and anterior pair hardly shorter than the slightly divergent ocellar bristles; the hardly convergent inner verticals the longest and strongest of all. One pair of distinct genal bristles present, darker than the others.

Thorax 2.7 mm. long and 1.5 mm. wide, pale ochraceous yellow in ground color; mesonotum densely covered with whitish dusting and with short whitish appressed hairs except the very narrow bare and shining posterior margin; mesonotum marked with three vittae, golden to reddish brown dusted, all equal in width, slightly narrower than the white dusted vittae among them, and narrowing towards anterior margin: a median vitta extending from anterior margin to scutellum, two lateral vittae extending from anterior margin to pair of long-oval black spots between upper postalar and prescutellar bristles; dorsocentrals inserted in the lateral brown vittae, and prescutellar ones in middle of the white median vittae; black spot beneath base of wing is relatively large and quadrangular.

The brownish yellow thoracic bristles are long and strong. Two pairs of mesopleural bristles are present, lower pair but slightly shorter than upper. Dorsocentral pair inserted in first third of distance between transverse suture and transverse supra-alar line. Apical pair of scutellar bristles slightly divergent. On the ochraceous yellow pleura three black markings: a double one on inferior part of dorsal and ventral pleurotergites, a large one above hind coxa, and a broad vitta on middle of sternopleura, which in the specimen examined extends from anterior to posterior margin of pleura, and is interrupted at its middle by a brown stretch.

Scutellum shining ochraceous yellow, with some black hairs at hind margin; postscutellum with two long-triangular lateral black spots, between them a small ochraceous yellow spot, whitish dusted; mediotergite entirely reddish brown, shining and translucent.

Coxae and legs testaceous yellow, with brownish yellow bristles and hairs, except anterodorsal row of rather closely spaced, short brownish black bristles.

Halteres ochraceous yellow.

Wing with the characteristic pattern of the genus; bands intensively colored; apical band of this specimen distinctly separated from costa by a pale linear margin, and in the three proximal bands there is much more dark yellow color than brown; basal band rather well developed but does not attain posterior wing margin, forming a large broad yellowish brown transparent spot on each side of apical process and petiole of anal cell; costa not blackened above the black spots on humeral cross-vein and at tip of subcosta. Stigma 2.8 times as long as wide basally. First costal section 0.88, second 1.91, third 1.0, and fourth 0.68 mm. long; first section of fourth longitudinal vein 1.75, penultimate 0.42, and ultimate 1.44 mm. long; inner cross-vein (*ta*) about as long (0.43 mm.) as distance between cross-veins, outer cross-vein 0.82 mm. long, less oblique than *ta*; anal cell together with its 0.54-mm.-long apical process 1.20 mm. long (whole anal cell only 2.2 times as long as apical process).

Preabdomen 2.5 mm. long and 2.2 mm. wide, shining, testaceous to brownish yellow, with broad ochraceous yellow hind margins, and covered with pale yellow and black appressed hairs; fifth tergite 0.66 mm. long, 1.75 times as long as fourth; lateral and hind margin of fifth tergite with rather closely spaced marginal bristles, strong and black; each of third to fifth tergites with a pair of lateral black spots, which are on third tergite rounded, on fourth oval, and on fifth long-triangular.

The small epandrium is testaceous yellow (see fig. 3. of Dr. A. da Costa Lima, 1934, p. 119).

The Argentine specimen was reared from sweet orange by Kenneth J. Hayward, according to information received from Dr. Hayward. After finishing this paper the writer received a small lot of Argentine *Tomoplagia* from the private collection of Dr. Everard E. Blanchard (Buenos Aires), and among them was a female specimen of *trivittata.* The author wishes to acknowledge this generous assistance. The description of this specimen with the same wing pattern as figured by Lima (in which much of the intensive yellow of the wing pattern of the São Paulo specimen is substituted by brown) is as follows:

FEMALE: Length 4.5 mm.; wing 4.1 mm. long and 1.7 mm. wide, 2.4 times as long as wide.

Head 0.89 mm. long, 1.36 mm. wide and 1.16 mm. high, colored as in the São Paulo male, but the two testaceous yellow vittae on frons nearly parallel. Frons at vertex 0.68 and at anterior margin 0.52 mm. wide, and in median line 0.59 mm. long. Postpedicel 0.29 mm. long and 0.19 mm. wide, 1.6 times as long as wide.

Cephalic bristles as in the São Paulo specimen but anterior upper orbital bristles (*ors*) slightly shorter than the two pairs of lower orbitals (*ori*), and posterior *ors* slightly shorter than anterior *ori;* the more divergent ocellar bristles as long as the outer verticals.

Thorax 1.6 mm. long and 1.4 mm. wide, ground color, vittae of mesonotum, and bristles as in the São Paulo specimen, but apical pair of scutellar bristles slightly convergent, and the black markings brown.

Coxae and legs as in the São Paulo specimen.

Halteres brownish yellow.

Wings with the typical pattern of this species (pl. 1, fig. 3 of Costa Lima, 1934); first costal section 0.59, second 1.45, third 0.73 and fourth 0.50 mm. long; first section of fourth longitudinal vein 1.41, penultimate 0.30, and ultimate 1.01 mm. long; inner cross-vein 0.29, outer, 0.66 mm. long; anal cell 0.85 mm. long, together with the 0.36-mm.-long apical process; apical process slightly shorter than in the São Paulo specimen (whole anal cell 2.3 times as long as apical process).

Preabdomen 1.8 mm. long and wide, without black spots, only faint brown lateral clouds on second to sixth tergites; fifth tergite considerably longer (0.27 mm.) than the sixth (0.19 mm.), 1.4 times as long as the sixth tergite.

Sheath of ovipositor flattened, short and wide, 0.66 mm. long, at base 0.88, at apex 0.50 mm. wide, and but 0.16 mm. high basally; dark testaceous yellow with apical third blackish brown.

Species originally described from Brazil.

TYPE: In Instituto Oswaldo Cruz (Rio de Janeiro).

SPECIMENS EXAMINED: Brazil: São Paulo, Guateparà, January 1945, ♂, M. Carrera (in Dept. Zool., São Paulo). Argentina: Entre Ríos, Concordia, ♀, May 14, 1936, K. J. Hayward, "No. 3272, ex Citrus" (in coll. Blanchard).

Tomoplagia unifascia Hendel

FIGURES 101,*g,h;* 102,*e;* PLATE 26, FIGURE 27

Tomoplagia unifascia Hendel, 1914, p. 39.

This small Chilean species is undoubtedly related to *costalimai*, differing from all known species by the mesonotum of which only the median third is dusted, the lateral thirds being bare and shining.

MALE: Length of body 3.6 mm.; wing 3.6 mm. long and 1.5 mm. broad, 2.4 times as long as broad.

Head testaceous yellow, 0.68 mm. long, 1.05 mm. wide, and 0.88 mm. high. Frons at vertex 0.50 mm., at anterior margin 0.41 mm. broad, and on median line 0.48 mm. long. Oral margin of mesofacial plate raised and prominent. Inferior margin of cerebral plate slightly raised. Postpedicel broad-oval, 0.20 mm. long and 0.15 mm. wide, only 1.25 times as long as wide. Seta bare, shining black, except for the testaceous yellow basal fourth, 2.4 times as long as postpedicel. Eyes in profile 0.68 mm. high and 0.39 mm. wide, approximately 1.7 times as high as wide. Genae below eyes 0.13, inferior region of postcranium in profile 0.30 mm. wide (that is to say, unusually wide).

Cephalic bristles brownish yellow; the usual garniture present, the distribution and the relation in length is normal as in *salesopolitana*. The distinct genal bristle in this species is also darker in color than the other bristles.

Thorax with scutellum 1.5 mm. long and 1.1 mm. wide, testaceous yellow; it is characteristic of this species that only median third of mesonotum is covered with whitish pruinosity, lateral thirds and posterior margin on both sides and behind this broad vittalike pruinose area bare and shining. Mesonotum, except for the narrow hind margin, covered as usual with evenly distributed short appressed pale yellow hairs. Hind region of mesonotum marked with the usual lateral black spots, each between prescutellar and upper postalar bristles; behind (and beneath) wing base a pointlike small black dot.

Pleura throughout shining, with only two dark brown to brownish black spots: above hind coxa a small spot on metapleura, and a larger one on inferior half of ventral pleurotergite, extending in form of a nearly linear process over inferior margin of dorsal pleurotergite. Scutellum shining, pale testaceous yellow with some scattered minute hairs on the sides. Postscutellum and mediotergite shining, intensive testaceous yellow, postscutellum with a pair of small lateral black spots.

Coxae and legs entirely testaceous yellow.

Wings with the general pattern of the genus, but slightly modified, since apex of apical band is prolonged into tip of first posterior cell, with its wide apex ending at second third of fourth costal section, which therefore has only the posterior third hyaline. Second basal cell mostly hyaline and basal band greatly abbreviated. Subcostal cell (stigma) long, approximately 3 times as long as wide at base. First costal section 0.63, second 1.11, third 0.59, and fourth 0.50 mm. long. Basal section of the fourth longitudinal vein (M_1) 1.16, median 0.23, and ultimate 1.11 mm. long. Inner (*ta*) and outer (*tp*) cross-veins nearly parallel and only slightly oblique, *ta* 0.23 and *tp* 0.50 mm. long; *ta* as long as median section of M_1. Whole anal cell 0.50 mm. long, 4.5 times as long as the short apical process (0.11 mm.).

Thoracic bristles brownish yellow; only upper mesopleural bristle present; posterior notopleural bristle slightly shorter and weaker than anterior. Dorsocentral pair inserted in anterior fifth of distance between transverse suture and supra-alar bristles (*sa*), and slightly wider spaced than prescutellar pair, which stands near level of *sa* pair. Apical pair of scutellar bristles convergent and crossed, much weaker than basal pair.

Halteres testaceous yellow.

Preabdomen 1.3 mm. long and 1.2 mm. wide, shining testaceous yellow (in the specimen examined it is irregularly darkened) and covered with dark brown appressed hairs. Second to fourth tergites each marked with a pair of rounded black lateral spots, pair on second tergite very small, nearly pointlike, pairs on third and fourth tergites large; fifth tergite with two pairs of lateral black spots, anterior pair large and oval, posterior pair represented by small, round dots touching posterior margin. The 0.50-mm.-long fifth tergite 1.7 times as long as the fourth (0.29 mm.)

Postabdomen shining, testaceous yellow; epandrium oval with normally shaped surstyli and with well developed shining black anterior gonapophyses; posterior pair very reduced.

Type. In Dresden Museum.

Type locality: Arica, Chile.

Specimens examined: Chile: Arica, La Meite, ♂, February 7, 1932, Kiskiuk and Cooley, "K. & C. Chile No. 56. on olive tree" (in USNM).

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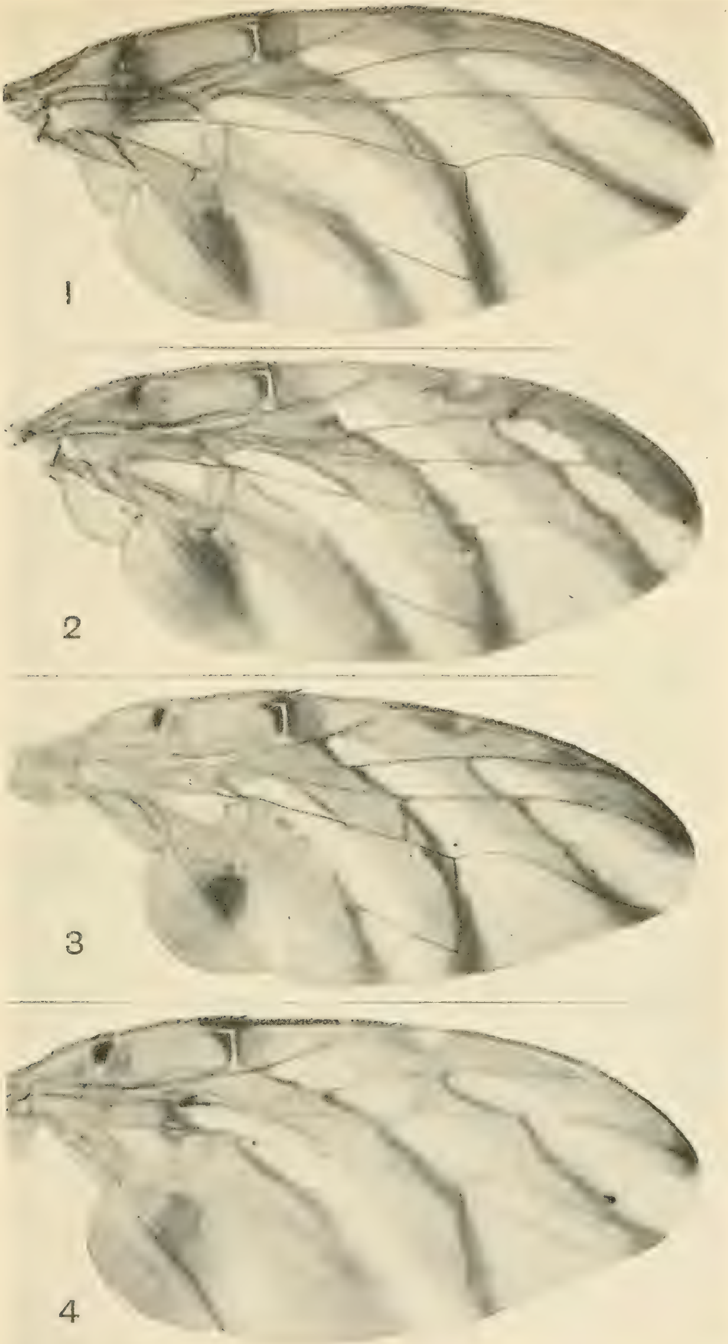
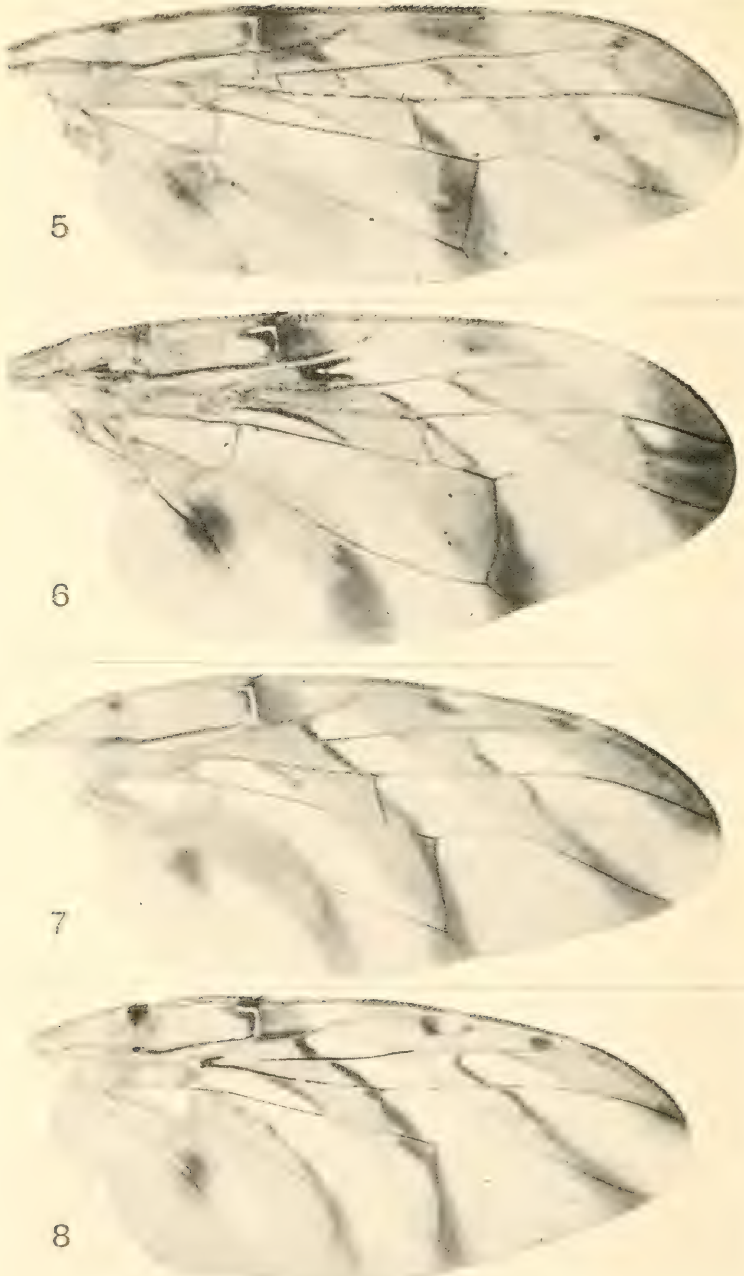
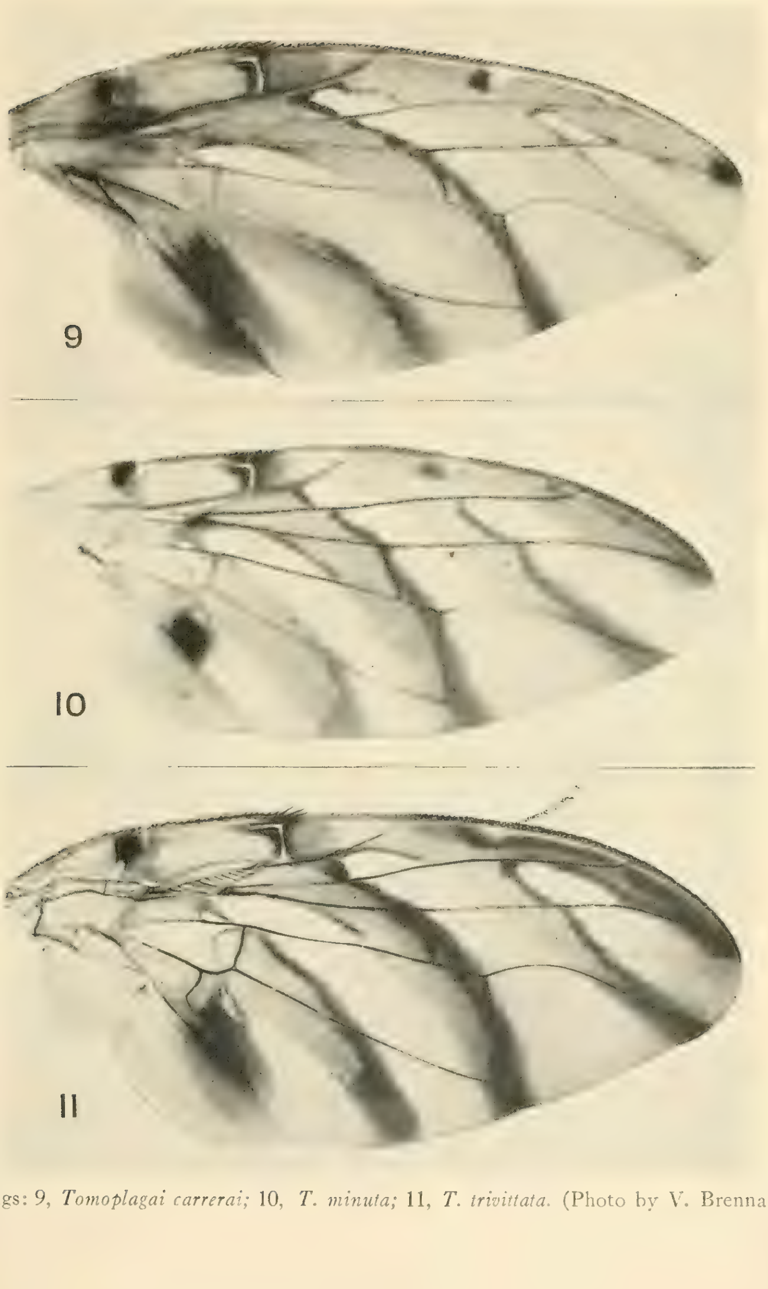


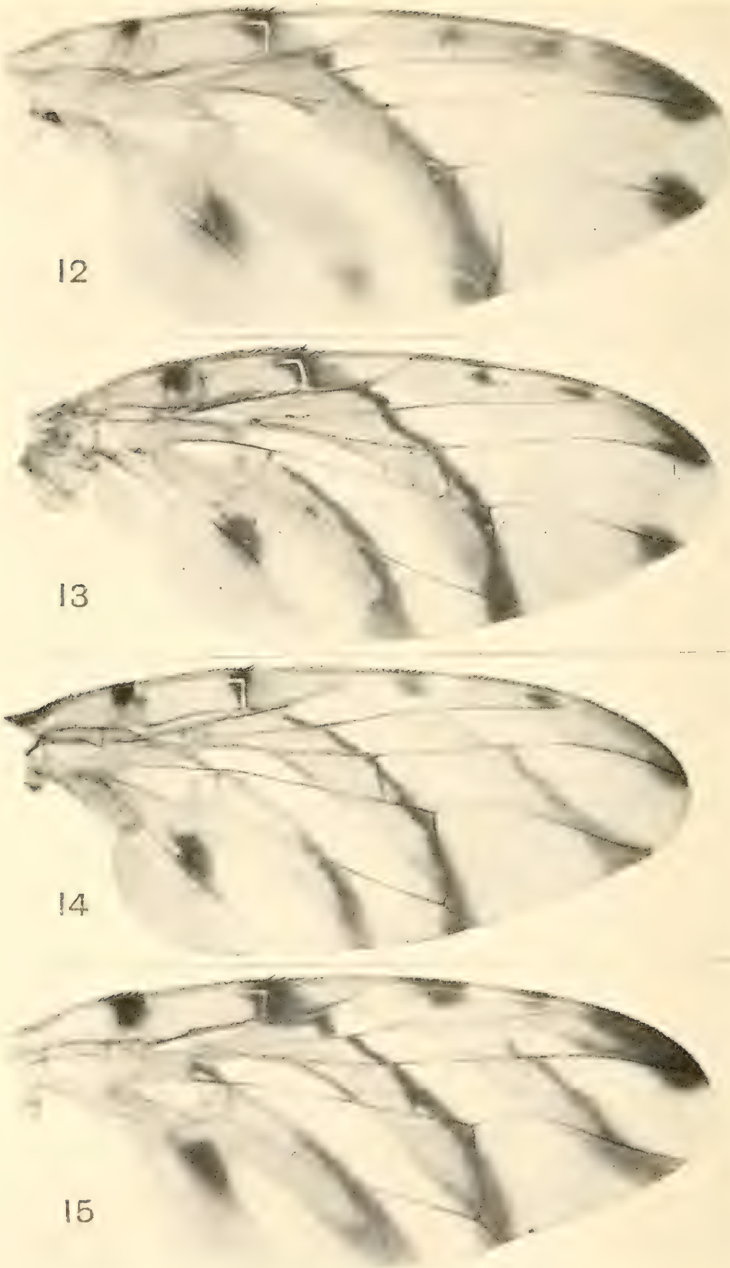
Wings: 1, *Tomoplagia stonei;* 2, *T. brevipalpis;* 3, *T. deflorata;* 4, *T. pseudopenicillata.* (Photo by V. Brennan)



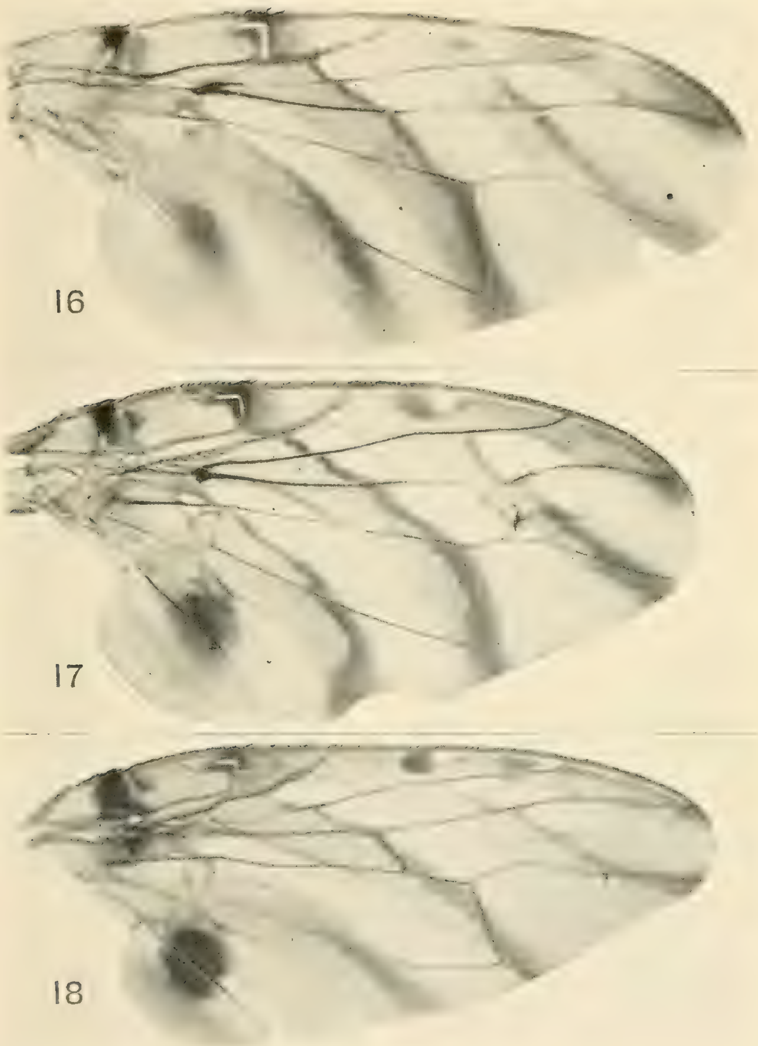
Wings: 5, *Tomoplagia propleuralis;* 6, *T. discolor;* 7, *T. cressoni;* 8, *T. monostigma.*
(Photo by V. Brennan)



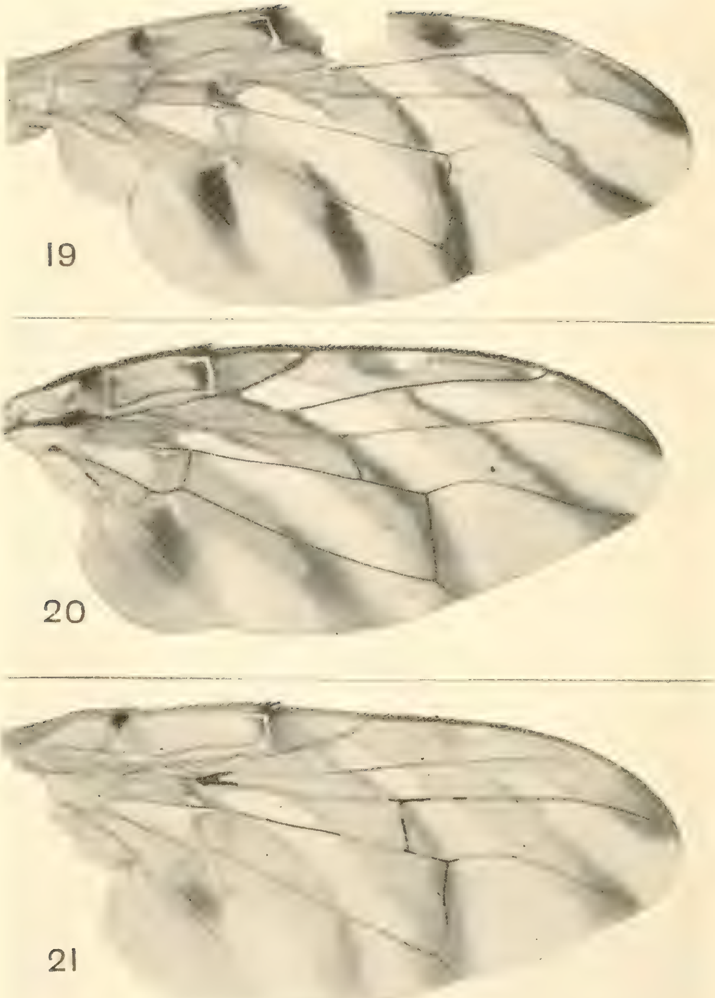
Wings: 9, *Tomoplagai carrerai;* 10, *T. minuta;* 11, *T. trivittata.* (Photo by V. Brennan)



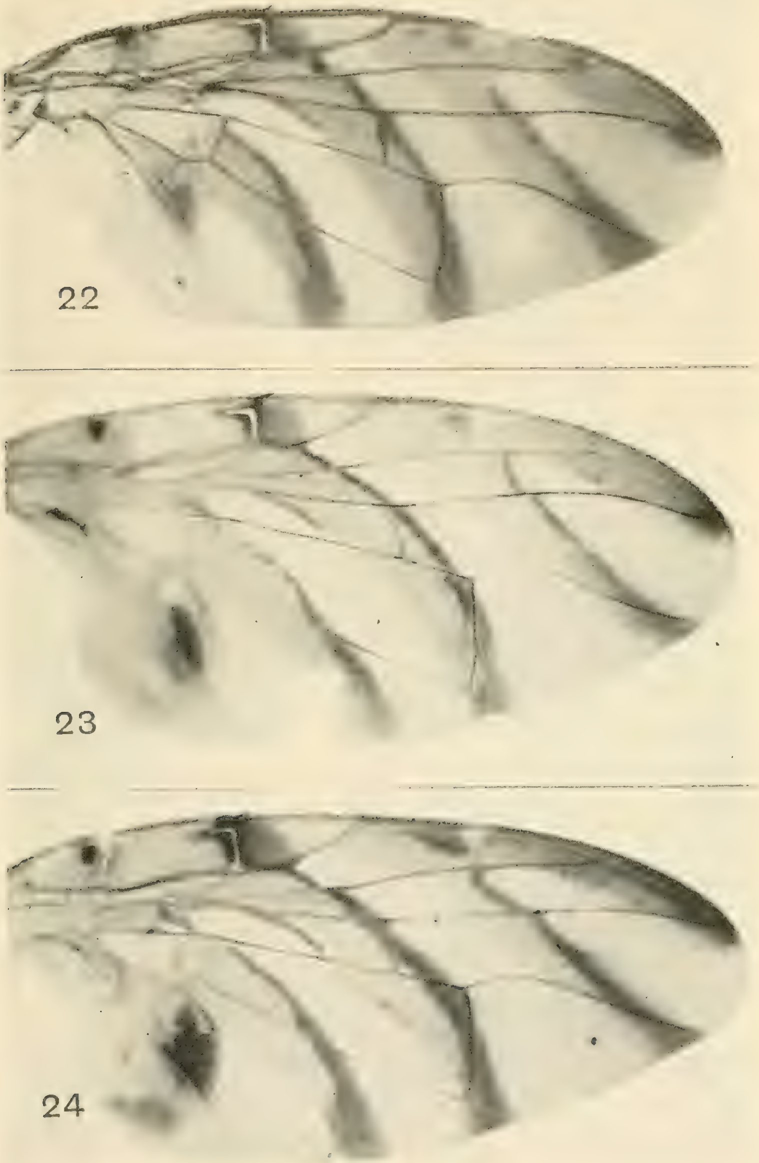
Wings: 12, *Tomoplagia incompleta:* 13, *T. argentinensis;* 14, *T. costalimai;* 15, *T. fiebrigi.* (Photo by V. Brennan)



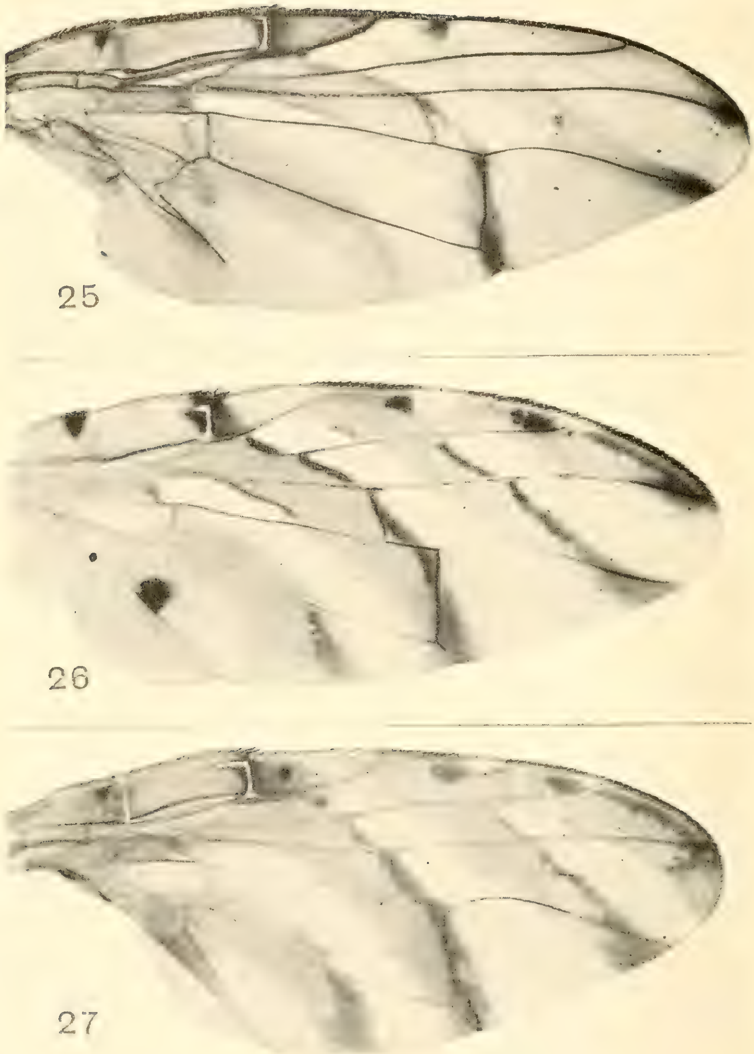
Wings: 16, *Tomoplagia formosa;* 17, *T. heringi;* 18, *T. kelloggi.* (Photo by V. Brennan)



Wings: 19, *Tomoplagia minattai;* 20, *T. ovalipalpis;* 21, *T. phaedra.* (Photo by V. Brennan)



Wings: 22, *Tomoplagia pleuralis;* 23, *T. punctata;* 24, *T. reimoseri.* (Photo by V. Brennan)



Wings: 25, *Tomoplagia rudolphi*; 26, *T. salesopolitana*; 27, *T. unifascia*. (Photo by V. Brennan)

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SCARAB BEETLES OF THE GENUS PSAMMODIUS IN THE WESTERN HEMISPHERE

By O. L. Cartwright

The beetles of the genus *Psammodius* are placed in the tribe Psammodiina of the subfamily Aphodiinae in the family Scarabaeidae. They are relatively small in size, from 2.5 to 4.6 mm. in length, usually some shade of brown or black in color, rather compact and convex, and oblong to strongly oval in shape. They occur in the sand dunes of the seacoast, the flood-plains of rivers, and other sandy places. The larvae are unknown, but those of the flightless species of the seacoast should be found rather easily at the proper season since the adults frequently occur in abundance among the roots of grasses growing in the sand dunes.

The genus is worldwide in distribution. Schmidt listed a total of 37 species in his monograph of the Aphodiinae, 15 of them from the Western Hemisphere, half the remainder from Europe and Africa, and an equal number from Australia and Asia.

In the present study, 35 species are recognized from the Western Hemisphere. Sixteen species are recorded from the United States. Four of these are also recorded from México, and a fifth also from Argentina. Six additional species occur in México and Central America and 13 more are found only in South America.

Of the 35 American species here recognized, 16 were described from the Western Hemisphere, 3 were described from Europe, and 16 are new. Two formerly accepted species, *P. aegialioides* Haldeman and *P. shermani* Cartwright, were found to be synonyms of other species and one, *P. ambiguus* Fall, is removed from *Psammodius*. *Psammodius desertus* Van Dyke was removed to the genus *Xeropsammobeus* by Saylor in 1937 (Bull. Southern California Acad. Sci., vol. 36, p. 36); *Psammodius grundeli* Van Dyke was removed to *Pleurophorus* by the writer in 1948 (Trans. Amer. Ent. Soc., vol. 74, p. 138); and *Psammodius schwarzi* Linell was removed to *Ataenius* by Brown in 1928 (Canadian Ent., vol. 60, p. 307).

The genus *Xeropsammobeus*, erected by Saylor for the species *Psammodius desertus* Van Dyke and to which I now add *Psammobius ambiguus* Fall, only superficially resembles *Psammodius*. *Xeropsammobeus* should be placed in the tribe Aphodiina because the head is not strongly bent downward but lies nearly horizontally as in typical *Aphodius:* the clypeus is punctate-rugose, not granulate; the pygidium is simple, not grooved basally; and the tibiae bear strong transverse ridges. It should be noted, however, that in *Xeropsammobeus* the posterior femurs are much wider than the middle femurs and that the middle and hind tibiae are strongly widened to a very noticeably oblique apex. The transverse tibial ridges are also strongly oblique. A paratype of *X. desertus* (Van Dyke) and the holotype of *X. ambiguus* (Fall) were examined in the present study.

I have examined type material (holotype, cotype, or paratype) of all *Psammodius* described from the Western Hemisphere except *cruentus* Harold and *interruptus* Say. Type material of the European species, *P. laevipennis* A. Costa, *basalis* (Mulsant and Rey), and *sulcicollis* (Illiger) were not available, but European specimens were studied. *Aphodius clypeatus* Say, sometimes placed in *Psammodius*, is omitted since it is impossible to place the species by the original description alone.

Measurements in millimeters were made with a Spencer stereoscopic microscope equipped with an ocular micrometer. Width is the greatest width. Length is measured along the midline. Length of the elytra is measured from the apex along the suture to a perpendicular base line touching the anterior margins of the humeri. Where long series of specimens were available, measurements were taken from an average individual to represent the relative lengths.

Specimens of *Psammodius* in the U. S. National Museum collection were so few the present study would have been impracticable without the generous cooperation and loan of specimens from other museum and private collections. I am grateful for having had the opportunity to study this material and thank the following who loaned museum specimens: G. J. Arrow and E. B. Britton, British Museum (Natural History); W. J. Brown, Canadian Department of Agriculture; H. Freude, Zoologische Sammlung des Bayerischen Staats, Munich; Frederico Lane and Ernest X. Rabello, Departmento de Zoologia, São Paulo; Rene Malaise, Naturhistoriska Riksmuseum, Stockholm; R. H. Beamer, Snow Museum, University of Kansas; M. A. Cazier, American Museum of Natural History; P. J. Darlington, Jr., Museum of Comparative Zoology; Henry Dietrich, Cornell University; L. S. Dillon, Reading Public Museum; Ray T. Everly, Purdue University; T. H. Hubbell, University of Michigan; P. W. Fattig, Emory University; P. D. Hurd, University of California; J. N. Knull, Ohio State University; L. M. Martin, Los Angeles County Museum; James A. G. Rehn, Academy of Natural Sciences of Philadelphia; H. J. Reinhard, Texas A. & M. College; E. S. Ross and Hugh B. Leech, California Academy of Sciences; V. D. Roth, Oregon State College; M. W. Sanderson, Illinois State Natural History Survey; G. E. Wallace, Carnegie Museum; and R. L. Wenzel, Chicago Natural History Museum. My thanks too to all who loaned specimens from their private collections: O. Bryant, C. A. Frost, J. W. Green, Henry Howden, Borys Malkin, Antonio Martínez, A. T. McClay, G. H. Nelson, F. H. Parker, P. O. Ritcher, Mark Robinson, Joe Schuh, and Floyd G. Werner. I am especially indebted to Dr. P. J. Darlington, Jr., for suggestions regarding exact measurements and for rechecking for me the type of *P. blandus* (Fall), and to Dr. E. B. Britton for assistance with locality data for the British Museum specimens. To Antonio Martínez I am greatly indebted and especially grateful for the loan of many fine specimens and for his permission to describe several of the species from South America.

Psammodius Fallén

Psammodius Fallén, Observationes Entomologicae, fasc. 3, p. 37, 1807.—Gyllenhal, Insecta Svecica . . . , Coleoptera, vol. 1, pt. 1, p. 6, 1808.—Curtis, British entomology, vol. 6, No. 258, 1829.—Heer, Fauna coleopterorum helvetica, vol. 1, fasc. 3, p. 532, 1841.—Chapin, Proc. U. S. Nat. Mus., vol. 89, p. 9, 1940.

Psammobius Heer, Fauna coleopterorum helvetica, vol. 1, fasc. 3, p. 531, 1841.—Schmidt, Coleoptera, Aphodiinae. Das Tierreich (Deutsche Zoologische Gesellschaft), pt. 45, p. 469, 1922.

Genotype: *Aphodius sulcicollis* Illiger (by subsequent designation of Curtis, 1829). As recorded by Chapin, 1940, this genus, usually credited to Gyllenhal, 1808, was originally proposed by Fallén in the previous year. The species originally included were seven in number: *Scarabaeus arenarius* Paykull, *Aphodius globosus* Illiger, *A. elevatus* Fallén, *A. sabuleti* Fallén, *A. porcatus* Fallén, *A. asper* Fallén, and *A. sulcicollis* Illiger. Curtis, 1829, choosing to preserve the name *Psammodius* free of conflict with *Aegialia* Latreille, 1807, selected the last species, *A. sulcicollis* Illiger, as type. His action was permissible under the International Rules and must be accepted.

A combination of characters separates the species of the genus *Psammodius* from those of closely allied genera. In *Psammodius* the species always have the front of the head distinctly granulate or verrucose, the granules rarely more than twice as long as wide, the clypeus emarginate, the pronotum usually fimbriate or ciliate at sides and base, the pygidium grooved basally to receive the ventrally dentate apices of the elytra, the hind spurs and tarsus placed in a straight line rather than in the triangular placing as in *Aphodius*, the apical fimbriae of the hind tibiae very short and well inside the margin, the external angle of the posterior tibia only very rarely forming a spine, and the first segment of the hind tarsus subequal to or shorter than the long spur. In addition, the pronotum frequently exhibits alternate transverse swellings and punctate furrows or grooves, the hind femurs are usually heavier and wider than the middle femurs, the middle and hind tibiae are usually noticeably widened apically, the tibiae usually without the oblique ridges found in *Aphodius* but with lengthwise series of setigerous tubercles and sometimes an ante apical carina paralleling the apical margin (species of the Pacific Coast of the United States), and the tarsal segments are nearly always distinctly widened apically and more or less triangular.

Over half of the American species of *Psammodius* have the maxillary galea provided with heavy chitinous teeth and the median, more heavily chitinized area of the epipharynx not extending to the thin membranous anterior edge, as found in the type of the genus, *Psammodius sulcicollis* (Illiger). In the remaining species the galea of the maxilla is covered with close parallel rows of mixed fine, hairlike, and heavy hooked setae, giving a brushlike tip, while the epipharynx has the more heavily chitinized area extended beyond the membranous anterior edge by one or two heavy setae or teeth, exactly as in the genus *Ataenius*.

Nearly all species having maxillary teeth also exhibit transverse pronotal furrows, wide hind femurs, short tarsi, and a strongly convex oval habitus. Those without maxillary teeth usually lack the pronotal furrows (the pronotum being more or less evenly punctate), show little disparity in the size of the middle and hind femurs, and usually are more elongate in habitus. Unfortunately several species, notably the new species *formosus*, *fimbriatus*, and *martinezi*, were found to have maxillary teeth combined with external characters of the second group. Because of this and the variation in the development of external characters it seems unwise to attempt a division of the species into subgenera.

It is interesting to note that the species *bidens*, *integer*, *aenictus*, *atopus*, and others all have affinities in the direction of *Ataenius*, while in *Ataenius*, the species *schwarzi* (Linell) and *puncticollis* LeConte show characters similar to this group of *Psammodius*. *Ataenius* and *Psammodius* probably should be placed in the same tribe of the Aphodiinae.

Key to the species of Psammodius in the Western Hemisphere

1. Pronotum with more or less distinct transverse grooves; clypeus usually deeply acutely notched or triangularly emarginate with each side weakly subdentate, obtusely angulate or rounded 2
   Pronotum without distinct transverse grooves; clypeus usually distinctly dentate each side of a wide shallow emargination 24
2. Occiput with deep oblique grooves arranged in chevron; five thoracic ridges sharply defined, at least first two complete from side to side 3
   Occiput without oblique grooves or with thoracic grooves not sharply defined from side to side 5
3. Last abdominal segment eroded anteriorly; elytral margins not noticeably fimbriate; width of posterior femur as long as middle line of metasternum; posterior tibia about 3 times as long as wide; elytra margined basally 4
   Last abdominal segment smooth anteriorly; elytral margins fimbriate with long hair; elytra not margined basally; posterior femur wider than length of middle line of metasternum; posterior tibia 2½ times as long as wide; Maryland . . . . **basalis** (Mulsant and Rey)
4. Pronotum fimbriate with clavate setae, the ends frequently split; Pennsylvania and New Jersey . . . . **sulcicollis** (Illiger)
   Pronotum fimbriate with fine, sharply pointed hairs; Maryland, Virginia, Indiana. . . . . **laevipennis** A. Costa
5. Elongate punctures covering entire surface of lateral pronotol convexity, tuberculate within anterior angles 6
   Lateral convexity of pronotum smooth 11
6. Elytra dull, noticeably, strongly alutaceous; intervals weakly tectiform, strongly crenate along inner edge; coarse punctures of pronotum close but distinct, arranged in four transverse furrows, the third furrow twice as wide as the others; México . . . . **culminatus** Bates
   Elytra shining, sometimes finely alutaceous 7
7. Elytral intervals with a row of distinct punctures near the outer edge and unusually deeply crenate along the inner edge; pronotum confusedly punctate-rugose throughout; México. . . . . **saltilloensis,** new species
   Elytral intervals without row of punctures along outer edge 8
8. Fifth transverse pronotal ridge completely broken up into tubercles; pronotum with entire surface roughly punctate-rugose but with four transverse furrows more coarsely punctate and evident; elytral intervals weakly tectiform, the ridges vaguely tuberculate; México, Wyoming to Kansas. **mimeticus** (Fall)
   Fifth transverse pronotal ridge usually quite distinct, sometimes roughly punctate but not completely broken into tubercles 9
9. Middle transverse pronotal ridges punctate-rugose; elytral intervals weakly tectiform, the ridges vaguely tuberculate; with an interrupted transverse occipital row of close, fine to medium punctures starting above each eye; Wyoming to New York to Georgia . . . . **interruptus** Say
   Transverse pronotal ridges relatively smooth, very finely punctate; discal intervals of elytra usually smoothly convex; occiput smooth above eyes 10
10. Punctures of median longitudinal line of pronotum usually more or less completely fused and run together, much finer than those of the transverse furrows; color piceous; larger species 2.9 to 3.8 mm.; Texas, México, Honduras . . . . **werneri,** new species

Punctures of median longitudinal line of pronotum about the same size as those of the transverse furrows, the third furrow usually continuous across and extending backward at the middle, merging in a wide triangle with the midline; elytral intervals smoothly convex, their inner edges irregular, not so deeply, sharply, and distinctly crenate as in preceding species, the crenations appearing more as small triangular notches; color ferrugineus; smaller species, 2.8 to 3.4 mm.; México . . . . **canoensis,** new species

11. Light brown species with five transverse swellings on pronotum 12
 Usually darker colored species, with three or less transverse smooth areas on the ponotum 14

12. Clypeal emargination more or less broadly, evenly rounded at middle; first or apical ridge of pronotum distinctly tuberculate even at middle, transverse furrows weak and poorly developed, punctures indistinct; abdominal segments 3, 4, and 5 apparently connate at middle, terminal segment not distinctly crenate anteriorly; Texas, Arizona, México . . **blandus** (Fall)
 Clypeal emargination angular at middle; first or apical ridge of pronotum indistinctly tuberculate at sides and almost smooth at middle, transverse furrows strong with distinct punctures; abdominal segments not connate. terminal segment distinctly, strongly crenate anteriorly at middle . . 13

13. Posterior tibia less than three times as long as wide at apex, rather suddenly narrowed from basal quarter to knee, the inner edge curved or arcuate in outline; elytra short and convex. width 1.45 mm., length 1.85 mm.; México . . . . **veraecrucis** Bates
 Posterior tibia more than three times as long as wide at apex, the inner edge nearly straight, width gradually reduced to knee; elytra longer, width 1.55 mm., length 2.0 mm.; Arizona to Texas, México.
 quinqueplicatus Horn

14. Posterior tibia without oblique ridge 15
 Posterior tibia with oblique ridge; Pacific Coast of United States . . . 22

15. Species less than 3 mm. in length, width less than half the length; Brazil and Bolivia 16
 Species more than 3 mm. in length, or width more than half the length. . 18

16. Midline of metasternum vaguely evident but not deeply impressed, anterior postcoxal line absent at middle, vague near sides, angular depression in front of posterior coxal plates small and weak; pronotal punctures mostly close in deep furrows; Bolivia, Paraguay, Argentina.
 bolivianus, new species
 Midline and postcoxal line of metasternum deep and distinct 17

17. Width of posterior femur barely one-half the length; apical width of posterior tibia one-third the length of the tibia; Brazil . . . **manaosi,** new species
 Width of posterior femur more than half the length; apical width of posterior tibia one-half the length of the tibia; Brazil . . **santaremi,** new species

18. Elytra fimbriate with moderately long fine hairs 19
 Elytra not fimbriate 20

19. Tenth elytral interval very flat to concave, others convex; Chile.
 indefensus (Schmidt)
 Tenth elytral interval convex, not differing from others; strongly convex, oval; only the anterior transverse groove of pronotum present; Argentina . . . . **inflatus,** new species

20. Rufopiceous; midline of metasternum deeply impressed at middle; clypeus weakly dentate; Argentina . . . . **placidus** (Schmidt)
 Lighter colored; midline of metasternum fine, not or only very weakly impressed; United States 21

21. Eyes well developed; elytral striae coarsely crenate; sides of pronotum entire; Florida . . . . **malkini** Cartwright
Eyes vestigial; striae feebly impressed, not distinctly crenate; sides of pronotum crenate; North Carolina to Mississippi . . . . **hydropicus** Horn
22. Elytral margins not fimbriate; anterior femur with a strong, complete anterior marginal groove; abdominal segments with a transverse row of setigerous punctures; anterior postcoxal line of metasternum continued outward to sides; Oregon to California . . . . **oregonensis,** new species
Elytral margins fimbriate with long fine hairs; anterior marginal line of anterior femur obsolete 23
23. With strong anterior metasternal line not reaching sides but converging with posterior line; base of elytra strongly margined; ante apical ridge of posterior tibia not quite complete, narrowly interrupted at inner margin; British Columbia to California . . . . **caelatus** (LeConte)
Without metasternal lines; base of elytra usually not distinctly margined; ante apical ridge of posterior tibia complete; California. **mcclayi,** new species
24. Pronotum margined with perimarginal groove, pronotal punctures fine to moderate, more or less evenly distributed, without trace of transverse grooves, without marginal setae; Brazil . . . . . **martinezi,** new species
Pronotum not margined in front 25
25. Edges of elytra not fimbriate or very inconspicuously so 26
Edges of elytra distinctly fimbriate 32
26. Pronotum without trace of basal marginal line; Brazil. **insulcatus** (Schmidt)
Pronotum with complete basal marginal line 27
27. Posterior tibia with a distinct but incomplete transverse ridge; edge of pronotum distinctly crenate, larger punctures on pronotum irregularly placed and absent anteriorly at middle and at extreme sides; New Jersey to Florida to Mississippi . . . . **bidens** Horn
Posterior tibia without transverse ridge 28
28. Larger pronotal punctures absent or very much finer over anterior third. 29
Pronotal punctures practically uniform in size almost to anterior margin; occipital band of punctures present 30
29. Pronotal punctures relatively dense, separated by one or two diameters, gradually smaller anteriorly and at sides but those of anterior third much finer than those on disc; occiput smooth, practically impunctate; small brown species 3 mm. in length; México . . . . **integer** Bates
Larger pronotal punctures absent over anterior third, sparse, irregularly placed over basal two-thirds, separated by one to six or eight diameters; México . . . . **formosus,** new species
30. Oblong, 3.5 by 1.6 mm., piceous; Bolivia . . . . . **chipiririi,** new species;
Elongate subparallel, 3.0 by 1.2 mm., dark brown or rufopiceous; Bolivia 31
31. Elytral intervals smooth, shining; Bolivia. . . . . . **aenictus,** new species
Elytral intervals punctate and alutaceous; Bolivia . . **atopus,** new species
32. Pronotum with more or less evenly placed fine to moderate punctures; Bolivia 33
Pronotal punctures coarse, irregularly placed, surface uneven 34
33. Pronotal punctures of disc quite dense, separated by one diameter or less; Bolivia . . . . **fimbriatus,** new species
Pronotal punctures more widely scattered, separated by one to three or four diameters; Bolivia . . . . **mapirii,** new species

34. Coarse pronotal punctures generally distributed; Florida . **armaticeps** (Fall)
Coarse pronotal punctures grouped in a transverse band behind the middle; South Carolina, Georgia, South America . . . . **cruentus** Harold

Psammodius basalis (Mulsant and Rey)

Psammobius basalis Mulsant and Rey, *in* Mulsant, Ann. Soc. Agr. Lyon, ser. 4, vol. 2, p. 636, (1869) 1870.—Schmidt, *in* Schenkling, Coleopterorum catalogus, pt. 20, p. 83, 1910.—Schmidt, Coleoptera, Aphodiinae. Das Tierreich (Deutsche Zool. Ges.), pt. 45, p. 474, 1922.

Oblong oval, broader behind, shining, dark castaneus to piceous. Antennae testaceous. Head convex, closely, coarsely verrucose, occiput smooth behind a diagonal elevated ridge each side of middle arranged in chevron. Clypeus broadly, shallowly, triangularly emarginate, angles each side obtusely rounded, sides weakly arcuate, a slight notch at clypeal suture, genae not prominent, rounded, fimbriate. Pronotum slightly narrower in front, width 1.5 mm., length 1 mm., all angles obtusely rounded, base sinuate, slightly lobed at middle, marginal line fine, entire, sides and base fimbriate with fine, simple hairs, strongly crenate toward anterior angles, base smooth, unbroken, surface divided into five smooth, convex, transverse ridges by four deep furrows, each with a single row of close, shallow, moderately coarse punctures, the first furrow extending almost into the anterior angles, then turning back and out to the sides at middle, the second and fourth relatively short, the third ending at the lateral foveae, posteriorly the median line smooth, lightly impressed, anteriorly indicated by irregularities in both ridges and punctures of the furrows. Elytra as wide as pronotum at base, width 2 mm., length 2.5 mm., sides fimbriate with long, fine, hairlike setae, weakly arcuate and divergent to beyond middle then evenly rounded to apex, base not margined, striae fine, not strongly impressed, intervals almost flat, with a slightly irregular median row of very close, minute punctures, tenth interval not different from the others. Metasternum smooth and shining at middle, setigerously punctate at sides, without anterior postcoxal line. Abdominal segments shining, each with a transverse row of long, fine hairs, terminal segment not eroded or crenate in front. Pygidium shining but somewhat irregularly punctate. Anterior femur margined in front, posterior face setigerously punctate with long hairlike setae. Middle femur half as wide as hind femur, both with strong, wide, alutaceous, entire marginal line, surface with numerous, scattered, hair-bearing punctures. Tibiae without oblique ridges but with rows of tubercles along edges and ventral surface. Spurs and tarsi of middle tibiae much longer and narrower than those of posterior, the long spur longer than the first three tarsal joints combined. Posterior tibia short and heavy, shorter than femur, apex half as wide as length of tibia, spurs short, somewhat foliaceous, the longer not equal to first three tarsal joints combined. Length 4 mm., width 2 mm.

Type: Location unknown to me.

Type locality: Southern France.

Specimens examined: 12.

Distribution: Maryland: Chesapeake Beach and Kenwood Beach. "D. C."

Season: August 29 to September 17.

Remarks: This species, probably accidently introduced from Europe, possibly in ships ballast, is found along Chesapeake Bay under debris and among grass roots in sand along the beaches. It has not been reported previously from the United States. *Psammodius basalis* (Mulsant and Rey) may be separated from the closely allied species, *P. sulcicollis* (Illiger) and *P. laevipennis* A. Costa, by the lack of a basal margin and fimbriate edges of the elytra, the lack of anterior crenation or erosion of the terminal abdominal segment, and the very short metasternum. The earliest date seen for an American specimen was Sept. 16, 1921.

Psammodius sulcicollis (Illiger)

Aphodius sulcicollis Illiger, Mag. Insektenk., vol. 1, p. 20, 1802.

Psammodius sulcicollis Fallén, Observationes entomologicae, fasc. 3, p. 37, 1807.—Gyllenhal, Insecta svecica, vol. 1, p. 9, 1808.

Psammobius sulcicollis Heer, Fauna coleoptorum helvetica, vol. 1, fasc. 3, p. 531, 1841.—Schmidt, Coleoptera, Aphodiinae. Das Tierreich (Deutsche Zool. Ges.), pt. 45, p. 473, 1922.

Oblong oval, moderately shining, piceous. Antennae pale rufotestaceous. Legs dark castaneous. Head convex, moderately verrucose, occiput with two grooves arranged in chevron separated by an elevated ridge. Clypeus broadly, shallowly, triangularly emarginate, the angles each side rounded, sides nearly straight, genae small, rounded, set off by a deep notch at clypeal suture. Pronotum, slightly narrower in front, width 1.3 mm., length 0.9 mm., all angles obtusely rounded, base margined, distinctly lobed at middle, sides and base fimbriate with club-shaped setae, sides crenate; surface with four coarsely, closely punctate transverse furrows and traces of a fifth basally, separated by smooth ridges, the ridges with scattered, minute punctures, the two basal ridges interrupted by the deep, coarsely punctate median, longitudinal line. Elytra at base as wide as pronotum, width 1.6 mm., length 2.3 mm., sides nearly straight, slightly divergent to posterior fourth; striae wide, moderately deep, punctures coarse, shallow, slightly crenating the intervals, under high magnification each puncture appearing alutaceous with a minute median granule; intervals smooth with a median row of close, minute punctures, convex on disc, the shortened tenth interval flat or very slightly concave, shining but minutely alutaceous; elytra not fimbriate at sides, the base not distinctly margined. Metasternum smooth, shining, slightly depressed at middle, median line fine, impressed, scabrous at extreme sides with a fine, more or less obsolete line extending inward behind the middle coxae. Abdominal segments shining, very minutely alutaceous, especially at sides, weakly convex, very finely margined posteriorly and with a fine, distinctly alutaceous line anteriorly at suture, a few small but distinct granules in a transverse median line at each side. Pygidium apically smooth with a few long setae around the edge. Anterior femurs finely margined in front, posterior surface uneven, alutaceous, a few scattered, setigerous punctures, the setae very short. Middle and posterior femurs with marginal lines alutaceous, visible from behind, surface with scattered, setigerous punctures with short setae anteriorly and over apical half, three or four widely placed, longer hairs along posterior edge; posterior femur about twice as wide as middle femur and subequal in width to length of metasternum. Middle and posterior tibiae without oblique ridges but with longitudinal rows of tubercles along edges. Posterior tibia 2½ times as long as wide at apex. Tarsal joints triangular, spurs narrow, the long spur about equal in length to first two tarsal joints combined. Length 3 to 3.5 mm., width 1.5 to 1.7 mm.

TYPE: Probably in "Naturhist. Museum, Braunschweig" or Zoologische Museum, Berlin.

TYPE LOCALITY: Konigsberg, Germany.

SPECIMENS EXAMINED: 21.

DISTRIBUTION: UNITED STATES: New Jersey: Browns Mills, Atsion. Pennsylvania: South Philadelphia.

SEASON: April 28 to June 11.

REMARKS: I have no record of this species having been previously recorded from the Western Hemisphere. The oldest label data from the United States reads "S. Phila. Pa. 4–28–06," the most recent, "Atsion, N. J., VI–11–45, J. W. Green." This species is slightly smaller and darker than *Psammodius laevipennis* A. Costa and *basalis* (Mulsant and Rey). It is easily recognized by the club-shaped setae around the pronotum.

Psammodius laevipennis A. Costa

Psammodius laevipennis A. Costa, Ann. Accad. Asp. Nat. Napoli, vol. 2, p. 18, 1844.

Psammobius laevipennis Schmidt, Coleoptera, Aphodiinae. Das Tierreich (Deutsche Zool. Ges.), pt. 45, p. 474, 1922. (See this paper for synonymy.)

Psammodius aegialioides Haldeman, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 1, p. 107, 1848.—Horn, Trans. Amer. Ent. Soc., vol. 14, p. 94, 1887. (New synonymy.)

Psammobius aegialioides Gemminger and Harold, Catalogus coleopterorum, vol. 4, p. 1068, 1869.—Schmidt, Coleoptera, Aphodiinae. Das Tierreich (Deutsche Zool. Ges.), pt. 45, p. 476, 1922.

Oblong oval, slightly broader behind, moderately shining, dark castaneous. Antennae pale rufotestaceous. Head convex, closely, coarsely verrucose, occiput with two deep grooves arranged in chevron separated by an elevated ridge. Clypeus broadly, triangularly emarginate, the angles each side rounded, sides weakly arcuate, a slight notch at clypeal suture, genae small, rounded. Pronotum slightly narrower in front, width 1.55 mm., length 1.0 mm., anterior angles very obtuse, posterior angles widely rounded, base sinuate and slightly lobed at middle, the marginal line distinct, sides and base fimbriate-crenate, fimbriae simple; surface with four deep, transverse, closely, coarsely punctate furrows and a trace of a fifth furrow along the base, the intervals between and the smooth areas at the sides strongly convex, shining, minutely, not closely punctate, the two basal ridges interrupted by the deep, closely, coarsely punctate median line. Elytra at base as wide as pronotun, width 1.8 mm., length 2.8 mm., sides nearly straight, slightly divergent, the striae moderately deep, finely, not closely punctate, punctures not distinctly crenating the slightly convex, smooth intervals, the shortened tenth interval flat and alutaceous, sides of elytra not noticeably fimbriate, base margined. Metasternum smooth, shining, median line deep, without anterior postcoxal line, smoothly rounded into the finely scabrous depressed area behind the middle coxae, a few very shallow, coarse, setigerous punctures at extreme sides. Abdominal segments smooth, each with a row of two or three setigerous punctures at sides, the terminal segment widely, deeply eroded anteriorly. Pygidium terminally scabrous. Anterior femur margined in front, posterior surface with scattered, setigerous punctures. Middle femur with deep, complete, posterior marginal line, numerous setigerous punctures anteriorly and over outer two-thirds. Posterior femur twice as wide as middle femur, posterior marginal line deep, entire, three or four setigerous punctures along posterior margin, a few scattered over outer third. Posterior tibia about three times as long as wide at apex, spurs narrowly foliaceous, bluntly rounded, the longer about equal in length to the first three tarsal joints combined. First tarsal joint elongate triangular. Length 3.3 to 4 mm., width 1.5 to 2.0 mm.

Type: *P. laevipennis:* Location unknown to me, but probably in Museo Zoologico della Università di Napoli if still in existence. *P. aegialioides:* Museum of Comparative Zoology, Cambridge, Mass.

Type locality: *P. laevipennis:* Shores of Granatello, region of Naples, Italy. *P. aegialioides:* "Middle States," i. e., Middle Atlantic States.

Specimens examined: 95.

Distribution: United States: Virginia: Arlington (Potomac River). Maryland: Chesapeake Beach, Kenwood Beach. New York: State label only. Indiana: Beverly Shores, Tremont, and Dunes State Park.

Season: April 28 to September 17.

Remarks: I have been unable to separate American specimens determined *aegialioides* from the European *laevipennis*. *Psammodius aegialioides* Haldeman was described in 1848 from "Middle States," which probably meant Maryland or Pennsylvania at that early date. George H. Horn in his "Monograph of the Aphodiini Inhabiting the United States" (Trans. Amer. Ent. Soc., vol. 14, 1887) gave the distribution "from New York southward to Georgia, but seems rare." Early specimens in the Horn and LeConte collections are labeled merely with pink circles indicating "middle states." A single specimen in the Horn collection is labeled "N. Y." I have seen no recent fully labeled specimens to confirm the wide distribution listed by Dr. Horn. The oldest Indiana specimen was collected in 1934.

Psammodius culminatus Bates

Psammodius culminatus Bates, Coleoptera, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 2, pt. 2, p. 103, 1887.

Psammobius culminatus Schmidt, Coleoptera, Aphodiinae. Das Tierreich (Deutsche Zool. Ges.), pt. 45, p. 481, 1922.

Oblong oval, very slightly wider behind, comparatively dull, only weakly shining, piceous. Antennae rufotestaceous. Head convex, closely, moderately verrucose; occiput smooth with a few fine punctures above the eye. Clypeus quite deeply, broadly, triangularly emarginate, the limiting angles rounded each side, sides arcuate, weakly reflexed; genae fimbriate, small and broadly rounded. Pronotum slightly narrower in front, width 1.30 mm., length 0.9 mm., anterior angles obtuse, posterior angles broadly rounded, sides and base crenate, fimbriate with moderate, obtuse setae, base margined; surface with very close, coarse punctures arranged in four, more or less distinct transverse furrows, the first, second and fourth one or two punctures wide, the third much wider, three or four punctures wide, the punctures close but separate and distinct except in the anterior angles and in the depressed basal half of the median line where they become confused, surface between the discal furrows uneven with confused, very fine, shallow punctures and alutaceous sculpture, laterally the coarse punctures become elongate and over the convexity beyond the lateral fovea appear as short arcuate lines, basally they run together leaving the intervening surface in rows of tubercles. Elytra as wide as pronotum at base, width 1.5 mm., length 2.0 mm., base margined, humeri strongly dentate, sides weakly arcuate, not fimbriate; striae sharply defined, moderately deep, strial punctures moderate and deep, intervals somewhat carinately convex, strongly alutaceous, with a median row of fine, indistinct, shallow punctures causing slight unevenness over discal intervals to distinct breaks and a vaguely tuberculate appearance of the lateral intervals, each interval weakly crenate on outer edge, strongly crenated along the inner edge by a row of punctures apparently independent of the strial punctures. Metasternum smooth and shining at middle, median line sharp and distinct, much deeper at each end, the anterior end extending well forward between the middle coxae, anterior postcoxal line with inner end remote from the coxae, strong, extending outward to scabrous area at side, posterior line deep and distinct. Abdominal segments unusually convex, shining but minutely alutaceous, very finely crenate along anterior margin and finely margined along posterior edge, each with a median, transverse row of moderate, setigerous punctures, the setae fine, moderately long, terminal segment with scattered fine punctures, widely crenate anteriorly. Pygidium alutaceous, fringed apically with moderately long setae. Anterior femur with a strong, deep, anterior marginal line. Middle and posterior femurs smooth, shining, with strong, entire, posterior marginal line, and with the usual curving row of three or four setigerous punctures near the knee. Posterior femur one-fifth wider than middle femur. Posterior tibia three times as long as wide at apex, spurs narrow, long spur subequal to first two tarsal joints in length. First tarsal joint elongate-triangular, as long as following two combined. Length 3.3 mm., width 1.5 mm.

Type: In British Museum (Natural History).

Type locality: "Mexico, Presidio (Forrer), Jalapa, Mexico City (Höge)."

Specimens examined.—A cotype from Jalapa, México.

Remarks: This species is very close to *interruptus* Say and eventually may be found to be identical; however, the single specimen examined is much darker in color, the alutaceous sculpture much more distinct, the coarse punctures of the pronotum more distinctly defined with intervening areas smoother, and the abdominal segments more convex.

Psammodius saltilloensis, new species

Holotype oblong oval, slightly broader behind, moderately shining, ferrugineous. Antennae rufotestaceous. Head convex, rather finely verrucose; occiput smooth, a few fine to moderate punctures above each eye. Clypeus moderately, deeply, rather broadly, triangularly emarginate, the limiting angles rounded each side, sides and angles finely reflexed, sides weakly arcuate; genae fimbriate, small, broadly rounded. Pronotum not narrower in front, width 1.4 mm., length 1.0 mm., anterior angles rounded, nearly right-angled, posterior angles distinct, obtusely rounded, sides weakly arcuate, base finely, indistinctly margined, sides and base crenate, fimbriate with moderate, obtuse setae; surface roughly sculptured throughout with close, mixed, fine, medium, and coarse punctures, four transverse and median longitudinal furrows lightly impressed and indistinctly indicated by closer, coarser punctures, convexity beyond lateral fovea with more elongate punctures, anterior angles rather widely, closely, tuberculate-alutaceous. Elytra as wide as pronotum at base, width 1.7 mm., length 2.3 mm., base strongly margined, humeri dentate, sides weakly arcuate, not fimbriate; striae moderate, strial punctures fine and deep; intervals moderately convex, finely alutaceous but shining, crenate along inner margin by a row of deep, moderate punctures, the punctures or crenations as wide as the stria and nearly separated from it, and with a row of fine to moderate, shallow, punctures near the outside margin. Metasternum smooth, shining, minutely punctate at middle, midline deep, the ends slightly deeper, anterior postcoxal line distinct, extending outward to the scabrous area at extreme sides, posterior depressed line in front of posterior coxal plate distinct. Abdominal segments minutely alutaceous, finely crenate along anterior margin, finely margined along the posterior edge, carinately margined at extreme sides, each segment with a transverse, median row of fine setigerous punctures bearing very fine, moderately long hair, terminal segment widely crenate in front. Pygidium scabrous, fringed with moderately long fine hairs. Anterior femur with deep, entire marginal line, posterior face smooth except for a few moderate punctures at elbow. Middle and posterior femurs with deep, almost entire posterior marginal line, otherwise smooth with the usual row of three or four setigerous punctures at the knee. Posterior femur about one-tenth wider than the middle femur. Posterior tibia three times as long as wide at apex, spurs very narrow, long spur subequal in length to first two tarsal joints combined. First tarsal joint elongate-triangular, equal in length to following two together. Length 3.6 mm., width 1.7 mm.

Type: USNM 61844.

Type locality: Saltillo, Coahuila, México.

Specimens examined: The unique holotype only.

Remarks: This single specimen, bearing Prof. Wickham's label and locality only, is another species in the *interruptus* complex. It is one of the larger species in the group and is easily identified by the punctures along each margin of the elytral intervals.

Psammodius mimeticus (Fall)

Psammobius mimeticus Fall, Journ. New York Ent. Soc., vol. 40, p. 192, 1932.

Oblong oval, moderately shining, rufopiceous. Antennae rufotestaceous. Head convex, closely, moderately verrucose; occiput smooth with a short band of close, fine to moderate punctures above the eye. Clypeus moderately, deeply, angularly emarginate, the limiting angles rounded each side, angles and sides finely reflexed, sides weakly arcuate; genae fimbriate, broadly rounded and inconspicuous. Pronotum narrower in front, width 1.4 mm., length 1.1 mm., anterior angles rounded, approximately right-angled, posterior angles obtuse, sides and base crenate, fimbriate with obtuse, moderate setae, base finely indistinctly margined; surface rough, uneven, and very finely punctate throughout, with four transverse furrows and ridges more or less distinct, the fifth ridge and basal area completely broken up into flattened tubercles, punctures of the furrows moderate to coarse, confused, frequently leaving intervening fine tubercles; median line distinct over basal half or three-fourths, punctures fine and confused; laterally the coarse punctures over the convexity beyond the fovea become arcuate, elongate, rather close, and frequently run together. Elytra as wide as pronotum at base, width 1.65 mm., length 2.1 mm., base margined, humeri dentate, sides weakly arcuate, not fimbriate; striae deep, strial punctures fine, deep; intervals convex, finely alutaceous but shining, weakly tectiform and vaguely tuberculate, strongly crenate along inner margin by a row of punctures independent of the strial punctures, outer margin weakly crenate. Metasternum smooth and shining at middle, median line sharp and distinct, deeper at each end, the anterior end extending well forward between the coxae, anterior postcoxal line strong and extending out to the scabrous area at extreme side, posterior line in front of posterior coxal plate deep and distinct. Abdominal segments shining but minutely alutaceous, finely crenate in front, the terminal segment much more widely so, very finely margined behind, each with a median, transverse, somewhat eroded line and row of moderate to coarse, setigerous punctures, the moderately long, fine, pointed hair appearing behind a very small tubercle or granule. Pygidium alutaceous, fringed apically with moderately long, fine, pointed hairs. Anterior femur with strong, deep, anterior marginal line. Middle and posterior femurs smooth, shining, with deep posterior marginal line extending two-thirds to three-fourths the distance to trochanter, four or five moderate setigerous punctures in a curving row from middle to knee, a more complete row of similar setigerous punctures bordering the anterior margin. Posterior femur one-fifth wider than middle femur. Posterior tibia three times as long as wide at apex, spurs narrow, long spur equal to length of first two tarsal joints combined. First tarsal joint elongate-triangular, slightly longer than the two following joints together. Length 3 to 3.6 mm., width 1.5 to 1.65 mm.

Type: In Fall collection, Museum of Comparative Zoology, Cambridge, Mass.

Type locality: San José del Cabo, in the Cape Region of Baja California.

Specimens examined: 16.

Distribution: United States: Wyoming: Fort Laramie. Colorado: Monon (?). Nebraska: West Point. Kansas: Topeka. Arizona: Chiracahua Mountains. México: Baja California: San José del Cabo. Coahuila: Saltillo. Tamaulipas: Nuevo Laredo. Colima: Colima.

Season: May, June, and November.

Remarks: This species is another in the difficult group closely related to *interruptus* Say (see remarks following that species).

Psammodius interruptus Say

Psammodius interruptus Say, Boston Journ. Nat. Hist., vol. 1, p. 178, 1835.—Horn, Trans. Amer. Ent. Soc., vol. 14, p. 95, 1887.

Psammobius interruptus Schmidt, Coleoptera, Aphodiinae. Das Tierreich (Deutsche Zool. Ges.), pt. 45, p. 482, 1922.

Oblong oval, slightly broader behind, moderately shining, rufopiceous. Antennae rufotestaceous. Head convex, closely, moderately verrucose; occiput very finely punctate each side of an interrupted band of fine to moderate punctures that varies from a few punctures above each eye to an almost complete band two or three deep from side to side. Clypeus quite deeply, triangularly emarginate, the limiting angles rounded each side, sides weakly arcuate, finely reflexed; genae fimbriate, small and broadly rounded. Pronotum, width 1.3 mm., length 0.95 mm., slightly narrower in front, anterior angles rounded, approximately right-angled, posterior angles very broadly rounded, sides and base margined, crenate, fimbriate with moderate, obtuse setae; surface roughly sculptured throughout but usually with four, more or less distinct, transverse furrows, punctures close, coarse, confused in the furrows, the intervening ridges with similar fine to moderate, confused punctures, median line shallowly impressed over basal half and similarly punctate, laterally the punctures become elongate and over the convexity beyond the lateral fovea they appear as short, arcuate lines, basally they run together, causing the intervening surface to appear tuberculate. Elytra as wide at base as pronotum, width 1.5 mm., length 2.1 mm., base margined, humeri dentate, sides weakly arcuate, not fimbriate; striae moderately deep, strial punctures moderate, deep; intervals somewhat carinately convex, the convexity broken by a median row of indistinct punctures, crenate each side, the crenations of the inner margin deeper and apparently caused by punctures independent of those in the striae, alutaceous sculpture variable, from distinct and completely covered to indistinct and very little at edges. Metasternum shining at middle, midline very distinct, deeper at each end and extending well forward between the middle coxae, anterior postcoxal line deep, extending outward to scabrous area at extreme sides, posterior line in front of posterior coxal plate distinct. Abdominal segments finely crenate in front and finely margined along posterior edge, very finely alutaceous but shining, each with a medianly interrupted, transverse row of coarse, shallow, setigerous punctures, the setae fine and moderately long, terminal segment more widely and deeply crenate anteriorly. Pygidium eroded basally, apically smooth and fringed with fine, moderately long setae.

Anterior femur deeply margined in front. Middle and hind femurs with deep, nearly complete posterior marginal line, with the usual posterior, curving row of three or four setigerous punctures from middle to knee. Posterior femur less than one-fifth wider than middle femur. Posterior tibia approximately three times as long as wide at apex, spurs narrow, long spur equal in length to first two tarsal joints combined. First tarsal joint elongate-triangular, equal in length to the following two joints combined. Length 2.8 to 3.4 mm., width 1.2 to 1.5 mm.

Type: Presumably destroyed.

Type locality: Indiana, probably New Harmony in Posey County.

Specimens examined: 206.

Distribution: New York: "L. I." (Casey collection). District of Columbia. Maryland. Virginia: Fort Monroe. North Carolina: Moore County, West End, Pinebluff. South Carolina: Clemson, Ridge Spring, Marion. Georgia: Peach County, Barnesville. New Mexico: Albuquerque. Colorado: Monon (?). Wyoming: Fort Laramie. South Dakota: Brookings. Nebraska: West Point. Kansas: Topeka. Iowa.

Season: January 13 to June.

Remarks: The band of fine to moderate punctures across the occiput is often covered by the pronotum in specimens having the head tilted upward.

Psammodius interruptus Say is an early spring species in South Carolina, the greater number of specimens being collected in March and early April. I personally collected 153 specimens, three-fourths of the total examined, crawling on or flying over flood-deposited sand along the Seneca River at Clemson, S. C. Its distribution apparently covers the greater part of the United States, from New York south and west to South Dakota and Wyoming. Since no specimens were available from the type locality, presumably New Harmony, Ind., it is preferable to defer the selection of a neotype until such specimens are obtained.

The group of species closely allied to *interruptus* Say is taxonomically perhaps the most difficult in the genus *Psammodius*. Superficially they appear almost identical and, in fact, a larger number of specimens for study might prove questionable the separation of one or two of them as distinct species. The material at hand, however, is separable into six species as shown in the key to species.

Psammodius werneri, new species

Holotype oblong oval, moderately shining, piceous. Antennae rufotestaceous. Head convex, closely, moderately verrucose, occiput smooth. Clypeus moderately deeply, triangularly emarginate, the limiting angles each side rounded, sides weakly arcuate, sides and angles finely reflexed; genae fimbriate, obtusely rounded. Pronotum narrower in front, width 1.45 mm., length 1.1 mm., anterior angles rounded, posterior angles broadly rounded, sides and base crenate, fimbriate with moderate, obtuse setae, base finely margined; surface with close, coarse punctures arranged in four transverse furrows, the first or postapical entire, the other three interrupted by the median line, which is very distinctly impressed over the basal half of the pronotum and much more finely punctate, the punctures very close, confused and run together, the first transverse or apical ridge is vaguely tuberculate at middle, more distinctly so toward the anterior angles, the remaining four transverse ridges are comparatively smooth and minutely punctate, laterally over the convexity beyond the fovea the coarse, deep punctures become elongate, arcuate, and frequently run together, just anterior to the basal line the surface is irregularly broken into one or two rows of flattened tubercles. Elytra as wide as pronotum at base, width 1.7 mm., length 2.4 mm., base margined, humeri dentate, sides weakly arcuate, not fimbriate; striae deep, strial punctures fine; intervals convex, weakly tectiform, minutely alutaceous, shining, outside margin slightly crenate, inner margin deeply crenate by a marginal row of punctures independent of the strial punctures. Metasternum smooth, shining, with scattered, very minute punctures, depressed at middle, midline sharp, rather fine and barely noticeably deeper at each end, anterior postcoxal line distinct, extending out to the scabrous area at side, arcuate posterior line in front of the posterior coxal plate deep and distinct. Abdominal segments shining, minutely alutaceous, finely margined posteriorly, finely crenate in front, the terminal segment more deeply so, and each with a transverse median row of fine shallow setigerous punctures bearing moderately long, fine setae. Pygidium scabrous, fringed apically with quite closely placed, rather short setae. Anterior femur with strong deep anterior marginal line. Middle and posterior femurs smooth, shining, with the usual curving row of four or five setigerous punctures over the apical half, posterior marginal line strong and deep, reaching three-fourths or more of the distance to the trochanter. Posterior femur about one-sixth wider than middle femur. Posterior tibia three times as long as wide at apex, spurs narrow, the long spur and first two tarsal joints combined equal in length. First tarsal joint elongate-triangular, equal in length to the following two joints together. Length 3.6 mm., width 1.7 mm.

Type: USNM 61845.

Type locality: Tamazunchale, San Luis Potosí, México (Rt. 1. km. 365).

Specimens examined: Holotype and 84 paratypes.

Paratypes: United States: Texas: 12, Austin, June 29, H. Soltau collection; 7, Bangs, Aug. 23, 1937, Turner; 5, Broun County, July 13, 1937, Turner; 1, College Station, May 24, 1931, Reinhard; 2, Brownwood, Oct. 5, 1905, Pierce. MÉXICO: San Luis Potosí: 42, Tamazunchale (Rt. 1, km. 365), May 30, 1948, Werner and Nutting; 7, 11 km. east of Ciudad de Valles, May 29, 1948, Werner and Nutting. Tamaulipas: 2, Nuevo Laredo, Nov. 24, 1905, Pratt. México: 1, Temascaltepec, July 1933, Hinton and Usinger. 1, Cuernavaca. Vera Cruz: 1, San Rafael Jicaltepec, June 19, 1896, Bowditch. HONDURAS: 3, 12 km. west of Olanchito, June 20, July 5, 1949, at light, Becker. Paratypes will be placed in the following collections: Naturhistoriska Riksmuseum, British Museum, Canadian Department of Agriculture, California Academy of Sciences, Texas A. and M. College, Museum of Comparative Zoology, Antonio Martínez, and Mark Robinson.

REMARKS: *Psammodius werneri* is the largest of the group of species closely related to *P. interruptus* Say, varying from 3 to 3.8 mm. in length and from 1.5 to 1.8 mm. in width. It is usually smooth above the eyes however; rarely it may have two or three very fine punctures in this area. See remarks following *Psammodius interruptus* Say (p. 429).

Psammodius canoensis, new species

Holotype oblong oval, shining, rufopiceous. Antennae rufotestaceous. Head convex, closely, moderately verrucose; occiput smooth, without punctures above the eyes. Clypeus moderately deeply, triangularly emarginate, the limiting angles each side rounded, sides and angles finely reflexed, sides weakly arcuate, genae fimbriate, broadly rounded, inconspicuous. Pronotum narrower in front, width 1.15 mm., length 0.85 mm., anterior angles rounded, approximately right-angled, posterior angles broadly rounded, sides and base crenate, fimbriate with rather close, very moderate, more or less pointed setae, base finely margined; surface with moderately coarse punctures arranged in four transverse furrows, the third slightly wider and posteriorly merging triangularly with the similarly punctate median longitudinal furrow, the latter deeper over basal half but extending to the apical ridge or margin; five finely punctate, quite smooth, transverse ridges, laterally the coarse punctures over the convexity beyond the lateral fovea become elongate, arcuate, and more or less run together, along the basal margin they leave the intervening surface in one or two irregular rows of tubercles. Elytra as wide as pronotum at base, width 1.4 mm., length 1.95 mm., base margined, humeri dentate, sides weakly arcuate, not fimbriate; striae deep, strial punctures fine, deep; intervals shining, smooth, weakly, evenly convex, inner margin irregularly, not deeply crenate, the crenations appearing as very small triangular notches, outside margin very slightly irregular, not distinctly crenate. Metasternum smooth, shining, depressed at middle, midline only slightly deeper at each end, anterior postcoxal line deep, extending outward to the scabrous area at side, posterior arcuate line in front of posterior coxal plate somewhat longer than usual, deep and distinct. Abdominal segments shining, minutely alutaceous, finely margined posteriorly, finely crenate in front, the terminal segment more widely so, each with a transverse, median, scabrous line and row of setigerous punctures, the very fine setae emerging behind small tubercles or granules. Pygidium scabrous, fringed apically with moderately long, very fine hairs. Anterior femur with strong, deep anterior marginal line, posterior face with scattered arcuate punctures. Middle and hind femurs with strong, deep posterior marginal line from knee to trochanter, otherwise smooth except for the usual curving row of coarse setigerous punctures over the apical half. Posterior femur about one-fifth wider than the middle femur. Posterior tibia about three times as long as wide at apex, spurs narrow, long spur equal in length to first two tarsal joints combined. First tarsal joint elongate-triangular, equal in length to following two together. Length 3 mm., width 1.4 mm.

TYPE: In collection of California Academy of Sciences.

TYPE LOCALITY: Paso Cano, Río Papaloapam, Vera Cruz, México.

SPECIMENS EXAMINED: Holotype and 22 paratypes.

PARATYPES: MÉXICO: Vera Cruz: 21, Paso Cano, Río Papaloapam, Apr. 19, 1932, Van Dyke collection. COSTA RICA: Guanacaste: 1, Santa Elena, Aug. 20, 1928, Nevermann collection. Paratypes will be placed in U. S. National Museum, Naturhistoriska Riksmuseum, British Museum, and California Academy of Sciences.

REMARKS: The typical series varies from 2.8 to 3.4 mm. in length and from 1.3 to 1.5 mm. in width. See remarks following *P. interruptus* Say (p. 429).

Psammodius blandus (Fall)

Psammobius blandus Fall, Journ. New York Ent. Soc., vol. 40, p. 191, 1932.

Oblong oval, moderately shining, rufotestaceous. Antennae testaceous. Head convex, closely, moderately verrucose; occiput finely, roughly, punctate-rugose. Clypeus broadly, rather shallowly emarginate, the limiting angles each side well defined, sides finely reflexed, weakly arcuate; genae small, rounded. Pronotum convex, width 1.25 mm., length 0.9 mm., anterior angles rounded, sides arcuate, posterior angles very broadly rounding into the arcuate base so that viewed from directly above the pronotum is almost evenly rounded from one anterior angle to the other, sides and base indistinctly margined, rather sparsely fimbriate-crenate, the hairs moderately fine and relatively short; surface finely scabrous throughout, with a wide, deep median line over basal half and four more or less evident transverse grooves, the first, postapical, deep, entire, from one anterior angle to the other immediately behind the distinctly tuberculate anterior margin, the others interrupted by the midline, the third deeper and more conspicuous than the second and fourth. Elytra convex, width 1.5 mm., length 1.95 mm., about as wide at base as pronotum, humeri rounded, base not margined, sides arcuate, not fimbriate; striae deep, punctures fine and deep; intervals moderately convex, sides crenate, each with a row of very fine punctures between middle and outside edge. Metasternum depressed at middle, smooth, shining, midline scarcely impressed, its length less than the width of the posterior femur, without anterior postcoxal line and only vaguely concave in front of the posterior coxal plate, finely alutaceous at extreme sides. Abdominal segments only moderately shining, the third, fourth, and fifth apparently connate at middle, very minutely alutaceous under high magnification, and with scattered very fine punctures, each segment except the last with a medianly interrupted transverse row of fine, setigerous punctures, the hairs moderately long and fine, the terminal segment and apical margin of the pygidium with complete rows of similar, more closely spaced, long fine hairs. Anterior femur more robust, thicker through than usual, without anterior marginal groove, posterior face smooth and shining in front, finely alutaceous posteriorly. Middle and hind femurs wihout posterior marginal line, convex, smooth and shining except for a curving row of three or four widely spaced setae over apical half in front of knee, middle femur about three-fourths as wide as posterior femur. Posterior tibia apically slightly less than half as wide as long, spurs slender, the long spur reaching middle of second tarsal joint. First tarsal joint elongate-triangular, equal in length to following two combined. Length 3 mm., width 1.5 mm.

Type: In Museum of Comparative Zoology, Cambridge, Mass.

Type locality: El Paso, Texas.

Specimens examined: 3, including holotype.

Distribution: United States: Texas: El Paso. Arizona: Globe. México: Chihuahua: Ciudad Juarez.

Season: November.

Remarks: In general appearance this species is superficially very much like *quinqueplicatus* Horn; however, the lack of distinct coarse punctures on the pronotum, the very short metasternum, and other differences are seen immediately on close examination. The scabrous surface of the pronotum, even over the area beyond the lateral fovea, shows relationship with *interruptus* Say and allied forms.

Psammodius veraecrucis Bates

Psammodius veraecrucis Bates, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 2, pt. 2, p. 103, 1887.

Psammobius veraecrucis Schmidt, Coleoptera, Aphodiinae. Das Tierreich (Deutsche Zool. Ges.), pt. 45, p. 477, 1922.

Oval, strongly convex, moderately shining, ferrugineous. Antennae testaceous. Head convex, closely moderately verrucose; occiput smooth. Clypeus broadly triangularly emarginate, the limiting angles each side obtusely rounded, sides weakly arcuate; genae inconspicuous, broadly rounded. Pronotum slightly narrower in front, width 1.15 mm., length 0.8 mm., anterior angles right-angled, posterior angles obtusely rounded, sides and base margined, crenate, fimbriate with fine hairlike setae; disc convex, surface with numerous, coarse punctures arranged closely in five transverse furrows, the first and third usually more distinct than the second and fourth, the fifth sometimes indistinctly represented by three or four punctures each side; median line represented by irregularly placed coarse punctures interrupting the smooth intervening ridges; sides smooth laterally beyond the fovea and in the posterior angles. Elytra as wide or very slightly wider than pronotum at base, width 1.45 mm., length 1.80 mm., base margined, humeri finely dentate, sides arcuate, not fimbriate; striae deep, moderate, punctures fine and deep; intervals convex, smooth, sides weakly crenate. Metasternum shining, minutely punctate at middle, midline deeply impressed, anterior postcoxal line and arcuate impressed line in front of posterior coxal plate distinct, a few setigerous punctures and alutaceous sculpture at extreme sides. Abdominal segments very finely crenate in front, minutely alutaceous, each with a medianly interrupted, transverse row of shallow, setigerous punctures bearing long fine hairs. Pygidium scabrous basally, smooth apically and fringed with fine hairs. Anterior femur with strong anterior marginal line, two or three coarse punctures at elbow, posterior face otherwise smooth. Middle and hind femurs with strong posterior marginal line, one or two fine, marginal setae near trochanter, a posterior curving row of five or six setigerous punctures outward from middle to front of knee, and the usual anterior fringe of similar fine hairs, otherwise smooth and shining. Posterior tibia arcuate, apex slightly more than one-third as wide as total length, inner edge more or less angulate near basal fifth, the tibia narrowing from this point to knee; spurs slender, the longer subequal in length to first two tarsal joints combined. First tarsal segment elongate-triangular, not as long as the following three combined. Length 2.7 to 2.8 mm., width 1.3 to 1.4 mm.

TYPE: In British Museum (Natural History).

TYPE LOCALITY: "Mexico, Vera Cruz, Tapachula in Chiapas."

SPECIMENS EXAMINED: 6.

DISTRIBUTION.—MÉXICO: Veracruz: Veracruz. Michoacán: Apatzingán.

SEASON.—August.

REMARKS: This species is very close to *quinqueplicatus* Horn and difficult to separate from it except by size, convexity, and more oval shape.

Psammodius quinqueplicatus Horn

Psammodius quinqueplicatus Horn, Trans. Amer. Ent. Soc., vol. 3, p. 292, 1871; vol. 14, p. 95, 1887.

Psammobius quinqueplicatus Schmidt, Coleoptera, Aphodiinae. Das Tierreich (Deutsche Zool. Ges.), pt. 45, p. 476, 1922.

Oblong oval, only slightly broader behind, convex, moderately shining, ferrugineous. Antennae rufotestaceous. Head convex, closely, moderately coarsely verrucose; occiput smooth. Clypeus broadly, triangularly emarginate, angles each side obtuse, sides weakly arcuate, genae inconspicuous, obtusely rounded. Pronotum not narrower in front, width 1.25 mm., length 0.9 mm., anterior angles obtuse, posterior angles widely rounded, sides and base strongly margined, crenate, fimbriate, base arcuate, very slightly lobed at middle; disc moderately convex, surface with numerous, close, coarse punctures arranged in five transverse furrows, the intervening convex, smooth ridges very finely punctate, the first two entire, the others interrupted by the coarsely punctate basal half of the median line; sides smooth beyond lateral fovea and in posterior angles. Elytra as wide at base as pronotum, width 1.55, length 2.25, base margined, humeri weakly dentate, sides nearly straight, slightly divergent to about apical third, not fimbriate; striae moderately deep, strial punctures deep, intervals moderately convex, their sides crenate and minutely alutaceous. Metasternum shining, minutely punctate, depressed at middle, midline strong and deep, a few coarse, shallow, setigerous punctures at extreme sides, anterior postcoxal line and depression in front of the posterior coxal plate evident but not strongly developed. Abdominal segments finely alutaceous, each with a medianly interrupted, transverse, median row of coarse, shallow, setigerous punctures bearing very fine long hairs. Pygidium scabrous basally, smooth apically, fringed with fine setae. Anterior femur with strong, deep anterior marginal line, posterior face smooth. Middle and hind femurs with strong, deep posterior marginal line three-fourths or more of total length, a row of three or four setigerous punctures at knee, otherwise shining and very minutely alutaceous. Hind femur about one-fifth wider than middle femur. Width of posterior tibia at apex one-fourth to two-fifths of the total length, spurs slender, the longer equal to the first two tarsal joints in length. First tarsal joint elongate-triangular, not as long as following three together. Length 3 to 3.7 mm., width 1.4 to 1.8 mm.

Type: Academy of Natural Sciences of Philadelphia, No. 3620.

Type locality: "Probably Arizona or Texas."

Specimens examined: 510.

Distribution.—United States: Arizona: Benson, Geronimo (Gila River, Graham County), Globe, Holbrook, Nogales, Oak Creek, Patagonia, Peach Springs, Phoenix, Robles Ranch (Pima County), Sabino Canyon (Santa Catalina Mountains), Superior, Tucson, Winslow. New Mexico: Albuquerque, Pyramid Peak (Dona Ana County). Texas: El Paso. México: México: Temascaltepec, Tejupilco. Nayarit: San Blas. Oaxaca: Salina Cruz.

Season: July 6 to September 6.

Remarks: *Psammodius quinqueplicatus* Horn has five well marked transverse ridges on the pronotum, counting the anterior margin as the first. A sixth is not so wide but is usually distinguishable behind the fifth furrow. The coarse punctures of the furrows are sometimes so close as to run together, the fifth furrow sometimes ill-defined. The tarsi are relatively long in this species, the tibia and tarsus of the middle legs being subequal in length, while the posterior tarsus is three-fifths to four-fifths as long as the posterior tibia.

Psammodius bolivianus, new species

Holotype oblong oval, convex, moderately shining, ferruginous. Antennae rufotestaceous. Head convex, closely, moderately verrucose; occiput smooth, a single, shallow, coarse puncture midway each side, scattered minute punctures posteriorly. Clypeus moderately deeply, triangularly emarginate with limiting angles rounded, edge finely reflexed, sides weakly arcuate; genae small, fimbriate, somewhat angulate. Pronotum slightly narrower in front, width 1.05 mm., length 0.75 mm., anterior angles rounded, posterior angles obtusely rounded, sides and base entire, not crenate, not fimbriate, distinctly margined; surface with close, deep, coarse punctures arranged in three transverse furrows interrupted by the median longitudinal furrow over basal three-fourths, the first much wider toward the midline, the punctures of the third furrow fewer and more widely separated, surface otherwise smooth. Elytra very slightly wider than pronotum at base, width 1.3 mm., length 1.7 mm., base margined, humeri not distinctly dentate, sides arcuate, not fimbriate; striae deep, finely punctate; intervals smoothly convex, margins slightly crenate. Metasternum smooth, shining, with scattered very fine punctures, depressed at middle, midline feeble and very weakly impressed, only a trace of the anterior postcoxal line at extreme side, surface triangularly depressed in front of posterior coxal plate but without a distinct line. Abdominal segments shining, very minutely alutaceous, laterally with a few fine setigerous punctures bearing very fine, moderately long hairs in a short transverse row, minutely crenate anteriorly and very finely margined posteriorly toward sides, terminal segment more widely crenate in front. Pygidium with a scabrous area each side basally, terminally smooth, fringed with very fine setae. Anterior femur finely margined in front, posterior face smooth. Middle and hind femurs with fine posterior marginal line visible from behind, smooth, shining, each with two setigerous punctures close together slightly beyond the middle near the posterior margin. Posterior femur nearly one-third wider than the middle femur. Posterior tibia about twice as long as wide at apex. Spurs narrow, long spur shorter than first two tarsal joints together. First tarsal joint elongate-triangular, as long as following two joints together. Length 2.8 mm., width 1.3 mm.

Type: USNM 61846.

Type locality: Tiguipa, Bolivia.

Specimens examined: 6; holotype and 5 paratypes as follows: Bolivia: 2 (holotype and paratype), Tiguipa, April 1922, Harrington; 1, Lagunillas to Río Grande, September 1-10, 1920, Harrington; Argentina: Tucumán: 2, Puente Rio Salí, Tucumán, November 1950, Martínez; Paraguay: Boquerón: 1, "Guarn. Oruro," November 1950, Martínez. Paratypes in collections of A. Martínez and U. S. National Museum.

Remarks.—The specimens show only slight variation. The smallest paratype is only 2.5 mm. in length. One has a slightly longer, more widely scabrous pygidium, likely a male sexual modification.

Psammodius manaosi, new species

Holotype oblong oval, convex, moderately shining, ferrugineus. Antennae testaceous. Head convex, closely, moderately verrucose; occiput minutely alutaceous with scattered, shallow, coarse punctures. Clypeus moderately emarginate, the emargination rounded out rather than angulate, limiting angles rounded, margin finely reflexed, sides weakly arcuate; genae fimbriate, small, rounded, set off by a slight sinuation of the margin. Pronotum very slightly narrower in front, width 0.9 mm., length 0.6 mm., anterior angles rounded, posterior angles obtusely rounded, sides and base entire, not crenate, not fimbriate, distinctly margined; surface with close, deep, coarse punctures arranged in three transverse furrows, the first somewhat expanded over the disc anteriorly, the third with fewer punctures more widely spaced in a single irregular row, the second and third interrupted by the similarly punctate, median longitudinal furrow; surface otherwise smooth. Elytra as wide at base as pronotum, width 1.1 mm., length 1.6 mm., base margined, humeri finely dentate, sides arcuate, not fimbriate; striae moderately deep, intervals smoothly convex, their sides not strongly crenate. Metasternum shining, smooth, with scattered very fine punctures, depressed at middle, midline strong, deeper over posterior two-thirds, anterior postcoxal line fine, strong, extending outward to similar lateral line along extreme edge, posterior arcuate antecoxal line strong, extending to lateral line in extreme posterior angle. Abdominal segments smooth, moderately shining, very finely alutaceous, very finely crenate along anterior margin, finely margined along posterior edge, terminal segment more widely crenate in front. Pygidium scabrous each side basally, fringed apically with eight rather short fine hairs. Anterior femur finely, deeply margined anteriorly, posterior face smooth and shining. Middle and posterior femurs smooth and shining, with fine, strong posterior marginal line visible from the rear, a single marginal setigerous puncture near apical third. Posterior femur one-seventh wider than middle femur. Posterior tibia about three times as long as wide at apex, spurs narrow, long spur shorter than first two tarsal joints together. First tarsal joint elongate-triangular, as long as following two joints together. Length 2.5 mm., width 1.1 mm.

Type: In British Museum (Natural History).

Type locality: Manáos, Amazonas, Brazil.

Specimens examined: The unique holotype only. Specimen collected August 1874 by J. W. H. Trail.

Remarks: This species is closely related to *P. santaremi* and *P. bolivianus*. It differs from the first-named by the finer striae and less crenate intervals of the elytra, more distinctly margined base of the elytra, and fewer coarse punctures of the pronotum. From the second it differs in the strong deep lines of the metasternum.

***Psammodius santaremi*, new species**

Holotype oblong oval, moderately shining, ferrugineus. Antennae rufotestaceous. Head convex, closely moderately verrucose; occiput with three or four shallow, coarse punctures each side near frontal suture, otherwise very finely punctate. Clypeus moderately deeply, triangularly emarginate, limiting angles each side rounded, margin finely reflexed, sides feebly arcuate; genae rounded, fimbriate. Pronotum slightly narrower in front, width 1 mm., length 0.65 mm., anterior angles rounded, posterior angles obtusely rounded, sides and base entire, not crenate, not fimbriate, distinctly margined; surface with close, deep, coarse punctures arranged in three transverse grooves, the first widely expanded anteriorly over the disc, the second and third interrupted by the similarly punctate median longitudinal line, the second two or three punctures wide, the third a single irregular row of punctures; surface otherwise smooth. Elytra as wide as pronotum at base, width 1.20 mm., length 1.55 mm., base feebly, not distinctly margined, humeri finely dentate, sides arcuate, not fimbriate; striae wide, deep, punctures moderate and deep; intervals evenly convex, both sides strongly and quite deeply crenate. Metasternum shining, smooth, with scattered minute punctures, midline distinct and moderately deep over posterior two-thirds, the extreme end still deeper, forward third shallow and less well defined, anterior post-coxal line fine but distinct, extending to eroded side line near posterior angle, posterior arcuate antecoxal line strong, deep, and extending outward to extreme edge. Abdominal segments smooth and shining, anterior margin minutely crenate, posterior edge finely margined, laterally with two or three fine setigerous punctures bearing very fine, inconspicuous hairs, terminal segment more widely crenate in front. Pygidium scabrous basally, fringed apically with moderately long, very fine setae. Anterior femur finely margined anteriorly, posterior face smooth. Middle and posterior femurs with fine posterior marginal line visible from behind, smooth and shining otherwise with one or two close setigerous punctures along posterior edge near apical third. Posterior femur nearly one-third wider than middle femur. Posterior tibia about twice as long as wide at apex. Spurs narrow, not much longer than first tarsal joint, the latter elongate-triangular and as long as following two joints together. Length 2.5 mm., width 1.2 mm.

Type: In British Museum (Natural History).

Type locality: Santarém, Pará, Brazil.

Specimens examined: Holotype and two paratypes from Santarém and Allo de Chia (100 miles from Santarém on the Tapajós River), all collected by H. W. Bates.

Remarks: This species is very close to *P. bolivianus* but the coarse punctures of the pronotum are more numerous, the elytral striae are much coarser and the intervals more noticeably crenate, the midline of the metasternum is distinct, and the anterior and posterior lines of the metasternum are deep and extended.

Psammodius indefensus (Schmidt)

Psammobius indefensus Schmidt, Soc. Ent., vol. 24, p. 60, 1909.

Oblong oval, slightly broader behind, moderately shining, piceous, legs and margins of head and pronotum dark castaneous. Antennae pale rufotestaceous. Head convex, moderately coarsely verrucose; occiput with a group of close, coarse punctures each side behind a short, diagonal, closely punctate groove and intervening smooth, weakly convex ridge. Clypeus broadly, triangularly emarginate, the limiting angles each side obtusely rounded, sides nearly straight to slight notch at clypeal suture, genae small, fimbriate. Pronotum slightly narrower in front, width 1.25 mm., length 0.85 mm., anterior angles obtusely rounded, posterior angles widely rounded, basal marginal line fine, entire, sides fimbriate-crenate with moderately long simple hairs from anterior angles to the smooth, unbroken basal margin beginning opposite the fifth elytral stria; surface with two deep, coarsely, closely punctate diagonal furrows each side not quite reaching the median line, the anterior from slightly before the middle to the anterior angles, the posterior parallel and extending to the deep lateral fovea, median line deep and closely, coarsely punctate, scattered coarse punctures elsewhere except between the parallel diagonal furrows and laterally beyond the fovea. Elytra not strongly margined at base, width 1.55, length 2.05 mm., humeri weakly dentate, sides fimbriate with moderately long hairs, slightly divergent to well beyond the middle, striae deep, finely punctate, weakly crenating the sides of the moderately convex intervals, short tenth interval flat. Metasternum smooth, shining at middle, the median line ending abruptly and much deeper posteriorly, a diagonal row of three, coarse, shallow, setigerous punctures on each posterior edge of the flattened, diamond-shaped discal area, a few similar punctures at extreme sides, anterior postcoxal line absent. Abdominal segments shining but minutely, obsoletely alutaceous, each with a transverse row of coarse, shallow, setigerous punctures bearing moderately long hairs, each finely crenate along anterior margin, the crenations somewhat wider on the terminal segment. Pygidium scabrous almost to apex. Anterior femurs margined in front, posterior face smooth. Middle and posterior femurs smooth except for a few hair-bearing punctures along the anterior edge, at the knee, and along the weakly impressed posterior marginal line. Posterior femur one-third wider than the middle femur. Middle and posterior tibiae without oblique ridges but with longitudinal rows of tubercles along edges and ventral side. Long spur of middle tibia slender, subequal in length to first three tarsal joints. Posterior tibia 2¼ times as long as wide at apex; long spur of hind tibia narrow, blunt tipped, shorter than first three tarsal joints combined. Length 3.3 mm., width 1.55 mm.

Type: Schmidt collection, Naturhistoriska Riksmuseum, Stockholm.

Type locality: Valparaíso, Chile.

Specimens examined: 4; holotype and three in the Martínez collection, collected at Quillota, Chile, December 1939, R. Guiterrez.

Remarks: The rather conspicuous fringe of elytral setae separates this species from *P. placidus* (Schmidt), which it superficially resembles.

***Psammodius inflatus*, new species**

Holotype broadly oval, strongly convex, moderately shining, dark castaneous. Antennae rufotestaceous. Head convex, closely moderately verrucose, the granules becoming smaller and weaker at middle of occiput which is otherwise smooth. Clypeus moderately deeply, triangularly emarginate, the angles each side broadly rounded, sides arcuate, sides and angles weakly reflexed; genae weak, smooth, broadly rounded with a deep eyelike pit in front of the eye; eyes well developed. Pronotum convex, width 1.70 mm., length 0.9 mm., all angles broadly rounded, sides and base margined, entire, sides fimbriate with long, fine, curving hairs, base broadly, somewhat angularly lobed at middle; surface with intermixed coarse and very fine punctures, the coarse punctures close but irregularly placed over disc, somewhat finer and much sparser laterally, smooth beyond lateral fovea, postapical furrow strongly impressed, interrupted only slightly at middle, other furrows absent. Elytra not quite as wide as pronotum at base, strongly convex, width 2.15 mm., length 2.5 mm., base not margined, humeri rounded, lateral margin fimbriate with rather sparse long, fine hairs, strongly diverging over anterior half then apically, evenly, almost hemispherically, jointly rounded from side to side, striae fine with moderate, deep punctures, separated by slightly more than their diameters, crenating the smooth, shining, very weakly convex intervals, tenth interval not differing from the others. Metasternum smooth, shining, medially flat and slightly depressed posteriorly, very short, not over two-thirds as long as width of posterior femur, deeply arcuately depressed in front of posterior coxal plates. Abdominal segments, except apical, smoothly connate at middle, finely, setigerously punctate at sides with rather long, close, very fine hairs, last two segments setigerously punctate from side to side. Pygidium convex, similarly with long fine hairs. Anterior femurs without marginal line, clothed posteriorly with sparse, long, fine hairs. Middle and hind femurs smooth, shining, with scattered, sparse, long, fine hairs anteriorly and a single fringe row posteriorly, the middle femurs only half as wide as the posterior femurs, the latter only a third longer than wide. Posterior tibia approximately twice as long as apical width, spurs short, foliaceous; first joint of tarsus subequal in length to long spur, and to remaining joints combined, the middle three shorter than wide. Length 3.8 mm., width 2.15 mm.

Type: In collection of A. Martínez, Buenos Aires, Argentina.

Type locality: Monte Hermoso, District of Cornel Dorrego, Province of Buenos Aires, Argentina, Jan. 1, 1954, A. Martínez.

Specimens examined: Holotype and one paratype bearing same data as type. Paratype in collection of U. S. National Museum.

Remarks: The size, brown color, very convex and strongly oval form, and long hair mark this species. I suspect it is flightless.

Psammodius placidus (Schmidt)

Psammobius placidus Schmidt, Stettiner Ent. Zeit., vol. 72, pt. 1, p. 38, 1911.

Oblong oval, moderately shining, dark castaneus. Antennae rufotestaceous. Head convex, verrucose, the tubercles comparatively small, separated by about their diameter, much finer anteriorly at middle, occiput with a few, scattered, coarse punctures. Clypeus finely margined, weakly dentate each side of broad, shallow, triangular emargination, sides arcuate, genae fimbriate. Pronotum not narrower in front, width 1.5 mm., length 1.05 mm., sides and base fimbriate with fine, simple, hairlike setae, finely, not noticeably crenate, basal marginal line distinct, surface, except for lateral, smooth, convex area beyond fovea, with intermixed very fine and very coarse punctures, the latter mostly in the deep median line, in the wide depressed area extending diagonally back each side from the lateral fovea, and in a vaguely parallel group from the anterior angles to the middle. Elytra widest about middle, width 1.80 mm., length 2.20 mm., sides arcuate, evenly rounded to apex, not fimbriate, humeri dentate, base margined; striae deep with deep, moderate punctures, intervals smooth, strongly convex, ninth and tenth not different from others. Metasternum smooth, shining, depressed at middle, median line short, deep, abruptly terminated, anterior postcoxal line distinct, posterior depressed area in front of posterior coxal plate short and indistinct. Abdominal segments smooth, shining, a short, transverse row of very moderate setigerous punctures each side, finely crenate along anterior edge, the crenations wider and deeper on the terminal segment. Pygidium finely alutaceous, a marginal row of moderate setigerous punctures apically. Anterior marginal groove of anterior femurs fine, indistinct, posterior face smooth. Middle and posterior femurs with very short posterior marginal line visible only from rear, smooth except for three or four setae in front and near posterior margin. Posterior femurs only slightly wider than middle femurs. Apex of hind tibia one-third as wide as length of tibia, the tibia noticeably smooth beyond the poorly developed across ridge slightly posterior to middle of tibia, spurs narrow, the longer about equal in length to first two tarsal joints combined, tarsus three-fourths as long as tibia, its joints more elongate than triangular in shape. Length 3.6 mm., width 1.8 mm.

TYPE: In Schmidt collection, Naturhistoriska Riksmuseum, Stockholm.

TYPE LOCALITY: Argentina.

SPECIMENS EXAMINED: Holotype only. Collected "2-11-1905," C. Bruch.

REMARKS: *Psammodius placidus* (Schmidt) superficially resembles *P. indefensus*, but is readily separated from it by the clypeal teeth, the setae continuing all the way across the base of pronotum, the dentate humeri, the lack of marginal setae on the elytra, and the very similar middle and hind legs.

Psammodius malkini Cartwright

Psammodius malkini Cartwright, Bull. Brooklyn Ent. Soc., vol. 41, p. 90, 1946.

Oval, moderately shining, rufocastaneous. Antennae pale rufotestaceous. Head convex, closely moderately verrucose, the granules well developed, occiput smooth. Clypeus moderately, triangularly emarginate, the limiting angles rounded, sides weakly arcuate; genae small but distinct, posteriorly angulate. Eyes normal, well developed. Pronotum slightly lobed basally, width 1.2 mm., length 0.8 mm., narrower in front, angles obtusely rounded, sides entire, fimbriate basally with fine, short hairs; surface finely, sparsely punctate throughout, an anterior, postapical, transverse line of closely placed, coarse punctures in a groove from one anterior angle to the other, a similar longitudinal, median groove over basal two-thirds, and another of about same length transversely inward from each side, disc otherwise with scattered coarse punctures. Elytra convex, width 1.5 mm., length 1.90 mm., striae deep, coarsely, crenately punctate, intervals weakly convex, very finely, irregularly punctate. Metasternum smooth, shining, anterior postcoxal line absent, posterior arcuate line obsolete, represented by a weakly impressed area in front of posterior coxal plate, median longitudinal groove fine, scarcely impressed, anteriorly alutaceous and very shallowly, moderately punctate at sides. Abdominal segments sparsely, minutely punctate and very finely alutaceous, apparently not crenate in front. Pygidium smooth, shining, fringed apically with a row of ten long, hairlike setae from moderate punctures. Posterior femur stout, minutely alutaceous, two or three setigerous punctures paralleling posterior edge and a similar row along the anterior margin; middle femur not half as wide as posterior, marginal rows of setae strongly developed. Posterior tibia two-fifths as wide as long, transverse ridges absent; posterior spurs narrowly foliaceous, the longer as long as the first two tarsal joints combined; first tarsal joint elongate-triangular, equal in length to following three together. Length 2.8 to 3.3 mm., width 1.5 to 1.6 mm.

Type: USNM 58991.

Type locality: MacDill Field, Tampa, Fla.

Specimens examined: 21.

Distribution: United States: Florida: Tampa, LaBelle, Sanford, Miami.

Season: May 5 to August 7.

Remarks: *Psammodius malkini* Cartwright is nearest *P. hydropicus* Horn but is not so greatly inflated, the elytral striae are deeper and rather coarsely crenate, the elytral intervals are more convex, the sides of the pronotum are entire, the pronotal punctures are coarser and deeper, and the eyes are well developed. In *hydropicus* the pronotum has the lateral edges crenate and the eyes are vestigial.

Psammodius hydropicus **Horn**

Psammodius hydropicus Horn, Trans. Amer. Ent. Soc., vol. 14, p. 97, 1887.
Psammobius hydropicus Schmidt, Coleoptera, Aphodiinae. Das Tierreich (Deutsche Zool. Ges.), pt. 45, p. 483, 1922.

Oval, moderately shining, rufocastaneus. Antennae pale testaceous. Head strongly convex, verrucose, the granules weakly developed; occiput smooth. Clypeus moderately, triangularly emarginate, the limiting angles each side obtuse, rounded, sides weakly arcuate, slightly notched at clypeal suture; genae weak, depressed, inconspicuous. Eyes very small and poorly developed. Pronotum narrower in front, width 1.35 mm., length 0.8 mm., angles obtuse, sides and base weakly crenate and fimbriate with moderately long, fine hairs; surface smooth but uneven, a vague, shallow depression inward near the anterior angles, and scattered, very shallow, coarse, indistinct punctures over disc and base. Elytra almost globular, width 1.7 mm., length 1.9 mm., base not margined, sides not fimbriate; striae moderately wide and deep, finely punctate, the punctures not noticeably crenating the sides of the smooth, weakly convex intervals. Inner wings absent. Metasternum very short, the scarcely impressed midline subequal in length to the width of the posterior femur, smooth and shining at middle, alutaceous at sides with intermixed, shallow setigerous punctures, anterior postcoxal line absent, posterior antecoxal line obsolete, parallel with posterior coxal plate. Abdominal segments finely alutaceous, each with a transverse, anterior row of close, long, very fine hairs. Exposed part of pygidium apically smooth and shining, base with transverse eroded line; groove beneath tips of elytra weakly impressed. Anterior femur not margined in front, clothed posteriorly with long, fine hair, as are the middle and hind femurs along anterior and posterior margins. Posterior femur about twice as wide as middle femur. Middle and hind tibiae arcuate inward, without transverse carinae but with short, longitudinal rows of three or four tubercles. Spurs slender, acute, the longer subequal in length to first three tarsal joints combined. First tarsal joint of posterior tarsus subequal in length to following three, all except the fifth wider apically and with the outer angle more or less produced. Length 2.6 to 3.5 mm., width 1.5 to 2 mm.

Type: In Academy of Natural Sciences of Philadelphia.

Type locality: Savannah, Ga.

Specimens examined: 322.

Distribution: United States: North Carolina: Wrightsville Beach. South Carolina: Isle of Palms, Folly Beach, Seabrooks Island, Edisto Beach. Georgia: Savannah. Alabama: Baldwin County, Mobile, Daphne. Mississippi: Ocean Springs.

Season: June 3 to November 11.

REMARKS: This small degenerate species, wingless and with vestigial eyes, is sometimes very numerous among the roots of grasses on the sand dunes along the seacoast of southeastern United States. It superficially resembles *P. malkini* but is easily separated from it by the crenate margins of the pronotum and the vestigial eyes. The underside is unusually hairy.

Psammodius oregonensis, new species

Holotype oval, very convex, piceous, shining. Antennae brown. Head convex, rather closely verrucose, occiput smooth. Clypeus moderately deeply and narrowly emarginate, the middle of the emargination rounded and very finely denticulate below the fine marginal bead, limiting angles each side rounded, sides arcuate; genae weak and inconspicuous. Eyes small and only moderately developed. Pronotum not narrowed in front, width 1.35 mm., length 0.9 mm., angles obtusely rounded, sides entire, hind angles and base weakly crenate-fimbriate with club-shaped setae; surface with close, moderately coarse punctures arranged in three or four more or less distinct, transverse, shallow grooves, the first or postapical distinct from side to side, the second less distinct, the third very distinct inwardly from middle of lateral declivities but interrupted at middle by the similarly punctate, rather vague, longitudinal midline, the fourth not impressed but represented by scattered punctures, surface otherwise with scattered minute punctures throughout. Elytra very convex, almost globular, width 1.8 mm., length 2.35 mm., base margined, humeri dentate, sides not fimbriate; striae coarse, deep, coarsely punctate, the punctures moderately close and feebly crenating the sides of the intervals; intervals weakly convex, smooth, shining, with a median, longitudinal row of close minute punctures. Inner wings absent. Metasternum at middle about equal in length to the width of the posterior femur, smooth, depressed at middle, midline impressed, anterior postcoxal line strong, deep, continuous with scabrous area at side, posterior line in front of posterior coxal plate also strong, deep, and extending to the side, well separated from the anterior line. Abdominal segments slightly convex, smooth to minutely alutaceous, finely crenate in front, each with a medianly interrupted, anterior row of well-separated, setigerous punctures, the hairs long and fine. Pygidium eroded basally, fringed apically with long, fine hairs. Anterior femurs anteriorly with a wide, eroded, marginal line. Middle and hind femurs with strong, posterior marginal line and parallel row of very coarse, setigerous punctures, the punctures uniting to form a second, deep, close, eroded line. Middle and hind tibiae with incomplete oblique ridges. Posterior spurs narrow, the longer as long as the first two tarsal joints combined. Tarsal joints triangular, the first elongate, slightly shorter than the following three together. Length 3.5 mm.,width 1.8 mm.

Type.—USNM 61847.

Type locality: Hauser, Coos County, Oreg.

Specimens examined.—207

Paratypes.—United States: Washington: 1, Long Beach (Pacific County), July 15, 1936, Van Dyke. Oregon: 148 (including holotype), Hauser, Sept. 6, 1952, Nelson; 11, Hauser, May 20, 1954, Ritcher; 9, Lake Tahkenitch, June 17, 27, 1936; 2, Lincoln County, June 8, 1941, Nunenmacher; 3, Cannon Beach, June 11, 13, 1927, Van Dyke; 3, Waldport, June 4, 1941; 2, Taft, May 1935, Ross; 1, Yamhill County, May 1935; 2, Woods, June 6, 1936, K. M. and D. M. Fender; 1, Gardiner, June 26, 1936; 4, Sunset Beach, June 28, 1938, Gray and Schuh; 3, Newport, Sept. 1908; 2, Winchester Bay, Lane County, Apr. 13, 1947, Malkin and Newell; 4, Hecate Beach, May 20, 1954, Ritcher; 1, Bandon, May 19, 1954, Ritcher. California: 2, Trinidad, June 6, 7, 1925, Martin; 2, Samoa, May 23, Barber; 17, Samoa Beach and dunes, Humboldt County, June 18, 1907, Bradley; 1, San Francisco County, Mar. 22, 1927, Leech; 1, Contra Costa County, Apr. 14, 1927, Leech; 3, "Cal."; 1, "S. Cal." Paratypes are in British Museum (Natural History), Naturhistoriska Riksmuseum, California Academy of Sciences, Canadian Department of Agriculture, American Museum of Natural History, Carnegie Museum, Chicago Natural History Museum, Museum of Comparative Zoology, Cornell University, Illinois Natural History Survey, Ohio State University, Oregon State College, and the private collections of Henry Howden, Antonio Martínez, Gayle Nelson, Mark Robinson, and Joe Schuh.

Remarks: *Psammodius oregonensis* is usually darker in color than *P. caelatus* and *P. mcclayi*, the two closely related species from the same region. It may be recognized by the strong, complete, anterior marginal groove of the anterior femur and the lack of marginal setae on the elytra.

Psammodius caelatus (LeConte)

Aegialia caelata LeConte, *in* Rep. Expl. Surv. Railr. to Pacific, vol. 12, pt. 3, No. 1, p. 42, 1857.[1]

Psammodius caelatus Horn, Trans. Amer. Ent. Soc., vol. 14, p. 97, 1887.

Psammobius caelatus Schmidt, Coleoptera, Aphodiinae. Das Tierreich (Deutsche Zool. Ges.), pt. 45, p. 484, 1922.

Oval, very convex, piceous, shining, legs rufopiceous. Antennae pale rufotestaceous. Head convex, rather closely verrucose, occiput smooth. Clypeus broadly, triangularly emarginate, the limiting angles rounded, sides weakly arcuate, clypeal notch scarcely discernible; genae weak and inconspicuous. Eyes very small, poorly developed. Pronotum not narrowed apically, angles obtusely rounded, sides entire, feebly arcuate, base strongly margined, hind angles and

[1] The Zoological Report on Insects, originally scheduled for inclusion in volume 9, was published separately in June 1857 and republished in volume 12 in 1860.

base laterally crenate-fimbriate; surface with moderately coarse, close, deep punctures arranged in a postapical groove, in a second groove near the middle of the declivity extending upward nearly to the middle of the disc, sometimes in a single line between these two, and in the basally impressed median line, otherwise with scattered coarse and minute punctures. Elytra very convex, almost globular, width 1.75 mm., length 2.2 mm., base margined, humeri dentate, sides fimbriate with long fine hairs; striae deep and quite coarsely punctate, the punctures scarcely crenating the feebly convex intervals; intervals smooth with a median longitudinal row of close, minute punctures. Inner wings absent. Metasternum smooth, somewhat depressed at middle, the midline finely impressed, not as long as the width of the posterior femur, anterior postcoxal line deep, coarse, merging midway to the side with the similar, anteriorly arcuate line just in front of the posterior coxal plate. Abdominal segments smooth or minutely alutaceous, finely crenate in front, and with an anterior, medianly interrupted row of moderate setigerous punctures, the hairs long and fine. Pygidium basally eroded, alutaceous, apically smooth and shining, fringed with long fine hairs. Anterior femur not margined in front. Posterior femur slightly less than twice as long as wide, nearly twice as wide as middle femur, smooth except for scattered, moderate hair-bearing punctures near anterior margin and a row of the same near the posterior edge. Middle and posterior tibiae with sharply carinate, oblique ridges, the posterior tibia about three times as long as wide apically. Posterior spurs narrow and relatively short, the longer subequal in length to the first two tarsal joints. Tarsal joints triangular, the first elongate, about equal in length to the following three combined. Length 2.8 to 3.6 mm., width 1.6 to 1.9 mm.

Type: Museum of Comparative Zoology, Cambridge, Mass.

Type locality: San Francisco, Calif.

Specimens examined: 333.

Distribution: Canada: British Columbia: Queen Charlotte Islands. United States: California: San Francisco, San Bruno Hills (San Mateo), Caspar, Antioch, Alameda, Carmel, Santa Cruz, Felton. Oregon: Bandon, Newport, Taft, Hauser.

Season: September to May 20.

Remarks: *Psammodius caelatus* (LeConte), the second species of the genus described from America, is closely allied to two other species occupying overlapping stretches of the Pacific coastline. All three are small, globular species having a transverse ridge or anteapical carina at posterior third, paralleling the apical edge of the middle and posterior tibiae. *Psammodius oregonensis* differs by not having fimbriate elytral margins. *P. caelatus* may be separated from *P. mcclayi* by the strong, anterior postcoxal line of the metasternum, a line not found in *mcclayi*.

Psammodius mcclayi, new species

Holotype oval, very convex, rufopiceous, shining. Head convex, rather closely verrucose, occiput smooth. Clypeus finely margined, moderately deeply, angularly emarginate, limiting angles sharply rounded, sides weakly arcuate, genae moderate. Eyes very small and degenerate. Pronotum width 1.3 mm., length 0.8 mm., angles obtusely rounded, sides entire, posterior angles and base weakly crenate and fimbriate, base and sides margined, surface with moderately coarse punctures arranged for the most part in two shallow, transverse grooves, one postapical, the other somewhat arcuately backward from one lateral fovea to the other, with a few scattered punctures on each side laterally, elsewhere with scattered very fine punctures throughout, median line shallow but distinct over basal half. Elytra very convex, almost globular, width 1.8 mm., length 2.1 mm., basally as wide as pronotum, base not margined, humeri not dentate, sides fimbriate with long, fine hair; striae moderate, deep, strial punctures fine, scarcely crenating the sides; intervals convex, smooth, with a barely perceptible median line of minute punctures. Inner wings absent. Metasternum at middle only two-thirds as long as width of posterior femur, smooth, slightly depressed at middle, midline distinct, laterally smooth to finely alutaceous, anterior postcoxal line absent, only a trace of a line or depression in front of posterior coxal plate. Abdominal segments slightly convex, smooth to minutely alutaceous at sides, minutely crenate in front, each with a medianly interrupted, anterior row of well-separated setigerous punctures bearing long fine hairs. Pygidium finely scabrous to extreme edges, fringed with long, fine hairs. Anterior femur without anterior marginal line, smooth posterior face with long, fine hair along margins. Middle femur half as wide as posterior, both with distinct, entire marginal lines and with setigerous punctures bearing long, fine hairs near anterior and posterior edges, otherwise smooth. Middle and hind tibiae with complete oblique ridges. Posterior spurs narrow, the tips oblique and slightly concave, long spur as long as first two tarsal joints combined. Tarsal joints triangular. Length 3.1 mm., width 1.8 mm.

Type: USNM 61848.

Type locality: Playa del Rey, Los Angeles County, Calif.

Specimens examined: 403.

Paratypes: United States: California: 9, state label only; 304, Playa del Rey, Feb. 10, 1934, McClay; 29, San Francisco, Dec. 20, 1919, Feb. 8, 1920, Dietrich; Dec. 20, 1919, Feb. 3, 1920, Martin; Mar. 1, 1908, Blaisdell, February 1933, Ross; 7, Santa Barbara, Jan. 2, 1929; 20, Santa Cruz, Feb. 23, 1929, Van Duzee; Jan. 15, 1938, Tilden; 1, Stinson Beach, Nov. 12, 1931, McCaleb; 2, "Hueneme," Jan. 28, 1932; 1, San Diego, Apr. 26, 1881; 17, Alameda County, November, December, Koebele; 6, Redondo, April; 2, Port Watsonville, Sept. 26, 1932; 4, Los Angeles County, Albright; 1, Newport, June 14, 1915, Muchmore (under kelp). Paratypes will be placed in all museum and private collections lending material for this study (see acknowledgements, p. 414).

Remarks: Two specimens of this species were not included in the typical series or listed in the distribution because of very doubtful label data. In one case, a specimen in the Chicago Natural History Museum was labeled "Ariz. 1879. Andreas Bolter Collection." In the other case, two specimens in the same small collection had evidently been remounted and the labels exchanged, placing *oregonensis* in Southern California and *mcclayi* in Oregon.

Psammodius mcclayi is one of the few species in which the sexes may be determined without dissection. The female is very similar to the male except that the pygidium is widely smooth apically, slightly narrower, and less widely rounded apically. *P. mcclayi* may be separated from the closely allied *P. caelatus* by the lack of the anterior postcoxal line on the metasternum, the complete transverse ridge or carina of the posterior tibia, and the lack of a basal margin of the elytra.

The species is named for Prof. A. T. McClay of the University of California at Davis, Calif. His fine, long series of specimens was collected around the roots of grasses on the sand dunes of the seacoast.

Psammodius martinezi, new species

Holotype strongly convex, oval, shining, piceous. Antennae rufotestaceous. Head convex, closely moderately verrucose, occiput moderately coarsely punctate above the eyes. Clypeus narrowly, deeply, triangularly emarginate, the limiting angles each side obtusely rounded, sides weakly arcuate, feebly reflexed; genae small, obtusely rounded, set off by a distinct sutural notch, two or three moderately long, fine, curving hairs from underneath. Pronotum convex, width 1.75 mm., length 1.1 mm., anterior angles obtusely rounded, posterior angles broadly rounded, sides and base entire, not fimbriate, distinctly, finely margined, the anterior edge more widely so, base very feebly, broadly sinuate each side, angulate at middle; surface closely, moderately punctate throughout, the punctures separated by approximately their own diameters, gradually less deep and somewhat finer at the extreme sides; median line broadly, vaguely impressed. Elytra convex, as wide at base as pronotum, width 2.1 mm., length 2.6 mm., base only vaguely margined, humeri not dentate, sides arcuate, not fimbriate; striae moderately deep and wide, strial punctures very moderate, deep; intervals feebly, evenly convex, smooth and shining with fine inconspicuous punctures in a very irregular row, sides only very feebly crenate. Metasternum smooth and shining at middle, scabrous at sides, midline evident but not distinctly impressed, anterior postcoxal line absent, posterior antecoxal area deeply impressed but without a sharp, distinct line. Abdominal segments smooth and shining but with scattered minute punctures and fine alutaceous sculpture at sides, minutely crenate in front, terminal segment with a transverse row of long, very fine hairs. Pygidium minutely alutaceous with marginal row and a few discal setigerous punctures bearing moderately long, fine hairs. Anterior femur without marginal line, posterior face very finely punctate, minutely alutaceous, feebly concave. Middle femur with a widely spaced row of fine setigerous punctures near anterior edge and a row of three or four similar setigerous punctures near posterior margin from middle toward the knee, posterior marginal line absent. Posterior femur three-fourths wider than middle femur, smooth and shining with scattered, very fine punctures and very minute alutaceous sculpture, setigerous punctures and posterior marginal line absent. Posterior tibia twice as long as wide at apex, spurs narrow, the long spur as long as the first two tarsal joints combined. First tarsal joint of posterior tarsus elongate-triangular, almost as long as following three together. Length 3.8 mm., width 2.1 mm.

TYPE: In collection of A. Martínez, Buenos Aires, Argentina.

TYPE LOCALITY: Nova Friburgo, State of Rio de Janeiro, Brazil.

SPECIMENS EXAMINED: Holotype and two paratypes bearing same data, Nova Friburgo, State of Rio de Janeiro, Brazil, Oct. 18, 1947, Wittmer Coll., Martínez. Paratypes are in collections of U. S. National Museum and A. Martínez.

REMARKS: *Psammodius martinezi* is one of the few species of *Psammodius* that have no trace of marginal fimbriae on the pronotum. It lacks also the typical transverse ridges and furrows of the pronotum.

Psammodius martinezi is named in honor of Dr. Antonio Martínez, who generously loaned his collection of South American *Psammodius* for study and had already recognized the present species as undescribed.

Psammodius insulcatus **(Schmidt)**

Psammobius insulcatus Schmidt, Arch. Naturg., abt. A, heft 1, vol. 82, p. 102, 1916.

Oblong oval, moderately shining, dark castaneous. Antennae testaceous. Head moderately convex, coarsely verrucose, occiput smooth. Clypeus dentate each side of broad, shallow emargination, sides slightly arcuate to the rounded genae, genae not fimbriate. Pronotum slightly narrower in front, width 1.80 mm., length 1.15 mm., anterior angles broadly rounded, posterior angles obsolete, very broadly rounded into base, base entire, without marginal line, sides crenate and fimbriate with moderately long simple setae, surface evenly convex, without furrows except for a short, shallow depression inward from each anterior angle, evenly, quite densely punctate, the moderate punctures separated by one or two diameters and slightly smaller anteriorly and at sides. Elytra margined at base, nearly parallel sided, width 2 mm., length 2.5 mm., not fimbriate; striae deep, punctures moderate, slightly crenating sides of the smooth, flat intervals, ninth and tenth intervals slightly convex, otherwise as on disc. Metasternum smooth at middle, median line deep, abruptly terminated at each end, anterior postcoxal line absent, a few close, shallow, very coarse, alutaceous punctures at extreme sides. Abdominal segments smooth at middle, finely crenate along anterior margin, the crenate area wider along median anterior edge of terminal segment. Pygidium scabrous over apical third except for smooth apex. Anterior femur with fine, indistinct anterior groove, posterior face smooth, three or four setae along posterior margin. Posterior femur one-third wider than middle femur, both with a submarginal row of setae along posterior edge and at knee, a few setae along anterior edge, posterior marginal line very short, only a trace at knee. Posterior tibia without oblique ridges, apex about two-fifths as wide as length of outside edge of tibia, spurs heavy, blunt, the longer about equal to first tarsal joint in length. Length 3.75 mm., width 2 mm.

TYPE: Schmidt collection, Naturhistoriska Riksmuseum, Stockholm.

TYPE LOCALITY: Blumenau, Santa Catarina, Brazil.

SPECIMENS EXAMINED: Holotype only.

REMARKS: The complete lack of basal marginal line on the pronotum will help in identifying this species.

Psammodius bidens Horn

Psammodius bidens Horn, Trans. Amer. Ent. Soc. vol. 3, p. 293, 1871, and vol. 14, p. 92, 1887.—Chapin, Proc. U. S. Nat. Mus., vol. 89, p. 9, 1940.

Psammobius cruentus Schmidt (not Harold, 1867), Coleoptera, Aphodiinae. Das Tierreich (Deutsche Zool. Ges.), pt. 45, p. 478, 1922.

Oblong, shining, dark castaneous. Antennae testaceous. Head convex, moderately coarsely verrucose; occiput smooth, sparsely, minutely punctate. Clypeus finely margined, widely, moderately deeply, arcuately emarginate, a strong acute tooth each side of the emargination, sides arcuate to the moderate, rounded genae, genae not fimbriate. Pronotum convex, width 1.5 mm., length 1.1 mm., sides and base crenate, fimbriate with very moderate, simple, hairlike setae, crenations finer, fimbriae shorter across the base, which is finely margined, slightly fimbriate and weakly lobed at middle; anterior angles obtusely rounded; posterior angles evident but very broadly rounded; surface polished, with very fine, sparse punctures throughout, a wide, curving band of moderately coarse punctures from anterior angles to base, coarse punctures lacking anteriorly and laterally beyond the foveae; no median line, transverse furrows or other depressions except a short, deep, punctate groove in anterior angles. Elytra convex, width 1.7 mm., length 2.3 mm., humeri slightly dentate, sides without fimbriae, arcuate, slightly wider at middle, base margined, striae deep, strial punctures moderate, all intervals convex. Metasternum smooth, shining at middle, median line long, moderately deep, anterior postcoxal line absent, scabrous at extreme sides. Abdominal segments shining but with moderately close, very shallow, fine to moderate punctures throughout, some alutaceous sculpture at extreme sides, finely crenate in front, the crenations of the terminal segment wider and deeper at middle. Apical third of pygidium shining, flat or slightly concave. Anterior marginal groove of profemur obsolete, posterior face smooth, shining. Middle femur about half as wide as the posterior femur, smooth, three or four setae along posterior margin, without distinct posterior femoral line. Posterior tibia with nearly complete oblique ridge at apical fourth, three incipient ridges above, tibia 2½ times as long as wide at apex, spurs narrow, the longer spur slightly longer than the combined length of the first two tarsal joints. Length 3.2 to 4.2 mm., width 1.4 to 2.0 mm.

TYPE: Horn collection, Academy of Natural Sciences of Philadelphia.

TYPE LOCALITY: Southern United States, probably Georgia.

SPECIMENS EXAMINED: 57.

DISTRIBUTION: UNITED STATES: New Jersey: Ocean City. Maryland: Kenwood Beach. Virginia: Virginia Beach. North Carolina: "N. C." South Carolina: Isle of Palms, Seabrook Island, Hunting Island, Folly Beach, Sullivans Island. Georgia: Tybee Island, St. Simon Island, Savannah, St. Catherines Island. Florida: Capron, Crescent City, Miami. Mississippi: Ocean City, Horn Island. PUERTO RICO: Humacao.

SEASON: April 12 to October 12.

REMARKS: *Psammodius bidens* Horn has been confused with *P. cruentus* Harold; however, it is very distinct and does not resemble that species even superficially. It is found among grass roots growing in the sand along the Atlantic and Gulf Coasts of the United States from New Jersey to Mississippi.

Psammodius integer Bates

Psammodius integer Bates, Coleoptera, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 2, pt. 2, p. 104, 1887.

Psammobius integer Schmidt, Coleoptera, Aphodiinae. Das Tierreich (Deutsche Zool. Ges.), pt. 45, p. 477, 1922.

Oblong, convex, sides subparallel, moderately shining, dark castaneous. Antennae testaceous. Head moderately convex, verrucose, more coarsely so anteriorly, the tubercles tending to unite transversely, posteriorly becoming only weakly wrinkled and merging almost imperceptibly with the smooth, minutely punctate occiput. Clypeus with a small, triangular tooth each side of the wide, very shallow emargination, sides slightly arcuate, the nearly right-angled genae not fimbriate. Pronotum convex, width 1.2 mm., length 0.85 mm., anterior angles obtuse, posterior angles broadly rounded, complete, fine marginal line, sides posteriorly and base fimbriate with very short, inconspicuous setae, the setae about as long as the diameter of the coarse punctures of the pronotum, surface without depressions or furrows except for the very small lateral foveae and a slight depression in the anterior angle, closely, evenly punctate throughout, the punctures moderate over basal two-thirds, gradually much finer anteriorly, narrowly along the base, and beyond the lateral foveae. Elytra convex, shining, width 1.2 mm., length 1.85 mm., sides almost parallel, base margined, humerus not noticeably dentate, margins not fimbriate; striae moderately deep, crenate-punctate, the punctures fine and deep; all intervals convex, practically impunctate, shoulders distinctly, closely, finely punctate. Metasternum shining, smooth but with sparse, scattered, minute punctures, depressed at middle, the median line long, deep, abruptly terminated at each end, anterior postcoxal line absent. Abdominal segments shining, sparsely, rather finely, shallowly punctate throughout, the punctures separated by two or three times their diameters, finely crenate along anterior margin, the terminal segment much more widely and deeply so at middle. Pygidium closely finely punctate, alutaceous basally along the transverse carina. Anterior femur with fine anterior marginal groove, posterior face shining, a few moderate punctures and alutaceous lines at opposite edge. Posterior femur only one-tenth wider than middle femur. Middle and posterior femurs smooth and shining, posterior marginal line very short or absent. Posterior tibia not quite three times as long as wide at apex, anteapical transverse ridge partly developed, spurs slender, the longer not quite as long as first two tarsal joints combined. Length 3 mm., width 1.2 mm.

Type: In Biologia collection, British Museum (Natural History).

Type locality: Veracruz, México.

Specimens examined: 2 cotypes.

Remarks: This small species is perhaps nearest *P. bidens* Horn, but it is not closely allied to any of the other species of *Psammodius*. It has both the appearance and many of the characters of an *Ataenius*.

Psammodius formosus, new species

Holotype oblong, convex, shining, rufopiceous. Antennae testaceous. Head moderately convex, verrucose, basally at middle with close fine tubercles which rapidly become finer and disappear toward the sides and the smooth, shining occiput. Clypeus moderately deeply, angularly emarginate at middle, a sharp triangular tooth each side of emargination, sides arcuate, finely reflexed; genea obtuse, shining, with a small deep pit in front of the eye, not fimbriate. Pronotum convex, width 1.3, length 0.8, anterior angles rounded, posterior angles very broadly rounded, sides finely crenate, fimbriate with moderately long, very fine, curving hairs, finely margined; without transverse grooves, surface smooth and shining but with intermixed extremely fine and rather widely, irregularly scattered, moderate punctures over basal two-thirds of discal area, smooth laterally beyond fovea. Elytra convex, margined basally, width 1.6 mm., length 2.0 mm., humeri finely dentate, sides arcuate, fimbriate with extremely short, fine, inconspicuous fimbriae; striae deep, fine punctures crenating the sides of the slightly convex intervals. Metasternum smooth and shining except for a small scabrous area at extreme sides, midline deep, terminating suddenly at each end. Abdominal segments convex, smooth and shining, a few scattered small tubercles outward near sides, finely crenate in front, the terminal segment more widely and deeply so at middle. Pygidium smooth, shining, but surface somewhat uneven. Anterior femur with four or five setae in anterior marginal line, posterior face with scattered setigerous punctures. Middle and hind femurs smooth, shining, with fringe hairs along anterior edge and four or five long hairs along extreme posterior edge, usual curving row near knee represented by only one or two short, fine hairs, posterior marginal line absent; posterior femur about one-third wider than middle femur. Posterior tibia twice as long as its apical width; long spur and first tarsal joint about equal in length, tarsus very slightly longer than apical width of tibia. Length 3.2 mm., width 1.6 mm.

Type: USNM 62491.

Type locality: San Blas, Nayarit, México.

Specimens examined: Holotype and 11 paratypes collected at San Blas, Nayarit, México, Sept. 17–21, 1953, at light, by Borys Malkin. Paratypes are in collections of Borys Malkin and U. S. National Museum.

Remarks: The typical series shows considerable variation in color, ranging from light castaneous to rufopiceous. The elytra become darker first, followed by the pronotum, with the head last. *Psammodius formosus* superficially resembles *bidens* but is shorter in length, the elytra are fimbriate with very short inconspicuous hairs, and the head has fine close granules above the front.

Psammodius chipiririi, new species

Holotype oblong, convex, sides subparallel, shining, piceous with legs, anterior margin of clypeus and pronotum rufopiceous. Antennae testaceous. Head moderately convex, verrucose, posteriorly with a band of close fine punctures above and between the eyes. Clypeus with a small triangular tooth each side of the wide, shallowly emarginate anterior margin, sides weakly arcuate, the nearly right-angled genae not fimbriate. Pronotum convex, width 1.4 mm., length 0.9 mm., anterior angles obtuse, posterior angles broadly rounded, sides and base finely margined, very weakly crenate, fimbriate with short, even spicules, the spicules about as long as distance between punctures of the pronotum; without transverse grooves, surface with evenly placed, very moderate punctures which very gradually become finer anteriorly from basal part of disc and a little sparser laterally where they extend beyond the lateral fovea to the extreme margin and into the anterior angles. Elytra convex, shining, width 1.6 mm., length 2.2 mm., base margined, humeri slightly dentate, sides subparallel, margins not fimbriate; striae deep, fine strial punctures crenating edges of the very weakly convex intervals. Metasternum smooth, shining, slightly depressed at middle, with a deep, sharply defined midline suddenly terminated at each end extending over the middle two-thirds of the total length; anterior postcoxal line finely scabrous, joining a similarly scabrous area at extreme sides. Abdominal segments smooth, shining, with scattered fine punctures from side to side, a few fine short hairs laterally, finely crenate in front, the terminal segment more deeply and widely crenate at middle. Pygidium very finely scabrous. Anterior femur with deep anterior and posterior marginal lines, posterior face with scattered, moderate punctures. Middle and posterior femurs smooth, shining, a few short hairs along anterior edge and a curving, posterior row of four or five short, stiff hairs outward near the knee; posterior femur only one-seventh wider than middle femur, posterior marginal line very fine, extending less than half the length from the knee. Posterior tibia more than twice as long as wide at apex, long spur equaling length of first tarsal joint plus half the second, tarsus subequal to tibia in length. Length 3.5 mm., width 1.6 mm.

Type: In collection of A. Martínez, Buenos Aires, Argentina.

Type locality: "S. F. del Chipiriri," Province of Chaparé, State of Cochabamba, Bolivia, 400 m., November 1953, A. Martínez.

Specimens examined: Holotype and 21 paratypes collected at same time and place as type. Paratypes are in collections of A. Martínez and U. S. National Museum.

Remarks: Superficially this species resembles *fimbriatus* and was collected with that species, however, the pronotal punctures are finer, the elytra slightly more elongate-parallel without the long marginal fimbriae, and the maxillae lack teeth.

Psammodius aenictus, new species

Holotype elongate-parallel, convex, moderately shining, rufopiceous. Antennae rufotestaceous. Head moderately convex, closely verrucose, with a band of close, fine to moderate punctures above between the eyes, occiput smooth. Clypeus broadly, shallowly emarginate with a small triangular tooth each side of the emargination, sides very weakly arcuate, finely reflexed; genae nearly right angled, not fimbriate. Pronotum convex, sides hidden from directly above, width 1.4 mm., length 1.0 mm., anterior angles rounded, posterior angles broadly rounded, sides and base finely margined, not noticeably fimbriate but the posterior angles and base actually very finely crenate with extremely short, stubby setae, the setae half as long as the distance between them; surface with close, evenly spaced, moderate punctures separated by one to two diameters, the punctures becoming gradually much finer from basal half of disc to anterior and lateral edges, similarly, but more abruptly to base. Elytra elongate, subparallel, not fimbriate, width 1.4 mm., length 2.2 mm., base margined, humeri dentate, striae deep, crenately punctured, intervals smooth, shining, weakly convex, smooth area at shoulders with a few moderate punctures. Metasternum shining, smooth with a few scattered fine punctures at middle, midline long and deep, terminating abruptly, sides scabrous. Abdominal segments shining, with evenly spaced moderate punctures separated by one to two or three diameters, punctures somewhat finer at middle than at sides, very finely margined posteriorly, finely crenate in front, the terminal segment more widely so at middle. Pygidium very finely, closely punctate. Anterior femurs smooth, shining, margined anteriorly and posteriorly, a few more or less indistinct punctures posteriorly. Middle and posterior femurs smooth, shining, a trace of marginal line at knee, without setae; the posterior femurs not noticeably wider than the middle femurs. Posterior tibia two-fifths as wide at apex as total length; spurs slender, the longer equal in length to first tarsal joint plus half the second, entire tarsus one-tenth shorter than tibia. Length 3.6 mm., width 1.4 mm.

Type: In collection of A. Martínez, Buenos Aires, Argentina.

Type locality: "S. F. del Chipiriri," Province of Chaparé, State of Cochabamba, Bolivia, 400 m., November 1953, A. Martínez.

Specimens examined: Holotype and two paratypes collected at same time and place as type. Paratypes are in collections of A. Martínez and U. S. National Museum.

Remarks: The two paratypes are smaller than the holotype, being 3.0 and 3.2 mm. in length by 1.1 and 1.2 mm. in width. Except for its strongly tuberculate head, this species is another of those that seem to have practically all the characters of an *Ataenius*.

***Psammodius atopus*, new species**

Holotype elongate-parallel, convex, moderately shining, rufopiceous. Antennae rufotestaceous. Head moderately convex, closely verrucose, with a band of close, moderate punctures above between the eyes. Clypeus widely, shallowly emarginate with a small, triangular tooth each side of the emargination, sides weakly arcuate, finely reflexed; genae nearly right-angled, not fimbriate. Pronotum convex, width 1.2 mm., length 0.9 mm., anterior angles rounded, posterior angles very broadly rounded, finely margined, not fimbriate; surface with close, very evenly spaced, moderate punctures separated by one diameter, somewhat finer anteriorly and at extreme sides beyond foveae. Elytra elongate, subparallel, not fimbriate, width 1.2 mm., length 1.85 mm., base margined, striae moderately deep, finely crenately punctured, sutural interval with a row of close, very moderate, distinct punctures, other intervals with a row of similar but very slightly smaller, more distant punctures along outside edge, inner edge slightly semituberculate in front of marginal punctures, otherwise finely alutaceous and weakly convex. Metasternum shining at middle, with a few scattered punctures and a deep distinct midline, anterior postcoxal line finely scabrous, extending outward to wide similarly scabrous area at side, deepest part of the triangular depressed area in front of the posterior coxal plates also scabrous and connected to lateral area. Abdominal segments with transverse bands of rather evenly spaced moderate punctures separated by one to two diameters, very finely margined posteriorly, finely crenate in front, more widely and deeply so at extreme sides and at middle of terminal segment. Pygidium finely scabrous. Anterior femur margined, shining and smoother in front, quite closely, roughly punctate posteriorly. Middle and posterior femurs shining, with scattered fine punctures, without setae or fimbriae, the middle femur about as wide as the posterior femur. Posterior tibia three times as long as wide at apex, spurs slender, first tarsal joint shorter than long spur, about equal to length of following three combined, entire tarsus one-ninth shorter than tibia, the joints not especially widened apically. Length 3.0 mm., width 1.2 mm.

Type: In collection of A. Martínez, Buenos Aires, Argentina.

Type locality: "S. F. del Chipiriri," Province of Chaparé, State of Cochabamba, Bolivia, 400 m., November 1953, A. Martínez.

Specimens examined: Holotype and one paratype collected at same time and place as type. Paratype is in collection of U. S. National Museum.

Remarks: This is another species that is very close to *Ataenius* except for the distinctly verrucose head.

***Psammodius fimbriatus*, new species**

Holotype oblong oval, moderately shining, piceous. Antennae rufotestaceous. Head convex, closely strongly verrucose, occipital area with a band of close, fine to moderate punctures above and between the eyes, smooth posteriorly. Clypeus widely, shallowly emarginate, the angles sharply dentate each side, sides weakly arcuate and reflexed; genae very sparsely fimbriate, not prominent, broadly arcuate in outline, smooth, with a small deep pit close in front of the eye. Pronotum convex, width 1.4 mm., length 0.9 mm., all angles broadly rounded, sides and base crenate, fimbriate with moderately long, stiff, tapering, sharply pointed hairs, base weakly lobed medially, sides and base distinctly margined except at middle of base; without transverse grooves, surface with intermixed, close, very fine and moderate punctures, the latter separated by less than their diameters, gradually slightly finer outward from disc and sparser laterally. Elytra as wide as pronotum at base, width 1.75 mm., length 2.15 mm., base finely margined, humeri not distinctly dentate, margins crenate, fimbriate with moderately long, fine bristles, scattered bristles around apical third also, expecially on ninth and tenth intervals, sides straight and diverging over basal half then strongly arcuate and curving to apex; striae fine, moderately deep, with fine punctures crenating edges of the flat to very weakly convex intervals, intervals with widely scattered irregularly spaced fine punctures usually near margins. Metasternum somewhat depressed, rather short, only as long as two-thirds the width of posterior femur, smooth and shining at middle, short midline sharp and deep over half the total length at middle, slightly roughened at extreme sides. Abdominal segments shining, with scattered very fine punctures at middle, slightly more numerous at sides and bearing very short fine hairs, terminal segment with an anterior row of about 12 to 14 long fine hairs, segments very finely crenate in front, the last segment more widely so at middle. Pygidium finely scabrous. Anterior femur smooth, shining, a few scattered, very finely setigerous punctures posteriorly and with a distinct anterior marginal line. Middle and hind femurs smooth and shining with moderately close scattered setigerous punctures along margin and a posterior row of the same extending outward to the knee; posterior femur about twice as wide as middle femur. Posterior tibia about twice as long as apical width, spurs short, foliaceous, equal in length to first two tarsal joints combined; basal tarsal joint apically widened. Length 3.5 mm., width 1.75 mm.

Type: In collection of A. Martínez, Buenos Aires, Argentina.

Type locality: "S. F. del Chipiriri," Province of Chaparé, State of Cochabamba, Bolivia, 400 m., Nov. 1953, A. Martínez.

SPECIMENS EXAMINED: Holotype and 27 paratypes collected at same time and place as type. Paratypes are in collections of A. Martínez and U. S. National Museum.

REMARKS: Except for the lack of transverse pronotal grooves and a narrowly notched clypeus, *Psammodius fimbriatus* exhibits all characters of more typical *Psammodius*, including maxillary teeth. It is one of the species bridging the slight gap between the more typical *Psammodius* and those having characters of *Ataenius*.

Psammodius mapirii, new species

Holotype oblong oval, moderately shining, rufopiceous. Antennae testaceous. Head moderately convex, coarsely verrucose, occiput smooth. Clypeus sharply dentate each side of a broad, shallow emargination, sides slightly arcuate to the rounded genae. Pronotal width 1.4 mm., length 0.85 mm., anterior angles broadly rounded, posterior angles very obtusely rounded, marginal line deep and distinct, sides and base fimbriate with fine, sharp hairs, weakly crenate; surface evenly convex, without furrows except for a short, shallow depression inward from each anterior angle, lateral foveae small but evident, coarse punctures very moderate in size, separated by one to three or four diameters, irregularly but generally distributed except at extreme sides, scarcely perceptible, scattered, minute punctures intermixed. Elytra margined at base, humeri weakly dentate, sides very slightly arcuate, fimbriate with short, fine hairs, width 1.60 mm., length 2.15 mm., striae moderately fine and deep, strial punctures fine; intervals smooth, weakly convex, their sides very slightly irregular and very weakly crenate. Metasternum smooth at middle, scabriculate at sides, median line deep, relatively short, abruptly terminated at each end, anterior postcoxal line absent. Abdominal segments smooth, finely crenate along anterior margin, crenations slightly wider at middle of terminal segment, each segment with a medianly interrupted, transverse row of setigerous punctures bearing moderately long, fine hairs. Pygidium finely scabriculate basally at sides. Anterior femur without anterior marginal line. Middle and posterior femurs smooth, without posterior marginal line but with a long line of close, setigerous punctures paralleling the posterior margin over outer two-thirds and curving forward in front of the knee to and along the anterior margin. Posterior femur one-third wider than the middle femur. Posterior tibia twice as long as wide at apex, spurs moderately narrow and foliaceous, the long spur very slightly longer than the first tarsal joint. First joint of posterior tarsus elongate-triangular, as long as following three together. Length 3.4 mm., width 1.6 mm.

TYPE: USNM 61849.

TYPE LOCALITY: Near mouth of Río Mapiri, Río Beni, La Paz, Bolivia.

Specimens examined: Holotype, collected in September by W. M. Mann, Mulford Biological Exploration, 1921–1922. Paratypes: 1, same data as holotype, U. S. National Museum; 1, Buenavista, Provincia de Ichilo, Santa Cruz, Bolivia, October 1949, A. Martínez, in Martínez collection.

Remarks: *Psammodius mapirii* may be separated from the other South American species having distinctly fimbriate margins of the elytra by characters given in the key to species. It is closely similar to *fimbriatus.*

Psammodius armaticeps (Fall)

Psammobius armaticeps Fall, Journ. New York Ent. Soc., vol. 40, p. 190, 1932.

Oblong, shining, dark castaneous. Antennae pale rufotestaceous. Head moderately convex, closely, not very coarsely verrucose, occiput smooth. Clypeus with an acute, triangular tooth each side of the wide, shallow median emargination, sides slightly arcuate, genae rounded, fimbriate. Pronotum convex, width 1.45 mm., length 0.90 mm., anterior angles obtuse, posterior angles very broadly rounded, base margined, sinuate and slightly lobed at middle, sides and base crenate and fimbriate with moderately long, simple hairs, shorter across base; surface smooth, shining, minutely punctate laterally beyond foveae, disc with many, irregularly placed punctures, very coarse at middle to less coarse outward in all directions, no middle line, furrows, or other depressions except the usual short depression inward from the anterior angles. Elytra margined at base, humeri weakly dentate, sides fimbriate with moderately long hair, width 1.75 mm., length 2.3 mm.; striae crenate punctate, the punctures moderate and deep; all intervals convex, ninth and tenth not different. Metasternum smooth, shining, median line half total length, deep, abruptly terminated at each end, minutely alutaceous at sides, anterior postcoxal line absent, depressed in front of posterior coxal plate but without a definite line. Abdominal segments smooth and shining at middle, a transverse row of three or four coarse, shallow, setigerous punctures at each side, usually a very small tubercle in front of each hair, segments finely crenate in front, the crenations wider at middle of terminal segment. Pygidium shining, smooth at apex, scabrous basally, a few scattered setigerous punctures. Anterior femur without anterior groove, posterior face smooth, shining. Posterior femur one-third wider than middle femur, smooth, shining, without posterior marginal line, a row of close, coarse, setigerous punctures parallel to but some distance from the posterior edge. Middle and posterior tibiae without transverse ridges but with longitudinal rows of tubercles. Outer edge of posterior tibia twice as long as apical width, spurs sharp, narrowly foliaceous, the longer subequal to the combined length of first two tarsal joints.

Tarsus four-fifths as long as outer side of tibia, the first joint more than twice as long as its apical width and as long as following three joints combined. Length 3.4 to 4 mm., width 1.7 to 2 mm.

TYPE: Fall collection, Museum of Comparative Zoology, Cambridge, Mass.

TYPE LOCALITY: Pensacola, Fla.

SPECIMENS EXAMINED: 56.

DISTRIBUTION: Florida: Pensacola, Tampa. Georgia: St. Simon Island.

SEASON: March 12 to May 22, August and September.

REMARKS: The only major difference between *P. armaticeps* (Fall) and *P. cruentus* Harold seems to be in the size and pattern of the punctures of the pronotum.

Psammodius cruentus Harold

Psammodius cruentus Harold, Berliner Ent. Zeit., vol. 11, p. 282, 1867.

Psammobius cruentus Schmidt, Coleoptera, Aphodiinae. Das Tierreich (Deutsche Zool. Ges.), pt. 45, p. 478, 1922.

Psammobius bidens Schmidt (not Horn, 1871), Coleoptera, Aphodiinae. Das Tierreich (Deutsche Zool. Ges.), pt. 45, p. 478, 1922.

Psammodius shermani Cartwright, Bull. Brooklyn Ent. Soc., vol. 41, p. 89, 1946. (New synonymy.)

Oblong, shining, dark castaneous. Antennae pale, rufotestaceous. Head moderately convex, closely, not very coarsely verrucose, occiput smooth. Clypeus with an acute triangular tooth each side of the wide, shallow median emargination, sides slightly arcuate, genae rounded, fimbriate. Pronotum convex, width 1.55 mm., length 1 mm., anterior angles obtuse, posterior angles very broadly rounded, base margined, sinuate and slightly lobed at middle, sides and base crenate and fimbriate with moderately long, simple hairs, shorter across base, surface with fine to minute punctures throughout and a curving, somewhat depressed band of few to many, coarse punctures back from the anterior angles, inside the lateral foveae to the base, in a few cases reduced to half a dozen or so large, deep punctures in a median transverse group at base, surface otherwise more or less uneven or wrinkled, especially so just back of the anterior margin. Elytra margined at base, humeri weakly dentate, sides fimbriate with moderately long hair, width 1.85 mm., length 2.5 mm.; striae crenate punctate, the punctures moderate and deep, all intervals convex, the ninth and tenth not different. Metasternum smooth, shining, concave at middle, the median line deep, abruptly terminated at each end, minutely alutaceous at sides, anterior postcoxal line absent, depressed but without line in front of posterior coxal plate. Abdominal segments smooth, shining at middle, slightly roughened at sides, laterally each with a transverse row of setigerous punctures, the punctures frequently close behind a very small tubercle, segments finely crenate in front, the crenations slightly wider on the terminal segment. Pygidium shining, smooth at apex, scabrous along transverse limiting carina, a few scattered setigerous punctures over disc. Anterior femur without marginal groove, posterior face smooth and shining. Posterior femur one-third wider than middle femur, smooth, shining, no posterior marginal line, a row of close, coarse setigerous punctures parallel to but at some distance from the posterior edge. Middle and posterior tibiae without transverse ridges, with longitudinal rows of tubercles. Outer edge of posterior tibia twice as long as width of apex, spurs sharp, narrowly foliacious, the longer subequal to combined length of first two tarsal joints. Tarsus four-fifths as long as outer edge of tibia, the first joint more than twice as long as its apical width and subequal to following three joints combined. Length 3.4 to 4.6 mm., width 1.6 to 2.1 mm.

Type: Location unknown to me.

Type locality: Harold's description of *Psammodius cruentus* appeared without locality data in his paper on "Die Chilensischen Aphodiden." The type locality, therefore, would be expected to be in Chile. The fact that the species has been taken over much of northern Argentina and in Bolivia and that at the time Harold wrote his paper part of present day Argentina was claimed by Chile would indicate Argentina may more likely have been the source of his specimens. I have seen no specimens from Chile.

Psammodius shermani Cartwright was described from Sullivans Island, S. C.

Specimens examined: 139.

Distribution: United States: South Carolina: Sullivans Island, Folly Beach, Isle of Palms, Mount Pleasant. Georgia: Tybee Island. Argentina: Salta: General Ballivian, Ruiz de los Llanos, Tartagal, Rosario de la Frontera, Cerro San Bernardo. Tucumán: Tucumán, Tacanas. Santiago del Estero: Campo Gallo, Santiago del Estero (Río Salado). Córdoba: Córdoba, Anisacate, Cerro Uritorco. La Rioja: Patquia, La Cañada. San Juan: Pie de Palo. Mendoza: Mendoza, Moliches. Buenos Aires: Punta Lara. Paraguay: Boquerón: "Guarn. Oruro." Bolivia: Tiguipa, Tatarenda, Villa Montes (Río Pilcomayo).

Season: October to April in South America, June 3 to Sept. 10 in North America.

Remarks: I have been unable to study type specimens of *Psammodius cruentus* Harold; however, specimens from South America and from museums in London and Munich determined as this species are all identical and agree with the original description. The earliest date I have seen on specimens from North America is that on a specimen collected at Tybee Island, Ga., June 1927, by H. A. Wenzel.

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A FURTHER CONTRIBUTION TO THE ORNITHOLOGY OF NORTHEASTERN VENEZUELA

By Herbert Friedmann and Foster D. Smith, Jr.

In 1950 we published an account of the birds collected by the junior author in northeastern Venezuela. The present paper contains a report on additional forms collected by him in the same region, with his field notes on them and additional notes on birds previously reported. At the same time, we include a complete list of the avifauna recorded from the region, with a summary of the months in which the forms were observed as present or as breeding. Although other forms may have to be added from time to time, this regional list is now reasonably complete. We have no illusions as to the completeness of the data on monthly occurrence and breeding. Part-time observations by one man, even over a period of approximately 8 years, cannot equal the accumulated work of the number of observers who have been available for the northeastern United States. Nevertheless, we believe the data are of interest, for information based on year-round observations over a period of years is still all too scarce in the scientific literature of tropical faunas. The reported presence or nonpresence of the commoner or more conspicuous birds within a given month is probably quite correct, but a form that is rare within the area, of difficult field identification, or shy and retiring, may be reported in only one, two, or more scattered months without implying absence from the study area during the remaining months.

The breeding dates have been based as far as possible on the time of egg-laying although, in addition to the actual discovery of nests and eggs, they have also been based on such evidence as female

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gonadal condition, copulation, the carrying of nesting material or food by the birds, and the observation of fledglings. In estimating avian breeding activity by time of year, we use as a criterion the number of species found breeding. While this appears to give to one nest found in December the same value as to 50 nests of the same species found in June, the results obtained appear to reflect accurately

FIGURE 103.—Breeding activity of birds actually recorded in the study area (dash line) and probable total breeding activity for birds in northeastern Venezuela (solid line).

the yearly fluctuation in total breeding activity. In this connection we note that in Skutch's (1950, pp. 191–194) excellent report on the breeding cycle of Central American birds the seasonal change in the number of nests found followed with similar fidelity the number of species nesting.

In figure 103 we show the number of species recorded by the junior author as breeding in the study area. Although this graph gives an idea of the increased April–July breeding activity, it is obvious from the truncated shape of the curve that we lack complete data. Especially do we lack May–June data, due in part to the collector's frequent absences from Venezuela during those months. The breeding species curve for northeastern Venezuela is probably better represented by the solid lines in figure 103, in which, for those forms recorded by us (Tropic-Zone birds, mainly of the savanna and seasonally deciduous forest), we have combined our breeding records with those of Cherrie (1916, upper Orinoco region) and of Belcher and Smooker (1934–37, Trinidad). While the procedure of combining data from different localities is open to criticism, the places are similar in their ecological features, and the entire area involved is only slightly larger than that of the States of Pennsylvania and New Jersey.

It will be noted that while some breeding activity continues throughout the year, it increases sharply in March, reaches a peak in April, May, and June, and then drops to a minimum in December. The strongly cyclic nature of avian breeding rhythm in our area of South America agrees generally with Skutch's graph of the species breeding at approximately the same latitude in El General, Costa Rica, which shows a sharp peak of activity in April and May, with a corresponding low in October and November. The slight difference may be due either to the different faunal zones involved (he was reporting on subtropical birds at 2,000 to 3,000 feet above sea level whereas we are reporting on lowland Tropic-Zone birds) or to insufficient observations.

The peak breeding months in our area correspond with those of the North Temperate Zone perhaps more than climatic or photoperiodic conditions would lead one to expect, although it appears that the causes for the pronounced rhythm may be different than those for that of the Temperate Zone. Temperature can hardly be a factor, for the temperature in northeastern Venezuela fluctuates very slightly from the mean of 80° F. For example, in 1944 the approximate average mean temperature (F.) at Cantaura, Anzoátegui, were: Jan. 75, Feb. 79, Mar. 80, Apr. 82, May 83, June 79, July 80, Aug. 83, Sept. 82, Oct. 82, Nov. 81, and Dec. 80.

While an increase in total hours of daylight might appear to be the stimulus, or one of the stimuli, for increased gonadal activity, the rate of daily change in length of daylight at latitude 10° N. is slight (about 15 seconds) and does not correlate with the rapid increase in breeding activity that takes place (fig. 104). And, although our area of the Tropic Zone has nothing directly comparable to the overcast days of the more northern latitudes, some of this slight increase in daylight during May, June, and July may be offset, so far as effect on birds is concerned, by the heavy rains characteristic of the period. It must be remembered, too, that migration, which is intimately connected with the breeding cycle, may cause considerable variation between the total hours of daylight experienced by different species (fig. 105), particularly for birds migrating to nesting grounds at latitudes of 40° N. and beyond. Yet the breeding seasons of these different species apparently remain remarkably uniform, even though the annual fluctuation in hours of daylight differs according to their various migratory habits.

Further complicating any attempt to correlate the migration and breeding cycle with changes in the hours of daylight experienced by any particular species is the fact that even in northeastern Venezuela, where the majority of breeding forms have no known migration, a seasonal fluctuation in numbers indicates at least local and perhaps extended movement. Here it must further be noted that while we may have a logical explanation for a limited seasonal north-south

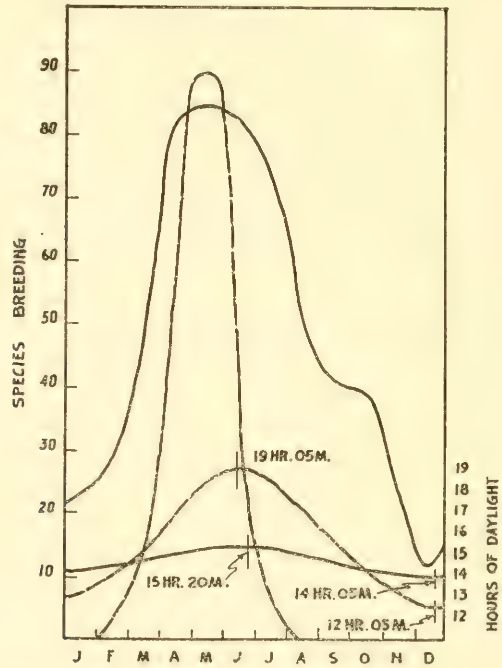

Figure 104.—Approximate avian breeding periods for northeastern Venezuela (solid line) and for northeastern United States (dash line) compared with length of day from twilight through twilight at lat. 10° N. (solid line) and at lat. 40° N. (dash line).

movement, we have little explanation for the extended and at times trans-equatorial migrations of some races, as well as for the astonishing temporal precision with which they are effected. In fact, some of the races which breed farthest north are among those which winter farthest south, as for example the fox sparrow *Passerella iliaca* (see Wetmore, 1926, p. 121, map). Also the general migratory pattern appears to be much the same whether the migrant is of presumed Holarctic origin (such as *Hirundo rustica erythrogaster*) or of Neotropical origin (such as *Piranga rubra*).

Thus, while for certain northern birds of limited migration the increasing hours of light per day may be an important factor stimulating the physiological reactions governing the migration and breeding cycle, it hardly appears to be an important factor for migrants which "winter" in the tropics close to the equator, where the length of daylight is so constant. One is indeed hard put to postulate a periodic, external stimulus capable of initiating the migration of birds "wintering" near the equator. For example, at approximately latitude 9°30′ N. in Venezuela the regular northward withdrawal in the spring of such migrants as the dickcissel (*Spiza americana*) and the

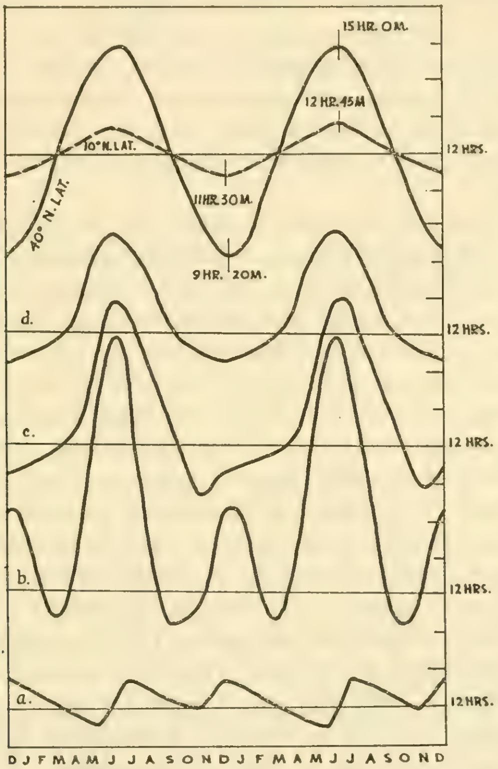

FIGURE 105.—Approximate hours of daylight for certain migrant birds compared to hours of daylight (sunrise to sunset) at lat. 40° N. and lat. 10° N. (vertical scale, 10 mm. equals 1 hr.): ***a***, *Muscivora t. tyrannus;* ***b***, *Pluvialis d. dominica;* ***c***, *Dendroica striata;* ***d***, *d. petechia aestiva.*

yellow warbler (*Dendroica petechia aestiva*) appears to be without observable external "cause" and in spite of increasingly favorable conditions at the wintering grounds. By the first of May, the hours of light per day have increased but little (around 53 minutes) over the December minimum; there is nothing obvious about the climate that would induce the birds to leave; and their departure comes at a time close to the peak breeding season of the resident population. Moreover, the closely allied yellow warbler (*Dendroica petechia rufopileata*) remains in the same general area throughout the year.

In contrast, the autumnal southward journey of North Temperate Zone migrants is begun in the face of increasingly unfavorable conditions: lessening hours of daylight, decreasing food supply, and lowering temperatures.

It is interesting to note the very slight morphological differences, as opposed to great behavioristic and possibly great physiological differences, between some migratory and nonmigratory races of the same species, for example: *Dendroica petechia aestiva* and *rufopileata; Vireo virescens virescens, vividior,* and *chivi; Capella gallinago delicata* and *paraguayae; Muscivora tyrannus tyrannus* and *monachus.* Where a species breaks up into highly migratory and relatively sedentary races, an experimental, comparative study of the physiological differences should prove of great interest, particularly as the breeding cycle has apparently remained, or has evolved to be, about the same.

Although a clear-cut external stimulus capable of initiating migration appears to be lacking, it seems that the annual cycle of wet and dry seasons is an important factor affecting breeding. From December through April the woods become increasingly bare and parched until the advent of the rains of May (often the latter half) and June causes the woods to leaf out again. At first glance it might seem that the breeding species curve closely approximates the rainfall curve, as does the upward curve of trees in leaf (fig. 106). However, the upward curve of breeding species precedes those of rainfall and vegetation. Both November and December rainfall is higher than that of February, March, and April, and much surface water is still present, whereas breeding activity is much greater in March and April, although the climate and soil have become extremely dry. In fact, the April peak represents many forms nesting in arid, still barren woods which will not be well in leaf before June.

During March and April the junior author made repeated trips by air from Cantaura (Anaco) to Caracas, both direct by way of Valle de La Pascua, and coastwise by way of Barcelona. With minor exceptions, he found the area covered with sparse, seasonally deciduous forest, the aridity and generally barren appearance of which was very marked during March, April, and at least the first half of May. In the region between Cantaura and Barcelona, the dominant tree is the "püi" (*Tabebuia serratifolia*), which, with the less common "araguaney" (*Tabebuia chrysantha*), makes up an estimated 75 percent of this woods. From the air it appears that it continues to be the dominant tree between Cantaura, Valle de la Pascua, and the foothills of the coastal mountain range before Caracas. On the whole, these *Tabebuia* do not come into leaf before June. Throughout the area observed on these flights at least 90 percent of the woods was leafless except at the rivers (generally without surface water) where a narrow line of trees in leaf paralleled the water courses. More rarely, there was a gentle rise in the percentage of green trees, usually a thin veil of partially opened buds, caused by local showers, subsurface water, or a local concentration of nondeciduous trees. In the region below the point of sharp change from the seasonally deciduous forest of the lowlands to the subtropical montane forest of the coastal mountain range the estimated percentage of trees in leaf nowhere attained 20 percent.

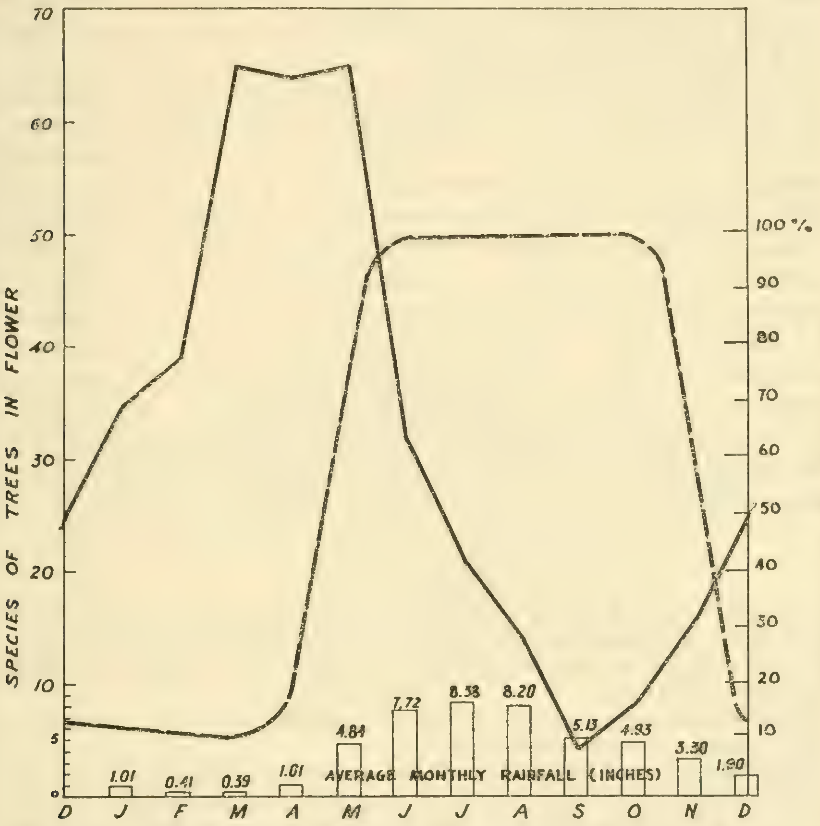

FIGURE 106.—Average rainfall (bars), number of species of trees in flower (solid line), and percentage of trees in leaf (dash line) in study area.

This area (fig. 107) stands in sharp contrast with the northeastern United States, where in spring the trees come into leaf with the gradually increasing warmth. Moisture is available from melting snow and from frozen interstitial water in the soil, and the rains, governed for the most part by extensive "lows," cover wide areas, so that at any given date the woods are at approximately the same stage of development throughout the region. In our area, on the other hand, temperature is presumably not a factor, as it fluctuates so little throughout the year, and "spring" comes at the end of the dry season, when the soil is extremely dry (at Cantaura, Anzoátegui, April 20, 1952, the interstitial water was less than one percent by weight at the surface and at 2- and 4-foot depths). With rare local exceptions moisture becomes available only with the oncoming rains, which, unlike those of northeastern United States, consist of very local showers of short duration. Thus, not before the middle of July has enough rain fallen to bring all the deciduous forest into full leaf; in May and June local areas characteristically remain undeveloped and practically without foliage, while but a few miles away in the same type of woods the trees have come into full leaf.

In addition to this "spotty" development, the leafing of the trees and herbaceous plants in our area may actually occur later than in the New York City area. At the end of April 1953 the seasonally deciduous forest was still approximately 90 percent bare, with rare local exceptions where repeated local showers had fallen in sufficient quantity to open the swollen buds. On May 2 of that year the woods of the New York City area were slightly more in leaf than those of northeastern Venezuela; they developed rapidly and were in apparent full leaf by June 1. However, on June 10, the Venezuelan woods were still quite bare; while most of the buds were swollen, over great areas not more than 25 to 35 percent of the trees had come into leaf, and the herbaceous plants were still undeveloped. Not before the end of June were most of the woods in apparent full leaf, and local areas, perhaps 2 to 10 square miles in extent, still remained bare,

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Description of Region

General location: Northeastern Venezuela, approximately lat. 9°30′ N., long. 64° W. in the States of Anzoátegui and Monagas and roughly forming a triangle between San Mateo (Anzoátegui) on the north, San Tomé (Anzoátegui) on the south, and Caicara (Monongas) on the east.

Principal collecting stations: Cantaura, Anzoátegui, elevation c. 815 feet; and Caicara, Monagas, elevation c. 590 feet.

Principal habitats: (1) Seasonally deciduous forest (approximately 90 percent deciduous during dry season), an extensive sparse woods composed of trees averaging less than 30 feet in height, with occasional taller trees scattered throughout; palms, heliconia, and ferns absent; vines and arboreal epiphytes rare; cactus generally confined to scattered individuals. (2) Savanna, an extensive short-grass plain, dotted with occasional scrubby trees. (3) Lowland seasonal forest, a limited intrusion along the Guarapiche River at Caicara of rather luxuriant forest, composed of trees averaging over 50 feet in height, somewhat over 50 percent of the trees being deciduous at the peak of the dry season although often only for a short time; palms, heliconia, and ferns present; arboreal epiphytes common. Characteristic of the study area is the absence of other habitats, such as seacoast, mountains, extensive marshes, or large lakes. Elevation within the area ranges roughly from 350 to 1,500 feet.

Mean temperature: Approximately 80° F. throughout the year, with very little fluctuation, either day to day or month to month, daily temperatures running roughly from a minimum of 70° to a maximum of 90° F. Extremes over a 10-year period were minimum 55° F. and maximum 101° F.

Rainfall: Averages approximately 47 inches (10-year average), with marked seasonal fluctuation and also considerable year-to-year fluctuation. The wet season extends from May to November and in it approximately 90 percent of the rainfall occurs.

presumably missed by the local showers. Likewise, over most of the savanna the grass was still short by June 15, being approximately 4 to 6 inches high in sparse, scattered bunches, although locally near Caicara, Monagas, and El Tigre, Anzoátegui, it had grown to about a foot in height.

We are not certain what effect this "spotty" development of vegetation has on the local breeding bird population. Some forms (*Icterus nigrogularis*, *Scardafella squammata*, *Columbigallina passerina*) appear to nest in the retarded barren portions without waiting for

FIGURE 107.—Map of region in which observations and collections were made. Opposite is a brief resume of the detailed description given in our previous (1950) report.

better conditions, but others (*Vireo virescens*, *Cyclarhis gujanensis*) may perhaps shift into the more advanced portions to nest. In any event, the local conditions differ from those of the Temperate Zone (New York City region), and further data on the breeding behavior of birds under these conditions should prove of interest.

Another factor that may affect the breeding seasons is abundance of food. This would appear to be most important when the young are still in the nest, because the nestlings possibly eat more during this period of rapid development than afterward, and because the parents must secure sufficient food for several, whereas later each bird fends for itself. We should, therefore, expect few insectivorous birds to nest before June. Our records are especially weak in respect to May and June, but it appears that many insectivorous birds commence nesting well before June.

Regarding insect abundance, counts at the collector's door-light at Anaco, Anzoátegui, will give a rough idea of the increasing numbers.

April 10–20: 1 cicada; 1 small moth.

May: no record.

June 10: 5 cicadas; 1 small scarab; 1 small hemiptera; 3 small moths.

June 15: 3 cicadas; 1 small scarab; 5 small, other beetles; 5 small moths; 1 ichneumon (?).

June 17: first swarm of tiny beetles (thousands).

June 20: swarm of small insects, mostly moths and beetles; 6 large moths; 3 cicadas; about 20 larger Coleoptera of at least six families (Cicindelidae, Carabidae, Scarabaeidae, Hydrophilidae (?), Cerambycidae, Elateridae); about 10 Hemiptera of at least two families (Reduviidae, Pentatomidae); about 20 Hymenoptera (winged ants and Cephidae (?)).

Since the foregoing paragraphs were written Pinto (1953, pp. 111–222, especially pp. 118–129) has published less complete but pertinent data from the region of Belém, Pará, Brazil, and Davis (1953, pp. 450–467) has reported more detailed and more complete data on conditions in British Guiana. In the latter country the seasonal distribution of rainfall differs from that of northeastern Venezuela; precipitation reaches a high peak in May, drops steadily to a low in September and October, and then rises to a prominent, though secondary, peak in December, whereas in Venezuela the high peak occurs in June–August, after which the rainfall declines steadily to a low in February and March, with a slight decrease in the rate of decline in September and October. In other words, there are two definite rainy and two dry seasons in British Guiana, while in Venezuela, as in Trinidad, there is but one of each. In this connection, it may be noted that the curve we have shown of actual recorded avian breeding activity in our study area (fig. 103) shows a slight secondary peak in September and October, which agrees better with the picture presented by Davis for British Guiana than does our second curve (fig. 104) in which this secondary peak has been smoothed down. However, there appears to be little evidence in our area of the two separate breeding seasons for any species of birds reported by Davis for British Guiana. It is possible that insufficient field observations may be the cause of this apparent discrepancy for some dozen forms, and it cannot be ruled out as impossible that occasional pairs may nest months before or after the customary breeding season.

Although there is some breeding activity throughout the year in northeastern Venezuela, it is perhaps significant that the breeding in the minimum months of November–February is confined to species nesting principally in prior or subsequent months. We find only one apparent exception to this "rule," the hummingbird *Amazilia fimbriata maculicauda*, which breeds from August through January. This confirms Skutch's (1950, pp. 197–204) observation that the hummers' main breeding season was during the months when other birds' breeding activity was at a minimum. Since in Central America those months are the months of maximum abundance of flowers, Skutch postulated a close connection between breeding season and maximum amount of food available. We have too little data to be able to comment in this regard, but we would like to record the following information:

The trees of our area, many of which have abundant, showy flowers, mainly bloom in the months of March, April, and May, just before the rainy season (fig. 106). Most of the herbaceous plants come into bloom later, with the advent of the rains. While the hummers are strong fliers, those of our area show restrictive preference for the type of flowers at which they feed; *Polytmus guainumbi*, *Glaucis hirsuta*, *Phaethornis anthophilus*, and perhaps to a somewhat lesser extent *Amazilia fimbriata* are low feeders, whereas *Chrysolampis mosquitus*, *Chlorostilbon canivettii*, and *Amazilia tobaci* prefer to feed at the tree flowers. If the breeding season of these hummers depended more on abundance of food than on other factors, then we should expect the high flying forms to nest in March, April, and May, with the low feeders breeding months later. Hummers as a group would then show a split breeding season, depending upon the food preferences of the forms involved. Field observations in this connection should prove of interest.

In this connection, further breeding data for tropical races of the horned owl *Bubo virginianus* would also be of interest. The breeding race of northeastern United States nests well in advance of the general breeding season of other birds. Were tropical races also to be found nesting early in the season, it would suggest that, provided food or other factors are not of prime importance, the breeding season itself may be a phylogenetically conservative character of the group, in common with certain other biological characters such as pair formation and display.

The status of North American migrants calls for some comment here. Davis (1954, p. 441) reports that in an inland area of British Guiana northern migrants are scarce both in numbers and in kinds. Only some 40 North American species, excluding rare or accidental vagrants, are known from all of British Guiana, nearly half of them being shore birds. Comparing observations with those in our earlier report, Davis rightly concludes that in this respect his part of British Guiana is essentially similar to our area in northeastern Venezuela. He adds that the reason why the South American tropics are not a more important wintering area for northern migrant land birds may be that Central America, where these migrants swarm in great numbers, provides sufficient suitable winter quarters to take care of most of these northern wanderers. ". . . It is improbable that suitable habitats are not available in tropical South America, for even if the heavy rain forest is avoided, there are savannas, cultivation, and the forest edge, both in conjunction with such open areas, and along thousands of miles of river. . . ."

It should be kept in mind, however, that seasonal suitability of terrain is a factor to be considered with, although not in place of, that suggested by Davis. In our area the time of year when the northern birds are wintering, roughly September through April, is the dry season when the lowlands are parched and the greenery is confined to a very thin strip along the rivers. Thus, although in the wet season many places would seemingly be suitable for these northern visitors, they would be not at all suitable during the dry season.

The junior author notes that in western Venezuela (upper Apure, Barinas) the blue-winged teal is very numerous, apparently because the habitat there is suitable, while in the east, where the land is so much dryer, it is much scarcer. Our area is one where, because of the unfavorable nature of the countryside during the dry season, most migrant land birds would not or could not stay. The one important exception to this rule is the dickcissel *Spiza americana*, which occurs in flocks of 500 to 1,000 in the dry-brush savanna-edge habitat. However, in its breeding range it is a bird of fairly dry fields and bush-lined roads and thus may be better adapted to the Venezuelan lowlands during the northern winter than are most other North American migrants. Numerically, it may be one of the most important Nearctic migrants to Venezuela, but curiously it seems not to have been recorded from the part of British Guiana studied by Davis, perhaps because that area is east of its winter range (there is but a single record for the bird in British Guiana, the Abary River).

This same area of northeastern Venezuela, which seems so unsuitable to northern migrant land birds in the dry season, supports during the wet months (July through September) vast numbers of a migrant from south of the tropics, the fork-tailed flycatcher *Muscivora tyrannus*

tyrannus. This fact further suggests that the suitability or unsuitability of the area is something determined by seasonal precipitation.

In the following annotated catalog are listed only such specimens as have been collected subsequent to those recorded in our 1950 paper.

Family TINAMIDAE: Tinamous

Tinamus major zuliensis Osgood and Conover

Tinamus major zuliensis Osgood and Conover, Field Mus. Nat. Hist., Zool. Ser., vol. 12, August 28, 1922, p. 24 (Río Cogollo, Perijá, State of Zulia, Venezuela).

1 unsexed, Caripito, Monagas, December 15, 1953; gonads small; iris brown, bill brown, feet dull blue green.

This is the tinamou typical of the heavy tropical forest at Caripito, Monagas. The collector never saw or heard of it at Caicara or Cantaura, nor would he have expected to find it there, as the woods are very different from those at Caripito.

Crypturellus soui andrei (Brabourne and Chubb)

Crypturus soui andrei Brabourne and Chubb, Ann. Mag. Nat. Hist., ser. 8, vol. 14, 1914, p. 321 (Caparo, Trinidad).

1 ♀, Caicara, captured alive in March 1950, died on August 10, 1950; ovary somewhat enlarged; iris tan, bill gray with the base of mandible flesh, feet olive.

2 sets of 2 eggs each, Caicara, August 6, 1950, and April 10, 1951.

This specimen is much darker and less rufescent above than a female of the nominate race from São Gabriel, Rio Negro, northern Brazil, and therefore agrees with the description of the subspecies *andrei* of Trinidad and the northern coastal belt of Venezuela. Below it is also darker but hardly less rufescent than typical *soui.* Its bill is not larger than that of the latter, disagreeing in this respect with the statement of Hellmayr and Conover (Catalogue of the birds of the Americas, pt. 1, No. 1, 1942, p. 38) that *andrei* generally has a larger bill than *soui.* The present specimen appears to be subadult, as it still has the strikingly barred under-tail coverts of immaturity.

This extremely secretive little tinamou was fairly common in the overgrown clearings around Caicara. It was never recorded at Cantaura, and was unknown there to the local residents. Were it not for the lovely, almost bell-like calls of early morning and evening the bird would pass unnoticed. The call is best likened to that produced by dragging the hammer up the upper keys of a xylophone, perhaps seven notes, and then, commencing with the same note at which the upward series began, running down the scale about five notes; or put vocally, *churreee-churoo.* The bird also utters a low *wup-wup* very similar to that of *Crypturellus noctivagus*, audible for perhaps ten feet.

This tinamou is much less active than the *Crypturellus noctivagus;* when approached it crouches motionless and does not move for considerable time thereafter. (See notes under *Crypturellus noctivagus.*) Also, it appears to travel singly or at most, in pairs, rather than in loose groups. Due to the difficulty in securing it, the bird is not hunted, although it is occasionally trapped.

The captive bird had the curious habit of rapidly raising and lowering the upper-tail coverts. This might be a sign of excitement or fear, or perhaps part of the mating ritual, as it was observed particularly in May.

The two sets of two eggs each are apparently full clutches, judging by information obtained from local farmers and hunters. In this connection it was observed that, upon preparation of the skin of the captive female, the specimen had absolutely no brood patch, although the gonads were somewhat enlarged.

Crypturellus noctivagus (Wied)

Tinamus noctivagus Wied, Reise Nach Brasilien in den Jahern 1815–17, vol. 1, 1820, p. 160, note (Muribecca, Espírito Santo [Brazil].)

Two races of this tinamou were collected, one at Caicara and the other at Cantaura. The specimens are listed separately by subspecific allocation, but our discussion of the two is united below.

Crypturellus noctivagus spencei (Brabourne and Chubb)

Crypturus cinnamomeus spencei Brabourne and Chubb, Ann. Mag. Nat. Hist., ser. 8, vol. 14, 1914, pp. 320, 322 (Venezuela; restricted type locality, Caracas).

5 ♂, 1 ♀, Cantaura, May 15–June 12, 1950.
2 chicks, Cantaura, July 29, 1951.

Crypturellus noctivagus erythropus (Pelzeln)

Tinamus erythropus Pelzeln, Verh. zoöl.-bot. Ges. Wien, vol. 13, 1863, pp. 1127, 1129 (Barra do Rio Negro=Manáos, Brazil).

2 ♂, 2 ♀, Caicara, March 19–June 6, 1950.
1 set of 6 eggs, Caicara, May 3, 1951.

In our 1950 paper the Cantaura birds were considered as eastern extremes of *idoneus.* The problems raised in our discussion were subsequently studied with ampler material by Wetmore and Phelps (1950, pp. 115–116), who revived the name *spencei* for this eastern population. Our subsequent material, listed above, was used by Wetmore and Phelps and, in fact, was collected for this express purpose. We are in full accord with their conclusions.

The six specimens of *spencei* taken from May 15 to June 12 were all in breeding condition, the female taken on June 12 even had a fully formed but still shell-less egg in the oviduct.

As might be expected, the habits of the two races are similar, and, as the birds could not be distinguished in the field, the following observations are based on both forms. The Cantaura birds proved all to be *spencei*, while those taken at Caicara were all assignable to the race *erythropus*. Insofar as could be determined, their habits and habitat preferences were identical, and it seems that the puzzling existence of two very similar forms with such similar habits at stations approximately 50 miles apart is probably explained by the isolating effect of the intervening shortgrass savanna. However, to the north, in the woods between San Mateo and Urica, the habitats of the two forms appear to come in contact. Collecting at this point should prove of interest.

At first acquaintance, the name *noctivagus* appears to be well chosen. The birds begin to call in the late afternoon and decoy most readily in that brief space of time before the woods become too dark to see. Shortly thereafter the calling falls off, but individuals keep uttering their clear whistled *soy-so-la* on and off throughout the night. The collector-author had thought that the birds were rather nocturnal, as the name and the nightly calls would suggest. However, a captive, kept for several months, while very nervous and restless during the day, slept so soundly at night that it often could be approached without awakening. It seems that the night calls are of the same nature as those of the domestic rooster, and that the tinamous are not otherwise active at night.

It is certain that both males and females call, as both were decoyed in by whistled imitation of the call, were observed calling, and were collected in the act. However, of about twenty birds taken in this manner, only one was a female. It appears that the females either call less or decoy less readily. The call of the female thus taken was identical to that of the males, although the collector had the impression that the sound was a little weaker than usual. He reports that the trachea of the male bears a slight bulbous enlargement, while that of the female is unmodified.

Inasmuch as Osgood and Conover (1922, p. 25) reported collecting a male of a related species of tinamou (*Crypturellus obsoletus cerviniventris*) as it was flushed from its nest, it was thought that incubation might be performed by the male. With this in mind, the present male birds were examined, but were found to show no sign of any brood patches. Furthermore, the female taken with a well-developed egg in the oviduct revealed almost no brood patch either, and showed only a very small denuded area well forward on the breast. However, it was noted that the June birds, collected at the peak of the breeding season, were actively molting the body feathers, with many pin-feathers on the lower abdomen. This was more observable before preparing the specimens than in the resulting study skins.

The young chicks collected on July 20 had dark brown irides, brown bills, the mandible paler than the maxilla, and pale flesh-colored feet. The juvenal plumage of this tinamou appears to be undescribed, and to fill this gap in our recorded knowledge the following description is appended: Forehead and anterior part of crown back to middle of the eye between pinkish buff and cinnamon buff, this same color extending over the eyes, the lores, the auriculars, and the sides of the occiput as a broad band, the two bands narrowing and meeting transversely on the nape, where, however, the dark bases of the feathers show through and produce a broken, mottled appearance; top and middle of crown and occiput argus brown to Brussels brown, a blackish line from the forward end of the eye to the base of the maxilla; on the posterolateral part of the cheeks a patch of argus brown narrowly edged with blackish above and also below; the upper back and mantle mottled transversely, the feathers dark fuscous to fuscous black, with narrow, widely spaced bars of cinnamon buff; wings in our specimens with no remiges as yet, otherwise like the upper back; back, median and lower back, and rump argus brown to Brussels brown; no rectrices as yet in our birds; chin and upper throat white; lower throat, breast, sides, flanks, and tibiae cinnamon buff with an effect of dusky barring due to the dark bases showing through; middle of abdomen cinnamon buff with no suggestion of bars, paling posteriorly to pale pinkish buff.

The chicks collected at the end of July were very active, chasing every little insect that passed their way. The call was a low *wup-wup*, very similar to the nonwhistled (perhaps flocking call?) of the adults. An attempt to raise the chicks failed, but the collector was told that they are occasionally raised in captivity, although the birds never become tame, as does, for example, the Cayenne lapwing *Belonopterus chilensis*. The captive bird mentioned above was caught in a fall trap. It and a captive *Crypturellus soui* remained in apparent good health for four months on a diet of cracked corn and occasional small snails, which were usually refused. Both died within several days of one another, apparently from diet deficiency or disease.

These tinamous wander considerably, although within the same general area. They are local, not to be encountered at all in some parts, while often common in other parts of the same type of woods. Nor can one count on finding them at a favorite locality. One week they may be very much in evidence, while the following week they are apparently absent. To some extent, this may be due to whether or not the birds are calling, for they are most difficult to find when silent; but it may also be that the group has simply moved off to another spot.

They are typically birds of the dry, sparse, deciduous woods. Within these woods they roam in loose groups of rather widely scattered individuals. Thus, while the group does apparently exist in reality, all the individuals which compose it are rarely seen at the same time. The main factor in the distribution of these flocks throughout the woods appears to be the existence of patches of the pineapplelike "maya," *Bromelia pinguin.* Although not restricted to these "mayales," the birds do show great preference for this habitat. They show no other marked preference, and appear to be quite independent of surface water.

While shy and difficult to observe, these tinamous are quite inquisitive. If the observer remains still, as when waiting for deer, the birds may approach to investigate. Often, the patter of its feet over the leaves is clearly audible, although the bird is most adept at keeping out of sight. It tries to keep under cover or behind fallen logs but, instead of observing in a crouched position, it stands on "tiptoe" with its neck stretched upwards as straight as possible, often moving its head from side to side. The difference between the captive *C. noctivagus erythropus* and the *C. soui andrei* was striking. Upon being frightened, as at the approach of a dog, both would crouch, but shortly thereafter the *noctivagus* would stand, raise its head until the neck actually appeared to stretch, and, still unsatisfied, would move to get a better view. When the cause for alarm had left and the *noctivagus* had long since returned to its eating or preening, the *soui* was often still quietly crouched.

The 6-egg clutch of *erythropus* must be close to the maximum number of eggs, if one may judge by the size of the covering bird's breast. These eggs are pale ecru drab with a slight gloss, and are markedly different from the very light bluish white *spencei* egg reported by us in 1950 (*T. idoneus=spencei*). It may be recalled that the latter was laid by a bird in badly injured condition. It now appears that the pathological state of that bird may have been reflected in the lack of further pigmentation in its egg; recently another hen *spencei* was taken with a fully shelled egg in its oviduct. The latter was smashed by the shot, but the pieces of the shell are even more highly colored than the eggs of *erythropus*, not less so as in the case of the lone egg previously recorded. They match very closely the hydrangea pink of Ridgway's color nomenclature.

The gizzard contents of five specimens of *C. n. spencei* consisted of 109 seeds of three sizes, 5 berries, 25 snails of two sizes, 37 lepidopteran chrysalids, 2 caterpillars, 11 beetles, 1 hymenopteran, 1 insect egg, 2 unidentified insect remains, and some small stones. A specimen of *C. n. erythropus* had in its gizzard 24 seeds (including a very large one 19 by 19 by 6 mm.), 1 cicada, and 1 beetle.

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Family Colymbidae: Grebes

Colymbus dominicus speciosus (Lynch Arribalzaga)

Podiceps speciosus Lynch Arribalzaga, La Ley, Buenos Aires, July 2, 1877, p. 1 (Baradero, Buenos Aires, Argentina).

In addition to the data recorded in our earlier paper, the collector reports two apparently undescribed call notes of this grebe, a nasal *yank* surprisingly similar to that of the red-breasted nuthatch (*Sitta canadensis*), and a weak chattering note.

Family Ardeidae: Herons, Egrets, and Bitterns

Bubulcus ibis ibis (Linnaeus)

Ardea ibis Linnaeus, Systema naturae, ed. 10, vol. 1, 1758, p. 144 (Egypt).

We recorded a Venezuelan example of this heron in our earlier paper. It has since been steadily increasing around the collecting stations. From 1945 through 1950 only one flock of 4 individuals was seen, that recorded by us. In 1951 the bird was recorded three times: 2 individuals, February, Caicara; a single, August, Cantaura; a single, October, Caicara. The 1952 records are: 10, August, about 10 kilometers south of Urica; a single, September, Cantaura; 5, October, Caicara; 10, December, Caicara. In January 1953 a flock of 6 was seen at Caicara and a flock of 8 about 10 kilometers south of Urica, Anzoátegui.

The compact flock formation, the short necks, and the rapid running of the members of the flocks as they chase their prey (generally grasshoppers?) serve to identify this bird at a glance. Usually, but not always, it was found in the vicinity of water, but always on the dry land; it was never observed hunting or wading in the water. On two occasions the birds were seen following cattle.

Cochlearius cochlearius cochlearius (Linnaeus)

Cancroma Cochlearia Linnaeus, Systema naturae, ed. 12, vol. 1, 1766, p. 233 (Guiana).

1, unsexed, Caicara, March 8, 1952.

Taken at Caicara; bill, foot, and wing saved to establish the record. Considered a very rare and strange heron by all local hunters who examined the bird. Otherwise unrecorded in the study area, although widely distributed throughout the American tropics.

Family CICONIIDAE: Storks

Euxenura galatea (Molina)

Ardea galatea Molima, Sagg. Stor. Nat. Chili, 1782, p. 235 in text, 344 (Chile).

1, unsexed, Caicara, June 4, 1951; gonads small; iris brown, bill gray, feet dull red.

This stork was occasionally recorded on the savanna lagunes, generally in pairs, more rarely in singles. It was uncommon; more than two birds were never seen in any one month.

Another even larger stork, the jabiru (*Jabiru mycteria*) also occurs in the study area, but has not yet been collected. The collector saw occasional individuals but was never able to crawl within shotgun range, even at night.

Family CATHARTIDAE: New World Vultures

Sarcoramphus papa (Linnaeus)

Vultur Papa Linnaeus, Systema naturae, ed. 10, vol. 1, 1758, p. 86 ("India occidentalis"=Surinam, designated by Berlepsch, Nov. Zool., vol. 15, 1908, p. 289).

One unsexed, Caicara, March 30, 1950; adult in good plumage.

The king vulture was seen occasionally, one bird at a time, at Caicara, except for one time when a flock of six was noted. It was not recorded at Cantaura.

Coragyps atratus (Bechstein)

Vultur atratus Bechstein, *in* Latham, Allgemeine Uebersicht der Vögel, vol. 1, 1793, Anhang, p. 655 (Florida, ex Bartram).

In our earlier paper we recorded a chick hatched about August 1. That the breeding season is prolonged, as might be expected, is shown by a "nest" of the black vulture, with two freshly laid bluish eggs mottled with reddish, found at Cantaura on March 29, 1952. The nest was simply a slight clearing on the ground; it was placed in a thicket under a large tree, within 300 yards of a house and within 10 yards of a travelled lane The eggs were destroyed by some animal within days after their discovery by the collector. A vulture was again flushed from this site on December 6, but no nest or eggs could be found.

Cathartes aura ruficollis Spix

Cathartes ruficollis Spix, Avium species novae . . . Brasiliam . . . , vol. 1, 1824, p. 3 (interior of Bahia and Piauí).

The junior author adds to our earlier account of this vulture his report of seeing single immature birds on June 4, 1950, and again on June 5, 1952. These were young dark-headed individuals, fully able to fly yet giving the impression of having but recently left the nest. If this were true, then this turkey vulture must nest in April or May.

Family Accipitridae: Hawks, Eagles, Kites

Leptodon cayanensis (Latham)

Falco cayanensis Latham, Index ornithologicus, vol. 1, 1790, p. 28 (Bahia, Brazil).

1 ♂, Caicara, May 26, 1952; gonads very small; iris brown, bill and cere black, facial skin and feet dull blue gray; gizzard contained hymenopterous adults and larvae and a large quantity of pulpy material; apparently it had eaten a whole wasps' nest! A fully adult bird in fairly fresh plumage.

A rare, quite *Buteo*-like hawk, typically encountered in pairs along the Guarapiche River at Caicara. It was not heard to utter a sound. The gizzard contents of the example collected proved quite a surprise to the collector; the bird had obviously eaten a wasps' nest—paper, wasps, larvae, and all. Stresemann (1940, p. 144) has already reported on this food habit.

Gampsonyx swainsonii leonae Chubb

Gampsonyx swainsonii leonae Chubb, Bull. British Orn. Club, vol. 39, 1918, p. 22 (León, western Nicaragua).

Whereas the collector previously found this little hawk to be very silent, in recent years he has occasionally seen it soaring in circles with much flapping, and often uttering a high-pitched scolding *kitt-y, kitt-y, kitt-y* note.

Rostrhamus sociabilis sociabilis (Vieillot)

Herpetotheres sociabilis Vieillot, Nouv. Dict. Hist. Nat., vol. 18, 1817, p. 318 (Corriente and Río de la Plata).

1 ♀, Caicara, May 26, 1952; gonads enlarged; iris yellow, feet and facial skin orange, bill and nails black; gizzard contained snails.

Although the snail kite was known to local hunters, only one was seen and taken by the collector on the Guarapiche River at Caicara.

Accipiter bicolor bicolor (Vieillot)

Sparvius bicolor Vieillot, Nouv. Dict. Hist. Nat., vol. 10, 1817, p. 325 (Cayenne).

1 ♀, Caicara, April 15, 1950; skull well ossified; gonads enlarged, the largest ovum 11 mm. in diameter; iris bright yellow; facial skin and feet greenish yellow; bill black, bluish basally; plumage worn.

This accipiter, while uncommon, was typical of the deciduous seasonal woods, both at Cantaura and Caicara. The female collected was uttering a series of loud *cak-cak-cak-cak* notes as it approached the collector. Judging from the condition of the gonads, the bird may have been breeding nearby and may have been scolding as the nest site was neared. The bird has the habit of perching quietly on the inner branches, whence it darts out in typical accipiter fashion. One was seen feeding on a mockingbird, *Mimus gilvus melanopterus*, while another struck a full-grown yellow-headed parrot *(Amazona ochrocephala ochrocephala)*, pet of the collector, and carried the protesting parrot about fifty feet from its perch before releasing it. The birds were not weighed, but the parrot probably weighed more than the hawk.

Heterospizias meridionalis meridionalis (Latham)

Falco meridionalis Latham, Index ornithologicus, vol. 1, 1790, p. 36 (Cayenne).

To the data previously recorded by us may now be added some definite breeding observations.

Two nests of this hawk were found each about 25 feet up in spiny trees in semiopen fields, and both at Cantaura. The nest found March 30, 1950, was large and well built, as if it had been used for many years. It contained one young, almost ready to fly, which gave a whistle similar to but weaker than the adult call. The parents were never seen. The second nest, found on October 30, 1951, was much smaller; it was well constructed and contained one half-grown young. One parent bird remained in the vicinity of the nest, calling as the collector approached, but did not offer to attack.

Buteo albicaudatus colonus Berlepsch

Buteo albicaudatus colonus Berlepsch, Journ. Orn., vol. 40, 1892, p. 91 (Island of Curaçao).

No further examples of this hawk were taken, but one was seen on April 12, 1952, feeding on a blue-winged teal (*Anas discors*), possibly one that had been wounded by hunters.

Buteo albonotatus abbreviatus Cabanis

Buteo abbreviatus Cabanis, *in* Schomburgk, Reisen im Britisch-Guiana . . . , pt. 3, 1848, p. 739 (upper Pomeroon River, British Guiana).

Since our earlier report, the collector added this hawk to the fauna known to breed in the study area. A nest was found at San Mateo, Anzoátegui, on May 1, 1950. It was well constructed, and was placed about 40 feet up in a tall tree in the deciduous woods. It contained at least one young, rather large, but still covered with grayish down. One of the parent birds at the nest protested closer examination with a typical *Buteo*-like, whistled scream.

Hypomorphnus urubitinga urubitinga (Gmelin)

Falco Urubitinga Gmelin, Systema naturae, vol. 1, pt. 1, 1788, p. 265 (Brazil).

Additional observations were made on this hawk. Usually it was very quiet, but on January 12, 1952, three were observed soaring together and uttering a rapidly repeated whistle very similar to that of the osprey *Pandion haliaetus* but somewhat weaker.

Spizaëtus ornatus ornatus (Daudin)

Falco ornatus Daudin, Traité élémentaire et complet d'ornithologie, vol. 2, 1800, p. 77 (Cayenne).

1, unsexed, Caicara, October 6, 1951 (only head and feet saved).

Although not previously taken in the study area, this magnificent crested eagle-hawk was rare but well known at Caicara. It was not recorded at Cantaura. One raided a farm at Caicara during the months of March and April 1951, carrying off half-grown chickens. The one collected had been eating a full-grown guan (*Ortalis ruficauda*).

Spizaëtus tyrannus serus Friedmann

Spizaetus tyrannus serus Friedmann, Smithsonian Misc. Coll., vol. 111, No. 16, 1950, p. 1 (Río Indio, near Gatún, Canal Zone, Panamá).

1 ♀, Caicara, January 5, 1952; gonads slightly enlarged, bird very fat; iris rich yellow, feet yellow, nails black; bill black, bluish at base; cere dull green; facial skin black; gizzard contained mammal hair (opossum ? or monkey ?) only, no bones. A fully adult bird in somewhat abraded plumage.

This specimen is referable to the subspecies *serus*, but is definitely intermediate between that form and the nominate race of eastern and southeastern Brazil in the preponderance of black over white in the under wing coverts, in which character it is like *tyrannus* although in size it is *serus* and in the amount of white barring on the thighs it is intermediate between the two. It is the first truly intermediate specimen seen, but it comes from a locality that is far from intermediate. The range of *serus* as known at present is from southern México to Colombia, Ecuador, Perú, Venezuela, Trinidad, the Guianas, to northern and western Brazil and to Bolivia, while the range of *tyrannus* is eastern and southeastern Brazil, probably to northeastern Argentina. Our one specimen of the tyrant eagle-hawk was wounded by Sr. Romualdo Ramos, who, recognizing the rarity of the bird, carried it in alive to the collector. The bird was reported to utter a loud scream, *frio-frio*. A splendid example of this species was seen quietly perched on a low branch overlooking the Guarapiche River at Carcara. It continued peering intently into the water for perhaps ten minutes, apparently actively following the movements of a school of fish below, but did not attempt to capture one. At close range the feathered tarsi were very evident. Otherwise, at a little distance, the bird could easily have been mistaken for *Hypomorphnus urubitinga*.

Circus brasiliensis (Gmelin)

Falco brasiliensis Gmelin, Systema naturae, vol. 1, pt. 1, 1788, p. 262 (based on "Caracara" Marcgravius, Historiae rerum naturalium Brasiliae, 1648, p. 211, northeastern Brazil=Pernambuco).

1 ♂, Cantaura, July 31, 1950; gonads small; skull not well ossified; iris light yellowish brown; bill blue gray with black tip; cere dull blue green; feet rich yellow. A very worn bird, in molt in the wings and tail.

The immature example collected was evidently very hungry; it attempted time after time to capture a Cayenne lapwing (*Belonopterus chilensis*) out of a flock of these birds. They were obviously too large for the harrier and it was quite unsuccessful. In his turn, the collector followed the harrier over a large expanse of savanna, with equal lack of success. Finally, in desperation, crouching behind a bush as near as he dared approach the bird, he tossed out, one after another, his three white handkerchiefs. At the third handkerchief, the harrier flew in at top speed to investigate and was taken. The hawk is rare in the area, but occasional singles are seen, always on the open savanna.

Geranospiza caerulescens (Vieillot)

Sparvius caerulescens Vieillot, Nouv. Dict. Hist. Nat., vol. 10, 1817, p. 318 (South America; Cayenne, designated as type locality by Berlepsch and Hartert, Nov. Zool., vol. 9, 1902, p. 114).

Some observations, additional to those in our earlier report, are here added to the recorded data on this crane hawk.

The common call note of this crane hawk is a typical sound of the sparse woods at late evening and early morning, but it is so different from the calls expected of a hawk that for years the collector never suspected this bird was its author. The call, a loud hollow *how* uttered singly and repeated at perhaps one or two minute intervals, carries for a long distance but is rather hard to place. When thus calling, the bird is usually quietly perched near the trunk in a well foliaged tree. To locate it in the poor light of the late evening, before the approach of the observer causes it to cease calling, is an extremely difficult task. This hawk also utters a *Buteo*-like *shreeuu* call, quite similar to that of *Buteo magnirostris* and *B. nitida*.

On January 11, 1952, at Caicara, one was observed in what might be considered a display. It flapped and soared in rather tight circles. After several circles, the bird would climb abruptly and immediately thereafter drop sharply, describing an inverted V rather like the courtship display of the marsh hawk *Circus cyaneus*.

Family PANDIONIDAE: Ospreys

Pandion haliaetus carolinensis (Gmelin)

Falco carolinensis Gmelin, Systema naturae, vol. 1, pt. 1, 1788, p. 263 (no locality given=Carolina, ex references).

Because of the unusual interest attached to the observations and because of the collector's long familiarity with this bird in life in eastern North America, we depart from our usual custom and include this hawk even though as yet no actual specimens have been collected in the study area. The allocation of these observations to the subspecies *carolinensis* is only inferential.

The collector's field notes for Barcelona, Anzoátegui (seacoast), are as follows:

February 19, 1950: One seen.

May 28, 1950: Pair seen together several times. Nesting here?

May 25, 1951: One—apparently nesting? Flew off nest or from branch near nest; however, did not scold.

January 26, 1952: One seen. Suspected nest examined, no sign of use.

Although it was not possible to take specimens, the identifications are positive—in each case the bird was observed with binoculars and in good light. To date the collector has not been able to offer definite information, but it does appear possible that this form may be breeding on the Venezuelan mainland. The pair together, the relatively late dates, and the presence near a large, ospreylike nest, which was not situated in the open where the bird might normally perch, all suggest this possibility. Otherwise the osprey is known to breed no farther south (in the Western Hemisphere) than Yucatán and British Honduras, although it has been recorded as wintering as far south as Perú, Paraguay, and Argentina. However, in Colombia, it has been observed practically throughout the year, but no indications of its breeding there are reported (de Schauensee, 1949, p. 403).

Occasional singles of this form were seen at Cantaura and Caicara.

Family FALCONIDAE: Falcons

Daptrius americanus americanus (Boddaert)

Falco americanus Boddaert, Table des planches enluminéez d'histoire naturelle, 1783, p. 25 (ex Daubenton, pl. 417; no type locality=Cayenne, ex Buffon).

1 ♀, Caicara, June 5, 1952; gonads slightly enlarged; iris brown; bill dull yellow; cere dull blue; face and feet dull red; gizzard contained some small, sticky, red-orange fruit (strangler fig? or mistletoe?).

This hawk was found in roving bands in the sparse deciduous seasonal forest and the denser lowland seasonal forest at Caicara; it was unknown at Cantaura. The flocks were very irregular in their appearance, present in one area for a short period and then absent again. They are birds of the treetops, difficult to find except when calling, but the presence of a flock is soon betrayed by the loud calls repeated by one and then another *cacao-ca-ca-ca-cao*. The local name is "cacao."

The gizzard contents of hawks are interesting as their food habits cover a wide range. Our example of this species was found to have eaten fruit, that of *Leptodon* had eaten an entire wasps' nest; a *Milvago chimachima* often came to the collector's food station to eat bread soaked in milk, not to mention such well known examples as *Rostrhamus* eating snails, and *Busarellus* feeding on fish.

Polyborus cheriway cheriway (Jacquin)

Falco cheriway Jacquin, Beyträge zur Geschichte der Vögel, 1784, p. 17, pl. 4 (Aruba and coast of Venezuela).

Additional observations by the collector add to our knowledge of this caracara.

A nest of this caracara was found at Cantaura on March 25, 1950. It was a large, well built nest of fine sticks, with no lining, placed about 30 feet up on a horizontal branch and contained two brown, heavily mottled eggs. Both parents came to scold the collector, perching about ten feet from him and uttering a pebbly *eh-eh-eh-eh* note.

In December 1952 a flock of about 75 birds assembled on the golf course to eat "caterpillars" (beetle larvae) which had reached plague proportions in the grass there. At this time one was observed to capture a wounded fork-tailed flycatcher (*Muscivora tyrannus*). The flycatcher was perched on a small clod and the caracara, about fifty feet away, did not appear to notice it. A passing car frightened the smaller bird, which tried to fly. The caracara noticed the bird's flutterings immediately and, flying about a yard above the ground, captured the flycatcher with its feet. The bill was used only to kill the bird. On another occasion, two were seen eating a dead lizard (*Iguana*). At the approach of the collector, one of the birds grasped the lizard with its feet and flew off about 50 yards with it. These two instances are unusual in that the birds are commonly seen carrying objects in their bills.

Falco femoralis femoralis Temminck

Falco femoralis Temminck, Nouveau recueil de planches coloriées d'oiseaux, livr. 21, pl. 343, and livr. 50, pl. 121, 1822 (Brazil, ex Natterer).

Although no additional specimens were obtained, the following notes add to what we recorded earlier of the aplomado falcon: This falcon often hunted in pairs and, like the pigeon hawk *Falco columbarius*, was often seen hunting in the late evening after sunset. The bird was recorded eating the small doves *Scardafella squammata* and *Columbigallina talpacoti*. One was seen trying to capture a pigeon, *Columba cayennensis*, a bird about as large as the domestic pigeon we (1950, p. 451) reported taken by this falcon. On September 18, 1950, another was seen hunting shore birds on the open savanna. These birds would take to the air each time the falcon appeared, except for the Cayenne lapwing (*Belonopterus chilensis*) which refused to flush and, in fact, appeared to take slight notice of the danger. The flock of shore birds included golden plover (*Pluvialis dominica*), greater and lesser yellowlegs (*Totanus melanoleucus* and *T. flavipes*), pectoral sandpiper (*Erolia melanotus*), and unidentified "peep" sandpipers.

Falco sparverius isabellinus Swainson

Falco isabellinus Swainson, Animals in menageries, 1837, p. 281 (British Guiana).

Further notes on the breeding of this race of the sparrow hawk are as follows: On March 20, 1950, a nest was discovered about 10 feet up under the eaves of a house. The female was either incubating well-developed eggs or brooding very young chicks (several days later very young chicks were removed by workmen cleaning the house). The male brought food, generally small lizards, to a treetop about 100 feet away and called the female by using a call like the juvenal food-begging note. The female then came out of the nest and ate, occasionally taking food back with her. At times, when the female did not appear, the male would take food to the nest site but apparently did not incubate. Another nest, found on April first about 15 feet up on a hollow tree, contained an incubating bird, again a female.

Once, in January, a small male sparrow hawk was seen attacking a *Falco femoralis,* keeping above the larger bird and diving at it. Knowing the powers of flight of the aplomado falcon, it did not seem possible to the collector that the bird, if it so desired, could not turn the tables on the little sparrow hawk.

Family Cracidae: Guans

Ortalis ruficauda (Jardine)

Ortalida ruficauda Jardine, Ann. Mag. Nat. Hist., vol. 20 1847, p. 374 (Tobago).

Since our previous report we are able to record the following notes on the breeding of this species: Four nests of this chachalaca, all with eggs, were seen during the period between May 1 and June 4. They were well made of twigs and many leaves, including fresh green ones. One contained four white eggs with a rough pebbly surface; although no record was kept of the number of eggs per clutch in the other nests, it is doubted that the clutches could be much larger, because the eggs were large and completely filled the nest. One nest was placed about 10 feet up in a tangle of vine, another was 3 feet up in a many-branched tree trunk, two were on the ground. Normally this guan is almost strictly arboreal, preferring the heavier wooded portions of the deciduous seasonal woods. Yet in each case, the nest was located in the savanna-edge habitant far from surface water and within 10 yards of grassy openings, in places where one would never expect to find the bird. It would seem that these were originally birds of the open country and had relatively recently acquired their present arboreal habits.

Family PHASIANIDAE: Pheasants, Quail, and Their Allies

Colinus cristatus mocquerysi (Hartert)

Eupsychortyx mocquerysi Hartert, Bull. British Orn. Club, vol. 3, 1894, p. xxxvii (Cumaná, Departamento de Sucre, Venezuela).

1 ♀, Caicara, March 19, 1950; gonads very small; iris brown; bill very dark brown; feet light blue gray; skull well ossified; gizzard contained seeds, one ant, and flowers.

This specimen agrees with the two recorded in our earlier paper. We are still of the opinion that *mocquerysi* is a valid race.

Family RALLIDAE: Rails, Coots, Gallinules

Neocrex erythrops olivascens Chubb

Neocrex erythrops olivascens Chubb, Bull. British Orn. Club, vol. 38, 1917, p. 33 (Venezuela).

1 ♂, Caicara, July 20, 1950; gonads enlarged; bill dull green with the base bright red; feet red; eyes shine red at night when illuminated by hunting lantern.

Two careful observers of local wildlife assured the collector that the red-faced crake nested in the cornfields around Caicara. This appears to be in agreement with the fact that the present specimen had enlarged gonads, and was probably a breeding bird.

Family HELIORNITHIDAE: Finfoots

Heliornis fulica (Boddaert)

Colymbus fulica Boddaert, Table des planches enluminéez d'histoire naturelle, 1783, p. 54 (Cayenne, ex Daubenton, pl. 803).

Whereas we had previously (1950) recorded this bird only from Caicara, during October four of these peculiar birds were subsequently observed on a little artificial lake near Cantaura, as they swam quietly about among the drowned trees and the overhanging underbrush. A very loud *wak-wak-wak* call, almost certainly made by these birds, was heard.

Family CHARADRIIDAE: Plovers

Hoploxypterus cayanus (Latham)

Charadrius cayanus Latham, Index ornithologicus, vol. 2, 1790, p. 749 (Cayenne).

1 unsexed, Cantaura, July 31, 1950; iris dark, bill black with base of mandible dull orange; feet bright orange; skull well ossified. Adult bird, molting the remiges.

This beautiful little spur-winged plover, rare in the area (not more than two were ever seen at one time), was recorded at savanna ponds in June, July, and August. The call is a clear, pleasant whistle, consisting of two separate notes, one high, the other quite low, in tone somewhat like that of the spring call of the greater yellowlegs

(*Totanus melanoleucus*). Rendered vocally, the call is a series of separate notes, *whee, whoo, whee, whoo.*

Pluvialis dominica dominica **(P. L. S. Müller)**

Charadrius Dominicus P. L. S. Müller, Natursystem, Suppl., 1776, p. 116 (Hispaniola).

No additional specimens were taken, but further observations extend our knowledge of this migrant plover. Extreme dates recorded for the golden plover were September 18 and December 5. The form was seemingly rare at the seacoast, perhaps due to the collector's limited time there, but common at the savanna ponds and burnt-over areas on the savanna. For the past 3 years these birds have taken to feeding at night on the well-watered lawns of the oil company camps at Anaco, Anzoátegui. Their presence would have passed unnoticed were it not for their startlingly loud *queedelee* whistle.

Squatarola squatarola **(Linnaeus)**

Tringa Squatarola Linnaeus, Systema naturae, ed. 10, vol. 1, 1758, p. 149 (Europe, restricted type locality Sweden).

1 ♀, Barcelona, February 20, 1950; gonads small; iris dark; feet blue gray; bird not fat.

The black-bellied plover was recorded only at the coast, and there in small flocks of four or five individuals.

Family SCOLOPACIDAE: Sandpipers, Curlews, Godwits

Bartramia longicauda **(Bechstein)**

Tringa longicauda Bechstein, *in* Latham, Allgemeine Uebersicht der Vögel, vol. 4, pt. 2, 1912, p. 453 (North America).

Because of the paucity of Venezuelan data, the following expansion of our earlier notes may be recorded. Extreme dates for the upland plover are September 11 to October 17 and (rarer) March 25 to April 2. In September the bird is quite common on the lawns of the oil company camps at Anaco.

Capella gallinago delicata **(Ord)**

Scolopax delicata Ord, *in* Wilson, American ornithology, vol. 9, 1825, p. ccxviii, reprint (Pennsylvania).

In our 1950 report we indicated a wide spread of this species in Venezuela. The collector's subsequent field observations deal not as much with distributional occurrences as with slight but generally overlooked details of habits, based on a captive bird. At Anaco, on October 12, 1952, a slightly wounded snipe was brought in to him. He identified it as *delicata* by measuring the bill, wing, and outer rectrices:

. . . The bird walked mincingly across the room, with delicate uplifted steps. When it wanted, it could compress its tail so that it looked about as wide as the central two rectrices. Usually, however, when the bird crossed in front of me it spread its tail fanshaped like a strutting turkey gobbler, but strongly twisted in line with its body, not at right angles to it. When the bird changed directions and crossed in front of me from the opposite side, the tail was immediately reversed so as to continue to present the upper side to me. The bird almost appeared to be strutting in front of me, a thing not to be expected under the circumstances, although I could not rule out the thought of camouflage in the sense that the spread tail looked somewhat like the head with the dark central spot (central coverts) as the eye spot. At this time the bird did not crouch preparatory to flying.

When I tried to recapture the bird, however, I noted that each time it crouched preparatory to taking off (it could but barely lift itself off the floor, as the pectoral muscles had been injured) it fanned its tail in exactly the manner described above. It might be mentioned that this is not just a slight fanning of the rectrices, but an extreme position—a very wide open fan, strongly cocked to the side of the observer. The bird appeared to take off with the tail so cocked. This may be the reason for the "corkscrew" flight of the snipe when flushed.

Crocethia alba (Pallas)

Trynga alba Pallas, *in* Vroeg, Catalogue . . . , 1764, Adumbr., p. 7 (coast of the North Sea).

1 unsexed, Barcelona, December 10, 1951; bill and feet black.

The sanderling was recorded only on the coast at Barcelona during December through February. It was not common; usually not more then five birds were seen at one time.

Family Laridae: Gulls, Terns

Sterna albifrons antillarum (Lesson)

Sternula antillarum Lesson, Description de mammifères et d'oiseaux récemment découverts (*in* Complément aux oeuvres de Buffon), vol. 20, 1847, p. 256 (Guadeloupe, West Indies).

1 ♀, 10 kilometers south of Urica, Monagas, April 27, 1952; gonads very small; skull soft, immature; iris dark; bill yellow with tip black; feet yellow, nails black.

1 unsexed, Barcelona, May 25, 1951 (wing and feet only); bill yellow with black tip; feet yellow.

The female taken is the only one known to have been seen within the study area; the Barcelona specimen was collected from a flock of five.

Thalasseus sandvicensis acuflavidus (Cabot)

Sterna acuflavida Cabot, Proc. Boston Soc. Nat. Hist., vol. 2 (1848), 1847, p. 257 (Tancah, Yucatán).

1 ♀, Barcelona, May 25, 1951; gonads enlarged (small yolks); iris brown; bill and feet black.

This specimen was collected out of a flock of eight birds. The enlarged gonads and the pugnacious, "attacking" behavior of the bird made it seem likely that the species was nesting nearby. The gull-billed tern was recorded only on the coast.

Family Columbidae: Pigeons, Doves

Columba speciosa Gmelin

Columba speciosa Gmelin, Systema naturae, vol. 1, pt. 2, 1789, p. 783 (Cayenne, ex Daubenton, Planches enluminées, pl. 215).

1 ♂, Caicara, May 30, 1950; gonads enlarged (17 mm. long); iris brown; bill bright red, the tip flesh color; eye ring red; feet dull purple; skull well ossified; bird molting the rectrices.

The large-scaled pigeon was apparently present at Caicara only during April, May, and June when small flocks of less than 10 individuals were seen, always in the rather heavy woods of the "quebradas" which cut back into the savanna of the mesa. The call was a very low *cooo* like that of distant cattle; for this reason the bird was known locally as "paloma tora" (bull pigeon). A cup-shaped nest of twigs, without lining, was found in late April, placed only about 10 feet up in a "chaparro" (*Curatella americana*) on the savanna in the immediate vicinity of a "quebrada" frequented by these birds. A fledgling was seen on May 22.

Columba corensis Jacquin

Columba (*corensis*) Jacquin, Beytrage zur Geschichte der Vögel, 1784, p. 31 (Coro, Venezuela).

In our 1950 report we recorded this bare-eyed pigeon from Cantaura, but not from Caicara. Subsequently it has been seen at the latter locality.

Zenaidura auriculata stenura (Bonaparte)

Zenaida stenura Bonaparte, Compt. Rend. Acad. Sci. Paris, vol. 40, No. 3, January 15, 1855, p. 98 ("Columbia"=Colombia).

The following field notes on the breeding habits of this dove extend the data in our earlier (1950) report: At least during the months of January through August, a type of display is given. Shortly after sunrise, an occasional single is seen to take off from a treetop and fly upwards with deep, rapid wing-beats. The flight upwards is at a steep angle, perhaps 30 to 40 degrees. When a height of perhaps 100 to 150 feet is reached, the bird glides down on rigid, downspread wings, describing, in the process, a large semicircle, which ends at, or in the immediate vicinity of, the starting point. This display is given only by birds in fully adult plumage and is apparently given by breeding birds, or at least by birds which have not joined a flock. Also, it is usually given, day after day, from the same starting point, perhaps because the bird is on territory, or perhaps merely because the bird habitually spends the night in the same spot. It was noted that the pair generally bills several times, in the manner of domestic pigeons, before the male mounts to copulate.

July 6: Pair seen together at nest site. Several twigs placed in position.

July 7: One sits on nest and slowly revolves, forming nest shape, while other brings in twigs in spurts, at times as fast as one every 20 seconds, laying them beside the dove in the nest, which accepts each one in its turn, placing it in position. Pair made no noise except a wing whistle (controlable?).

July 8: Bird on nest all day—must have laid first egg either late yesterday or early this morning.

July 9, 7 a. m.: One egg in nest.

July 10, 4 p. m.: Two eggs in nest.

The young were brooded until quite well feathered and large enough to fill the nest to such an extent as to make further brooding physically impossible. During this period the female (?) did not leave the nest to search for food, the male (?) bringing food for the young. On one occasion the female (?) begged food from him and then later fed the young by regurgitation.

In addition to a soft *coooo* rising very slightly at the end, this dove also utters a low *oooo-ah-oooo*, reminiscent of the mourning dove (*Zenaidura macroura*), but very low in pitch, as well as in volume, scarcely audible at 50 feet.

Scardafella squammata ridgwayi Richmond

Scardafella ridgwayi Richmond, Proc. U. S. Nat. Mus., vol. 18, 1896, p. 660 (Margarita Island, Venezuela).

Two additional crumbs of information: copulation is preceded by the briefest of preliminaries, a split-second billing before the male mounts; also, at least on one occasion both parents roosted with the young for two nights after they had left the nest.

Columbigallina passerina albivitta (Bonaparte)

Ch[*amaepelia*] *albivitta* Bonaparte, Compt. Rend. Acad. Sci. Paris, vol. 40, No. 1, 1855, p. 21 (Cartagena, Colombia).

Since our previous report, this dove has also been observed nesting on the ground, the nests being very meager affairs when compared to the bulky nests built in bushes. This form had a wing-twitching "display" identical to that described under *Columbigallina talpacoti rufipennis*, except that, in this case, the display is accompanied by a low, froglike *aaack* note, barely audible at 20 feet.

Columbigallina talpacoti rufipennis (Bonaparte)

Chamaepelia rufipennis Bonaparte, Compt. Rend. Acad. Sci. Paris, vol. 40, No. 1, January 1855, p. 22 (environs of Cartagena, Colombia).

In our 1950 publication, this form was reported as rare around Cantaura. It has since become common in the nearby well-watered oil company camps at Anaco. Within these camps, it has become commoner than the *C. passerina albivitta* as a breeding bird. On September 24, 1952, three occupied nests were found in a triangular area not more than 50 feet apart; there was an occupied nest of *Scarda-*

fella squammata not 15 feet from one of these. Two of the *talpacoti* nests contained eggs, while the third contained well-grown young. One of these nests was used a second time, while another was used three times in August, September, and October of the same year. Each successive time the nest was relined by the birds. Nests were found in bushes and trees, from 2 to 20 feet above the ground, and were composed mostly of grasses, not twigs, as are those of *passerina albivitta.* The nest-building is carried on in very much the same manner as that described for *Zenaidura auriculata.* In one case the male (redder bird) *talpacoti* brought in all the nesting material, while the female (paler bird) did all the actual construction, the major portion being done in 1 day.

The following notes were made:

August 21: Nest contained one egg, bird brooding (noon).

August 22: Nest contained two eggs at 4 p.m. Thus, second egg laid between 12 noon August 21 and about 3 p. m. August 22.

September 2: Eggs not yet hatched at 4 p.m.

September 3: One chick recently hatched. 9 a.m.

September 4: Remaining chick hatched. 7 a.m. Is dry, appears to have hatched yesterday, or during the night. Thus, hatched between 9 a. m. and about midnight September 3. Incubation period of second egg was, therefore, between 13¼ and 14½ days. (All clutches seen were composed of two eggs.)

September 14: Young left nest, remained in bush.

September 15: Still in bush, parent feeding.

September 16: Left nest site.

During the breeding season the male (?) would chase the female (?) and, when perched alongside, would indulge in a curious, nervous, wing-twitching motion; with wing folded in normal position, the bird would alternately jerk the tip slightly above and then slightly below the normal position.

Claravis pretiosa **(Ferrari-Perez)**

Peristera pretiosa Ferrari-Perez, Proc. U. S. Nat. Mus., vol. 9, 1886, p. 175 (new name to replace *Columba cinerea* Temminck, 1811, not of Scopoli, 1786; Brazil).

Since our previous report, the vocalisms of this dove have been identified, a resonant *woop-woop-woop-woop* frequently heard in the deeper woods in May and June.

Leptoptila verreauxi verreauxi **Bonaparte**

Leptoptila verreauxi Bonaparte, Compt. Rend. Acad. Sci. Paris, vol. 40, No. 3, January 15, 1855, p. 99 ("Nouvelle Grenada").

1 ♀, Caicara, March 10, 1950; gonads somewhat enlarged; eye ring dark blue, iris yellow; feet red, bill black; skull well ossified.

Zenaidura auriculata stenura, young about to leave the nest, Cantaura, Aug. 7, 1949.

Scardafella squamata ridgwayi on nest, Cantaura, Aug. 7, 1949.

Nyctibius griseus, adult.

Amazilia fimbrieta maculicauda: top, adult; lower, nest and young.

Family Psittacidae: Parrots

Ara manilata (Boddaert)

Psittacus manilatus Boddaert, Table des planches enluminéez d'histoire naturelle, 1783, p. 52 (Cayenne; ex Daubenton, pl. 864).

1 ♀ El Tigre, August 20, 1950; gonads somewhat enlarged; feet and bill black; iris dark brown; facial skin lemon yellow; feeding on fruit of moriche palm, *Mauritia minor* (fide H. Pittier, La Mesa de Guanipe, ensayo de fitogeografía, Caracas, 1942).

This little macaw is found near groves of the "moriche" palm (*Mauritia minor*) on the savanna between El Tigre, Anzoátegui, and Ciudad Bolívar on the Orinoco River, often in flocks of well over 100 individuals. Small flocks were occasionally recorded near Cantaura. The call was very similar to that of *Aratinga acuticauda*, quite different from that of *Aratinga leucophthalmus*. The slightly larger size is not easily discernible in the field; this *Ara* looked very much like the larger *Aratinga*, only the relatively longer wings and somewhat different wingbeat aroused the collector's suspicions enough for him to take one as the flock passed by. Obviously, the yellow facial skin sets this bird off from the *Aratinga*, but this is not often visible when the bird is flying. When perched in the tops of the palms these macaws are, in spite of their size, often very difficult to find.

Aratinga leucophthalmus leucophthalmus (P. L. S. Müller)

Psittacus leucophthalmus P. L. S. Müller, Natursystem, Suppl., 1776, p. 75 (Guiana).

Upon better acquaintance, the collector was able to distinguish this bird quite readily from the very similar *acuticaudata* by a dry *che-chek* note often, but not always, given by the present species. A flock was seen at Caicara, feeding on the flowers of the tree *Erythrina glauca*.

Forpus passerinus viridissimus (Lafresnaye)

Psittacula viridissima Lafresnaye, Rev. Zool., 1848, p. 172 (Caracas, Venezuela).

During the last week of July, a pair of these parrotlets was found nesting in the end of a piece of 3-inch pipe used as the cross arm of a clothesline support, 6 feet above the ground, while a pair of *Sicalis flaveola* nested in the other cross arm, 30 feet away. The nest was composed of twigs which, however, may have been rearranged by the inhabitants from a previous *Sicalis* nest. The pair had a well-established morning ritual. Within a very few minutes before or after 6:30 a. m. the incubating bird would leave the nest, and, accompanied by its mate, would circle the area at top speed, with much twittering. The pair would then disappear, returning in about ten minutes. One bird entered the nest hole immediately, while the other remained beside the entrance for a short period and then also entered, often spending five to ten minutes inside before taking leave. The nest was destroyed about a week later, making further observations impossible.

Brotogeris chrysopterus chrysopterus (Linnaeus)

Psittacus chrysopterus Linnaeus, Systema naturae, ed. 12, vol. 1, 1766, p. 149 (India, error, Guiana designated as type locality by Brabourne and Chubb, Birds of South America, 1912, p. 88).

1 ♂, Quiriquire, September 11, 1949; gonads small; bill flesh color; iris dark; eye ring whitish; feet pale blue-green; skull well ossified.

Adult bird, molting the outer remiges.

This little parrot was collected in the heavy lowland forest at Quiriquire, the only place where it was encountered.

Pionus menstruus (Linnaeus)

Psittacus menstruus Linnaeus, Systema naturae, ed. 12, vol. 1 1766, p. 148 (Surinam).

1 adult ♂, Caicara, October 4, 1949; gonads small; bill black with a small spot of flesh color at base of maxilla; eye ring and feet black; gizzard contained corn.

The blue-headed parrot was usually seen in the heaviest woods around Caicara, in small flocks of less than 10 birds. Like the blue-and-yellow macaw (*Ara ararauna*), this form appears to be at the extreme edge of its preferred habitat, the heavy lowland forest of Quiriquire and Caripito. However, in spite of being a bird of the heavy woods, it is quite partial to cultivated corn. Although in life the bird was quite similar in general appearance and call notes to *Amazona amazonica*, the red under-tail coverts of the present species were often visible as the bird passed overhead and the wings appeared relatively longer than those of the *Amazona*.

Amazona ochrocephala ochrocephala (Gmelin)

Psittacus ochrocephalus Gmelin, Systema naturae, vol. 1, pt. 1, 1788, p. 339 (South America, restricted to Venezuela by Berlepsch and Hartert, Nov. Zool., vol. 9, 1902, p. 109).

The collector raised a pair of these parrots from nestlings. Although their primaries were clipped from time to time, the birds were otherwise at liberty in the trees around the house. These notes are offered on the breeding habits of this pair:

Nestlings received during first half of February 1945.

First breeding activity noted in late February 1951; believe it quite certain that such activity would not have gone unnoticed during prior years, as birds were under careful observation. Thus this pair was 6 years old when first copulation and egg-laying took place.

	First copulation	*Complete clutch*	*Number of eggs*
1951	c. Feb. 25	c. Mar. 20	3
1952	c. Feb. 8	c. Mar. 25	3
1953	c. Feb. 10	c. Mar. 3	3

Copulation proceeds as follows: Both sit close together side by side for periods of 20 to 45 minutes; caress one another, run bill through neck and crown feathers. Both begin to utter a soft, somewhat modified, nestling food-begging note and to agitate the wings in the manner of young when being fed. Female assumes position, hanging head down at approximately a 45 degree angle. Male with one foot on branch, places other foot on back of female, tails brought together with undersurfaces touching; body of male horizontal, but not covering female, being directed off at an angle of approximately 30 degrees; wings agitated more or less continuously throughout copulation (1–2 minutes?). Female remains motionless throughout copulation, hanging head down as described; wings not agitated. Both continue the modified food-begging note throughout. Copulation is carried on daily, often three or four times a day, throughout February, March, and April, generally in the early morning hours.

Work on the nest cavity was commenced within 3 days after copulation began. Generally female works while male remains outside, but at times both work together. Work continued sporadically, usually in the morning, until eggs are laid, about a month later.

During this time, the parrots become quite ill-tempered toward people, dogs, etc. The (threat?) display used particularly at this time by both may be described as follows: Body erect to horizontal, rarely hanging down from branch, crest and neck feathers erected, wings opened at leading edge, but with flight feathers still folded in near-normal manner over back, tail outspread showing red of inner webs, head often twisted so that yellow crown patch is directed at intruder. Continuous loud calling.

Female does all the incubation, male generally remains in immediate vicinity, often at the entrance itself, but was not seen to enter cavity after incubation began. Female leaves nest in early morning and late afternoon, pair flies in circles around nest site with much loud calling. At times before incubation, and continuously thereafter, the male feeds the female by regurgitation, the female begging food by using the same note as that used by both during copulation, and by agitating the wings. Even when standing beside a plate of food, she commonly begs and receives food from the male, although at times she will eat by herself. The eggs themselves were not fertile and never hatched.

While the foregoing notes are on captive birds, field observations (generally brief glimpses) on nesting dates, nest-building activity, and early morning and late afternoon flights confirm the above observations. Display was observed in the field, but never at the nest site—presumably this is not characteristic. Copulation and feeding of the female were not observed in the field, although fledglings were seen being fed. In this connection, this parrot was observed eating the ripe fruit of *Pereskia guamacho* and *Curatella americana*.

Amazona amazonica amazonica (Linnaeus)

Psittacus amazonicus Linnaeus, Systema naturae, ed. 12, vol. 1, 1766, p. 147 (Surinam, error="le pays des Amazones," Hellmayr, Nov. Zool., vol. 17, 1910, p. 406).

1 ♂, Caicara, May 1. 1950; gonads small; iris orange; bill horn color; extremities dark gray; feet gray; skull well ossified; gizzard contained seeds of *Curatella americana*.

We previously recorded a specimen from Cantaura, and sight records from Caicara. A bird was taken at Caicara chiefly because it seemed to the collector that the call notes of the Caicara birds were lower in pitch than those of the Cantaura area. However, the Caicara specimen differs neither in size nor in coloration from the Cantaura bird.

Family Cuculidae: Cuckoos

Coccyzus melacoryphus Vieillot

Coccyzus melacoryphus Vieillot, Nouv. Dict. Hist. Nat., vol. 8, 1817, p. 271 (Paraguay).

1 immature ♀, Cantaura, August 21, 1949; gonads small; iris dark; bill black; feet dull blue-gray; gizzard contained large grasshoppers and caterpillars; bird in very worn plumage.

This cuckoo was generally seen in two's and three's, and invariably its habitat was the edge of the deciduous seasonal woods. One rainy afternoon a pair were heard uttering a call somewhat similar to that of the yellow-billed cuckoo (*Coccyzus americanus*) but not as loud, and perhaps more rapid. The call may be written *ca-ca-ca-ca-ca-cow-cow-cow.*

Piaya cayana mehleri Bonaparte

Piaya mehleri Bonaparte, Conspectus generum avium, vol. 1, 1850, p. 110 (Santa Fé de Bogotá; emended to Cartagena by Todd, Proc. Biol. Soc. Washington, vol. 60, 1947, p. 59).

Recorded in our earlier (1950) paper as *P. c. columbianus,* which name is now considered a synonym of *mehleri.* On April 17 an incubating bird was seen on a well-built nest of coarse twigs, placed about 15 feet up in a small tree. It was not possible to climb without dislodging the nest so the size of the clutch was not determined.

Crotophaga major Gmelin

Crotophaga major Gmelin, Systema naturae, vol. 1, pt. 1, 1788, p. 363 (Cayenne).

In addition to an aspirate hiss and a low chucking note recorded in our earlier (1950) paper, the greater ani utters a long series of bubbling calls, which reminded the collector of a heron rookery or a group of frogs. Perhaps this bubbling, "boiling" call is the reason for the local name of "hervidor" (hervir—to boil) given by Phelps (1944, p. 290).

Crotophaga sulcirostris sulcirostris Swainson

Crotophaga sulcirostris Swainson, Philos. Mag. (new ser.), vol. 1, 1827, p. 440. (Temascaltepec, México).

Additional observations on this bird are as follows: The groove-billed anis had a nest about 15 feet up in a dense mango tree, which was used off and on throughout the months of August through October. The nest was of twigs, lined with fresh green leaves which the birds brought in even while the nest contained eggs. The eggs were always destroyed prior to hatching, probably by the southern mockingbird

(*Mimus gilvus*) or the Swainson's grackle (*Quiscalus lugubris*) which frequented the tree. Several eggs were found on the ground under the nest site, apparently laid there, as they would have broken in a fall from the nest.

A fledgling was found on September 16; it could barely fly, but could run very well. It uttered a *check-check* note and the *kt-cheeeu* typical of the adults. When a band of adults passed nearby it called frantically and, when released, rejoined the flock without difficulty.

These anis are very active ground feeders. They walk and run rapidly, occasionally giving two or three big hops and run, twisting and turning with the aid of their long tail. At times they fly up to catch an insect a yard above the ground. The flock is generally silent while on the ground, except for strays that have to fly to rejoin the flock. However, when the band takes to flight, the members call repeatedly.

Family STRIGIDAE: Owls

Otus choliba subspecies

1 juv. ♂, Caicara, May 1, 1953; gonads small; bill and feet blue-gray; iris bright yellow.

This specimen is unidentifiable to subspecies. Two possibilities have to be taken into consideration *O. c. crucigerus* (Spix) and *O. c. margaritae* Cory, but an adult bird in good plumage is needed to determine which form occurs at Caicara.

A pair of these owls were found nesting at Caicara, about 15 feet up in a hollow tree at the road edge in deciduous woods. On March 25 the nest contained three half-grown young. This is the only time this little owl was recorded by the collector. Apparently, the call note is not similar to that of the North American screech owl (*Otus asio naevius*) or he would scarcely have overlooked the bird during the past years. At the nest, the parent bird uttered a soft hoot, repeated at rare intervals. Since this owl's eyes do not shine at night in the light of a hunting lantern, the bird was very difficult to locate. The young bird, taken from the nest, gave an aspirate call very similar to that of the barn owl (*Tyto alba*). If the adults give this call, it may be that the collector has, at times, misidentified its author, and that some of his *Tyto* records actually belong to the present form.

Bubo virginianus scotinus Oberholser

Bubo virginianus scotinus Oberholser, Mus. Brooklyn Inst. Arts Sci., Sci. Bull., vol 1, 1908, p. 371 (Caicara, Río Orinoco, Venezuela).

1 ♂, Cantaura, September 20, 1949; skull well ossified; gonads small; iris yellow; bill black; feet pale blue-gray; gizzard contained a lizard about 12 inches long, and grasshoppers.

1 ♀, Cantaura, July 5, 1950; skull well ossified; gonads somewhat enlarged; iris dull yellow; bill black; gizzard contained a small snake.

In our 1950 report we recorded a young bird from Cantaura. Because of its immaturity it was not possible to ascertain to which race it belonged. The area of origin is more or less intermediate between the range of *B. v. scotinus* and *B. v. elutus*. For aiding us in critically determining the racial allocation of our present specimens we are indebted to Dr. John T. Zimmer, who informs us that they agree with the type and with four specimens of *scotinus* from British Guiana—two from Surinam, and one from Mérida, Venezuela.

At Cantaura, shortly before sunset one was heard and seen calling. The call was identical in tone with those of this owl in eastern North America but consisted of four notes, *hoo, hoohoo, hoo.* It is not certain that this is typical of the present race, as these owls are not common in the collector's area, and are rarely heard. Peterson (1947, p. 133) gives the call of the North American races of the great-horned owl as "three, five, or six uninflected hoots," usually five, *hoo, hoohoo, hoo, hoo.*

Glaucidium brasilianum phaloenoides (Daudin)

Strix phaloenoides Daudin, Traité élémentaire et complet d'ornithologie, vol. 2, 1800, p. 206 (Trinidad).

No further specimens were collected, but three nests were found, all in hollowed-out termite nests. Two were found at Cantaura, one about 40 feet above the ground, containing young (March 25), and one about 20 feet up, containing three eggs (April 25). Both adults were at the latter nest site, one in the nest hole and the other either also in the hole or close to the entrance. The third nest was found at Barcelona about 100 yards from the seacoast and about 10 feet above the ground; it contained two eggs (May 28).

Rhinoptynx clamator clamator (Vieillot)

Bubo Clamator Vieillot, Histoire naturelle des oiseaux de l'Amérique septentrionale, vol. 1, 1807, p. 52, pl. 20 (Cayenne).

1 ♀, Caicara, March 11, 1950; gonads small; skull well ossified.

The present example was taken at night in a large open field, near deciduous seasonal woods. It was quietly perched on top of a tall pole, apparently hunting in this manner rather than coursing back and forth across the field in the manner of the barn owls (*Tyto alba stictica*) which were also present.

Family NYCTIBIIDAE: Potoos

Nyctibius grandis (Gmelin)

Caprimulgus grandis Gmelin, Systema naturae, vol. 1, pt. 2, 1789, p. 1029 (Cayenne). Specimen collected.

1 ♀, Caicara, December 28, 1952; gonads somewhat enlarged (small ovarian yolks); skull not well ossified; bird very fat.

This specimen is in the pale phase and agrees very closely with one from the Rio Cauaburi in northern Brazil, less so with a darker bird from San Antonio, on the upper Orinoco.

The giant potoo is a rare bird in the study area as the present example is the only one seen in approximately 8 years of observing and collecting. It was taken in an open field in the midst of deciduous woods. When shown to experienced local hunters, quite familiar with the smaller *Nyctibius griseus*, all were agreed that they had never seen the species before.

Family Trochilidae: Hummingbirds

Phaethornis anthophilus anthophilus (Bourcier)

Trochilus anthophilus Bourcier, Rev. Zool., 1843, p. 71 (upper Magdalena Valley, Colombia).

1 ♀, Caicara, June 6, 1950; gonads enlarged, brood patch evident; iris dark; maxilla and tip of mandible black, rest of mandible bright orange.

1 ♀, Caicara, April 26, 1953; gonads somewhat enlarged, brood patch evident; iris dark, maxilla black, mandible dull orange with black tip.

In our earlier report we commented on the long median rectrices of a specimen from Caicara. Since then, two others from the eastern end of the range of this hummingbird have been examined and measured. The results suggest that in the birds from the eastern part of the range the central tail feathers tend to become longer, but the variation in Colombian birds is so great that until more abundant Venezuelan material is available it seems unwise to attempt to divide the eastern birds from typical *anthophilus*. Inasmuch as our three northeastern Venezuelan examples are all females, the measurements of specimens of that sex only are given below.

Venezuela: Caicara (3), median rectrices 60, 64, and 73.1 mm. Colombia: Lower Magdalena (1), 50 mm.; Magdalena, El Conejo (1), 43 mm.; Bolivar, Norosi (1), 42 mm., and La Raya, Río Cauca (1), 53 mm.; Guajira, Nazaret (2), 47, 50 mm.; Santander del Norte, Petrolea (1), 54.5 mm.; Río Tarra (1), 54 mm., and Villa Felissa (1), 76 mm.

The last specimen listed, from Villa Felissa, has the tail even longer than any of the northeast Venezuela birds. If one could discount it as wrongly sexed, the difference between typical *anthophilus* and the Caicara population would be striking indeed. However, it would be unusually long for males as well. Thus, a male from Santa Marta, Colombia, has the median rectrices 60 mm. long, another from Espinal, Tolima, Colombia, measures 57 mm., and a male from Ocumare de la Costa, central northern Venezuela, has these feathers 62 mm. long.

Anthracothorax prevostii viridicordatus Cory

Anthracothorax prevosti viridicordatus Cory, Field Mus. Nat. Hist., Publ. Orn. Ser., vol. 1, 1913, p. 286 (El Panorama, Río Aurare, Venezuela).

1 ♂, Cantaura, August 15, 1953; gonads small, skull well ossified; bird very fat; bill and feet entirely black; iris dark.

The single specimen obtained was sent to Dr. John T. Zimmer for identification, as no material of *viridicordatus* was available to us. He informs us that it is a somewhat immature male of *viridicordatus*, and agrees with adult males in his series except that the tail is bluer, less purplish, a difference that may be due to immaturity.

The crop of the bird contained 15 hemiptera, 3 gall wasps, 5 aphids, and 1 tiny spider.

Polytmus guainumbi guainumbi (Pallas)

Trochilus guainumbi Pallas, *in* Vroeg, Catalogue . . ., Adumbr., 1764, p. 2 (Cape of Good Hope, error=Surinam, cf. Richmond, Smithsonian Misc. Coll., vol. 47, 1905, p. 344).

1 ♂, Cantaura, March 7, 1952; gonads small; iris dark.

At Cantaura and Caicara this low-flying hummingbird was typically encountered on the open savanna and in extensive clearings in the edge habitat, wherever the ground cover was composed of low grasses and other herbaceous plants. It was a rapid feeder, rarely remaining more than a brief moment at any one place, rapidly flying long distances (50 to 100 feet) between feeding stops. It was uncommon, or at least rarely recorded; perhaps, since it flew so close to the ground, it was often simply overlooked by the collector.

Leucippus fallax richmondi Cory

Leucippus fallax richmondi Cory, Field Mus. Nat. Hist., Publ. Orn. Ser., vol. 1, 1915, p. 303 (new name for *Leucippus pallida* (Richmond) 1895, not of Taczanowski, 1874; Margarita Island).

1 unsexed, Barcelona, January 26, 1952; maxilla and tip of mandible black, rest of mandible pale red; feet black; iris dark.

This specimen, taken within a hundred yards of the seacoast, is unusually dark. It was kindly identified for us by Dr. Zimmer, who compared it with numerous examples of *richmondi* from the Cumaná region. It is more deeply colored than were the Cumaná birds, but not enough so to match *occidentalis*, and even more decidedly different from *fallax*, which occurs between the other two races. It is therefore best referred to *richmondi*.

Amazilia chionopectus chionopectus (Gould)

Thaumatias chionopectus Gould, Monograph of the Trochilidae, pt. 18, September 1859, p. [8] and text [=5, pl. 293 of volume] (Trinidad).

1 ♀, Caicara, June 6, 1950; gonads enlarged, brood patch evident; iris dark; bill and feet black.

This little white-bellied hummingbird was common at times at Caicara, although only recorded in June, October, and November, probably having been overlooked in other months. The call is not at all that which one would expect of a tiny hummer; it was a rather loud *diddle-ee, diddlee, diddle-ee,* rather like that of *Euscarthmus* *meloryphus.* Often three or four birds would be calling at the same time, generally while perched rather than while flying. The preferred habitat was groups of small trees at the savanna edge. The form was recorded only at Caicara.

Amazilia fimbriata maculicauda (Gould)

Thaumatias maculicaudus Gould, Introduction to the Trochilidae, 1861, p. 154 (British Guiana).

The following observations add to our earlier notes: Six nests were found, two about 10 feet up, while the remainder were at less than 3 feet above the ground. Especially in January and February, groups of five and six birds could be seen chasing each other, and apparently copulating on the wing. In chasing each other, they uttered a very typical call, a loud *peep-peep* running up and down the scale, somewhat in the manner of contented chicks under a brooding hen. Of the four common hummingbirds of the deciduous woods, *Chrysolampis mosquitus, Chlorostilbon canivetii caribaeus, Amazilia tobaci aliciae,* and the present species, the first three feed typically at the flowers of high trees; the *Amazilia fimbriata* is a low feeder.

Family Trogonidae: Trogons

Trogon strigilatus strigilatus Linnaeus

Trogon strigilatus Linnaeus, Systema naturae, ed. 12, vol. 1, 1766, p. 167 (Cayenne).

In addition to the specimen recorded by us earlier, a female was shot on May 25, but was too damaged to be saved. The gonads were slightly enlarged, but not as much as in a breeding bird. The specimen was actively molting.

Family Alcedinidae: Kingfishers

Ceryle torquata torquata (Linnaeus)

Alcedo torquata Linnaeus, Systema naturae, ed. 12, vol. 1, 1766 p. 180. (Martinique and México).

No additional specimens were collected, but a pair was observed digging a nest hole during the middle of January. There were four or five of the tunnels about 30 feet up in a 50-foot perpendicular bank at the river's edge.

The commonest call of this kingfisher was a harsh, rapidly repeated *kit-ti, kit-ti.*

Family GALBULIDAE: Jacamars

***Galbula ruficauda ruficauda* Cuvier**

Galbula ruficauda Cuvier, Règne animal, vol. 1, 1817, p. 420 ("La Guyane"; Cayenne).

This jacamar, a specimen of which was included in our earlier report, has a decided preference for the deeper woods, especially gullies and river bank areas. However, its distribution during the nesting season shows that then the need for approximately perpendicular banks becomes great; these need be no higher than from 3 to 6 feet. No nesting holes were ever seen in higher banks (from 10 to 20 feet) frequented by kingfishers. On April 20 a pair were found nesting almost at the top of a barren hill near Puerto La Cruz, where, in the course of construction of a new road, a sharp bank had been cut in the side of the hill.

Family BUCCONIDAE: Puffbirds

***Hypnelus bicinctus bicinctus* (Gould)**

Tamatia bicincta Gould, Proc. Zool. Soc. London, 1836 (1837), pt. 4, p. 80 (Cayenne ?=Venezuela).

To our earlier statements about this puffbird the following notes are added: This 2-banded puffbird has a very curious manner of swinging its tail; it perches quietly, motionless, and then swings its tail from side to side in a series of three or four abrupt jerks. Thus, beginning at a 4-o'clock position, the tail is "clicked" into the 5- 6-, 7-, and 8-o'clock positions, and then "clicked" back again to the 4-o'clock position. This was a quiet bird, but one was observed uttering a rhythmic *tak-ta-tooo* repeated over and over, with the accent on last syllable.

Family PICIDAE: Woodpeckers

***Chrysoptilus punctigula punctipectus* Cabanis and Heine**

Chrysoptilus punctipectus Cabanis and Heine, Museum Heineanum, vol. 4, 1863, p. 163 (Venezuela).

Further familiarity with this woodpecker in life leads the collector to observe that it is reminiscent of the flicker (*Colaptes auratus*) not only in coloration but also in habits, as it is commonly seen on the ground, feeding at ant-hills. In addition to a low harsh *peeek*, this bird utters a loud, whistled *tu-tu-tu-tu-tu-tu*, also rather flickerlike.

***Phloeoceastes melanoleucos melonoleucos* (Gmelin)**

Picus melanoleucos Gmelin, Systema naturae, vol. 1, pt. 1, 1788, p. 426 (Surinam).

1 ♀, Cantaura, October 15, 1951; gonads small; iris yellow; feet gray-green; bill blue-gray; adult bird in worn plumage.

This woodpecker is so similar in general appearance to *Dryocopus lineatus*, previously recorded by us from Cantaura that the relative abundance of each in the study area is uncertain, since too large a percentage of the sight records are thereby put in doubt. The somewhat lighter colored bill of *Phloeoceastes* appears to be its best field mark.

Family FURNARIIDAE: Spinetails, Ovenbirds

Xenops rutilus heterurus Cabanis and Heine

Xenops heterurus Cabanis and Heine, Museum Heineanum, vol. 2, 1859, p. 33 ("Columbia"? Bogotá, Salvin, Ibis, 1809, p. 319).

1 juvenal unsexed, Caicara, May 25, 1952; gonads very small; skull soft; maxilla brown, mandible horn color; feet dark gray; gizzard contained (wood-boring?) beetle larvae.

While the specimen reported in our previous publication was taken in the densest part of the lowland seasonal forest, the present example was found in very sparse deciduous seasonal woods, near the open savanna.

Family FORMICARIIDAE: Ant-thrushes

Thamnophilus doliatus fraterculus Berlepsch and Hartert

Thamnophilus doliatus fraterculus Berlepsch and Hartert, Nov. Zool., vol. 9, 1902, p. 70 (Altagracia, Venezuela).

The following observations by the collector add to our knowledge of the habits of this bird: On July 31, a male was observed about 10 feet up in a bush "displaying" to a *Volatinia jacarina* somewhat below. The display was very striking, even from a distance. Crest erect, body feathers fluffed out, body horizontal, the bird would "quiver" forward, somewhat as if in the act of copulation, tail being raised and lowered as body shifted forward. No sound was heard, (the collector was not very near) but the bill was opened. A white supercilliary line was very apparent when the crest was so raised.

Family COTINGIDAE: Chatterers

Pachyramphus polychopterus tristis (Kaup)

Psaris marginatus tristis Kaup, Proc. Zool. Soc. London, vol. 19, 1851 (October 1852), p. 48 (no locality stated; Cayene suggested by Bangs and Penard, Bull. Mus. Comp. Zool., vol. 64, 1921, p. 387).

1 ♂, Caicara, May 15, 1952; one testis enlarged, one atrophied; iris brown; bill blue-gray; feet black.

1 ♀, Cantaura, October 20, 1952.

This form was found in the dense lowland seasonal forest at Caicara and in the sparse deciduous seasonal woods at Cantaura. The two examples collected were the only ones seen.

Tityra cayana cayana (Linnaeus)

Lanius cayanus Linnaeus, Systema naturae, ed. 12, vol. 1, 1766, p. 137 (based on "La Pie-griesche grise de Cayenne," Brisson, Ornithologia, vol. 2, 1760 p. 158, pl. 14, fig. 1 (=male); Cayenne).

1 ♂, Caicara, June 4, 1952; gonads slightly enlarged; iris brown; feet black, facial skin and bill red, the tip of the bill black.

The specimen collected, in the deciduous seasonal woods, was the only one seen. Local hunters believed it was the "campanero" (bell-ringer) supposedly common in the hills toward Caripe.

Family PIPRIDAE: Manakins

Chiroxiphia lanceolata (Wagler)

Pipra lanceolata Wagler, Isis, 1830, p. 931 ("Guiana sive Cajenna," error).

To what we recorded of this bird in 1950 may be added these notes: On May 25 two males were observed by the collector displaying in the immediate vicinity of a female, which, incidentally, appeared to show not the slightest interest. The males were perched about two feet apart on a branch about a foot above the ground. They faced each other, with raised crests, and, alternately, one would flutter up in a semisomersault in such a manner as to show the sky-blue back to his rival, uttering at the same time a peculiar insectlike buzz, quite different from the whistled *beni? toro-toro toro* usually given. The jet-black bodies, bright red crests, and powdery-blue backs formed a striking pattern as the birds displayed.

After checking other field notes, the collector believes he has seen portions of the same display, performed high in the trees.

Family TYRANNIDAE: Tyrant Flycatchers

Machetornis rixosa flavigularis Todd

Machetornis rixosa flavigularis Todd, Ann. Carnegie Mus., vol. 8, 1912, p. 210 (Tocuyo, State of Lara, Venezuela).

Formerly this strange flycatcher was rather uncommon, remaining in the vicinity of water, rarely far from cattle and burros. Now it has become common in the well-watered oil company camps and, instead of following animals, it has taken to capturing disabled or freshly killed insects at parked automobiles and to capturing insects which were attracted to lights during the previous night. Like the groove-billed ani (*Crotophaga sulcirostris*), it has also taken to following men mowing the lawns. These birds are often seen in trios. During the period from April to July they were seen displaying and chasing one another. The birds face one another in a curious, hunched position, crown feathers spread to show the reddish concealed crest, and feathers of the upper back erected. Their bulky nests of grass were placed under the eaves of houses, and in the crotch formed by the basal portion of palm leaves.

Muscivora tyrannus (Linnaeus)

Muscicapa tyrannus Linnaeus, Systema naturae, ed. 12, vol. 1, 1766, p. 325 (Surinam).

Two races of the fork-tailed flycatcher are here involved. For the sake of clarity and convenience we shall list the specimens under each of the two races and then combine the discussion of both.

Muscivora tyrannus tyrannus (Linnaeus)

Muscicapa tyrannus Linnaeus, Systema naturae, ed. 12, vol. 1, 1766, p. 325 (Surinam).

2 ♂, 3 ♀, Cantaura, August 4, 6, 12, 1950, and July 17, 1952; all birds are young; all with small gonads and incompletely ossified skulls; iris dark brown; bill black with the remnant of the gape dull yellow; feet black.

Muscivora tyrannus monachus (Hartlaub)

Tyrannus (*Milvulus*) *monachus* Hartlaub, Rev. Zool., vol. 7, 1844, p. 214 (Guatemala).

2 ♂ adults, Caicara, May 15, July 20, 1952; gonads small in July specimen; fairly enlarged in May bird.

1 nestling, partly grown, Caicara, May 26, 1952; iris brown; bill and feet brown.

1 nest, Caicara, May 26, 1952.

Apparently, there is little information in literature about the nesting of the fork-tailed flycatcher *M. tyrannus*, except in the southern part of its range in Argentina. In fact, even the breeding in Venezuela of the resident race, *M. tyrannus monachus* (Hartlaub), appears to be unsubstantiated. Cherrie (1916, p. 246) fails to include it in his long list of birds breeding in the Orinoco region. Chubb (1921, vol. 2, p. 237) states that its nesting is unknown in British Guiana. Belcher and Smooker (1937, p. 228) did not find it breeding in Trinidad. Zimmer (1937, p. 6) was unable to determine whether it breeds in Venezuela and, as a matter of fact, appears to have had at hand only one breeding record for Colombia, that of Salmon (no date). In discussing the breeding range of *M. tyrannus tyrannus* (Linnaeus), Zimmer based his conclusions on plumage and gonadal condition, as no eggs or nests were available. Dugand apparently has not treated the problem, nor, for that matter, has Phelps, except to consider *monachus* as the resident race of Venezuela, and *tyrannus* as the migrant race from austral South America (Phelps and Phelps, 1950). Considering the striking appearance and the relative abundance of this flycatcher, as well as the accessibility of its habitat, the paucity of information regarding its breeding habits is indeed surprising.

Therefore, we believe it of interest to record that a nest of the resident race, *M. tyrannus monachus*, was found at Caicara, Monagas, Venezuela, on May 25, 1952, a date which corresponds with that given by Cherrie as the breeding date for the same race in Costa Rica (Zimmer, 1937, p. 6).

The nest was found on the savanna, in a locality sparsely covered with "chaparro" trees (*Curatella americana* L.). It was placed in one of these trees, at the end of a branch, about four feet above the ground. The nest was of bulky construction, approximately 15 cm. outside diameter, 6 cm. inside diameter, and 8 cm. deep, composed of coarse grasses with many feathers woven into it, and lined with slightly finer grasses. At the time of discovery, it contained three well-feathered nestlings.

Through the courtesy of Mr. William Phelps, the junior author has examined the magnificant collection of Venezuelan birds in the Colección Phelps at Caracas, Venezuela. Of the series of *monachus*, collected throughout the year, the June specimens had enlarged gonads. One immature specimen, taken in October at Cerro Upuima, Bolivar, was so young it could almost be classified as a nestling. This fact, in conjunction with the nestling skin of May 25, appears to substantiate a breeding period of May through September. In the same collection, *M. tyrannus tyrannus* is represented by skins from May through October inclusive, with one immature specimen taken in March. Thus, *tyrannus* is present in Venezuela, and in approximately the same habitat, during the breeding season of *monachus*. Actually, while both are birds of the open country and are occasionally encountered together, the concentrations of typical *tyrannus* in eastern Venezuela are found in the vicinity of wooded country, whereas *monachus* prefers the open short-grass savanna dotted here and there with stunted "chaparro." As a rule, the flocks do not have an opportunity to mix with one another. A perhaps extreme example of the seasonal concentration of *tyrannus* occurs at Carpito, Monagas, where the Creole Petroleum Corporation has established a large camp in the lowland seasonal forest, with the resultant clearing of the surrounding woods. This area, particularly the golf course, is regularly visited by a large concentration of *tyrannus*, whereas *monachus* has apparently not been able to invade the area.

The race *tyrannus* is abundant locally on the northeastern Venezuelan plains from July through September, generally in flocks of 1,000 to 5,000 birds; in contrast *monachus* is rarely found in flocks of more than 50 individuals. During this time the gonads of the adult *tyrannus* are small, while those of *monachus* are enlarged. It is to be noted that the young *tyrannus* arrive with the adults and form a large percentage of the July concentrations. Zimmer (1937, p. 3), speaking of the birds of Argentina and Paraguay, places the breeding season as November through January. However, the collector believes the immature birds present in his region in July may be younger than the minimum of 6 months Zimmer's estimate would necessitate. He bases this opinion on the general appearance of fresh-killed birds, especially the appearance of the gape. Such a conclusion, if correct, would lead one to suspect that the breeding season of the *tyrannus* reaching Venezuela extends later than the season suggested by Zimmer, or that these migrants may be from a population breeding much closer to the equator (perhaps the east coast of Brazil), a population to which Zimmer has already drawn attention, or possibly even from the upper Orinoco region of Venezuela.

Thus, we have here an abundant species divided into extremely similar continental races, and we find two races in the same area during the breeding season of one. While Mayr (1942, pp. 199, 253) states that this is of fairly common occurrence in birds, the only examples he gives are of island races geographically isolated by water. The possibility exists that the breeding ranges of these two races are not geographically isolated, as we know of no effective barrier between the ranges. On the other hand, we know of no zone of integration, with intermediate populations. It is possible that at some point between the now-known breeding ranges both may be breeding races in the same area but during different months of the year, being reproductively isolated one from the other principally by different breeding seasons in the manner foreseen by Mayr (1942, page 199), who states: "It is thinkable that a race, whose range extends from the equator southward and which nests from September to November, overlaps near the equator the range of another subspecies, whose range extends from the equator northward and which breeds from February to May. No definite cases are known, but Dr. Chapin tells me that some indirect evidence points to its occurrence in two African species." We may here have a similar case in South America. In this connection, we point out that in the upper Orinoco region, near the Venezuelan-Brazilian border, the two races are present together in February and March (Friedmann, 1948, p. 500), and that in northeastern Venezuela during these months *tyrannus* is absent (or extremely casual) arriving there in late June to early July.

Even without direct breeding evidence, gonadal and plumage condition of additional specimens collected in southern Venezuela and north to central Brazil should shed light on the breeding seasons and ranges of these two races, and we look forward with interest to the findings of future expeditions.

Tyrannus melancholicus chloronotus Berlepsch

Tyrannus chloronotus Berlepsch, Ornis, vol. 14, 1907, p. 479 (Temax, Yucatán).

Inasmuch as this form presented no taxonomic problems, it was not considered necessary to collect additional specimens.

Members of this genus are noted for their habit of chasing hawks, and on one occasion the collector observed a pair attacking an aplomado falcon which had just attacked and badly wounded a ground dove (*Columbigallina passerina*). The dove had somehow escaped and had hidden under several weeds, leaving a trail of feathers behind. The falcon was waiting in a nearby tree when the kingbirds attacked it and finally forced it to leave the area. This falcon, which is capable of capturing pigeons in flight, attempted to fight off the kingbirds, but was apparently unsuccessful because it divided its efforts between the two birds. There appears to be no other reason why it could not have killed them.

On another occasion one was observed attacking a flock of swallow-tailed kites (*Elanoides forficatus*) soaring high above.

Megarhynchus pitangua pitangua (Linnaeus)

Lanius pitangua Linnaeus, Systema naturae, ed. 12, vol. 1, 1766, p. 136 (based on Brisson (ex Marcgrave), eastern Brazil).

Further observation causes us to revise our previous estimate of this bird from "probably not uncommon" to common, in the deciduous woods-edge environment. It is not as strictly limited by the presence of surface water as is the "cristofue" (*Pitangus sulphuratus rufipennis*). Its call is a harsh, insectlike *chreereererr*.

Pitangus sulphuratus rufipennis (Lafresnaye)

Saurophagus rufipennis Lafresnaye, Rev. Mag. Zool., ser. 2, vol. 3, 1851, p. 471 (Caracas).

As we mentioned in our earlier report the birds of the study area are *rufipennis* and are not intermediate between this race and *trinitatis*.

These large flycatchers were not averse to coming to the collector's feeding station and eating cooked rice, bread and milk, bananas, and papaya. Their large, globular nests of grass are often seen in the telephone poles between Puerto La Cruz and San Tomé.

Platyrinchus mystaceus insularis Allen

Platyrhynchus insularis Allen, Bull. Amer. Mus. Nat. Hist., vol. 2, 1889, p. 143 (Tobago).

1 ♂, immature, Caicara, October 12, 1949; gonads small; skull not well ossified; iris brown; bill dark brown with the base of the mandible dull yellow; feet pale tan.

This little flycatcher was not common in the deciduous seasonal woods at Caicara, it was not found around Cantaura. The call was a harsh, rather loud, but not at all flycatcher-like *squeeeek*.

Tolmomyias sulphurescens exortivus (Bangs)

Rhynchocyclus sulphurescens exortivus Bangs, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 163. (La Concepción, Santa Marta).

1 ♀, Caicara, May 20, 1952; gonads slightly enlarged; iris pale yellow-white; macilla black, mandible horn color; feet black.

An adult bird in fairly fresh plumage.

This flycatcher was fairly common locally in the deciduous seasonal woods at Caicara during May. Its call note was a weak *shree*.

Sublegatus arenarum orinocensis Zimmer

Sublegatus glaber orinocensis Zimmer, Amer. Mus. Novitates No. 1109, May 15, 1941, p. 5 (Altagracia, Río Orinoco, Venezuela).

1 ♂ juvenal, Caicara, May 20, 1950; gonads small; skull not well ossified; base of bill soft; iris brown; feet and bill black.

Dr. J. T. Zimmer kindly identified this young bird for us. The posterior lower parts are whitish, not yellow as in the adults and the upperparts also lack the yellowish tone of mature birds, being dingy brown with narrow white tips to the feathers.

Camptostoma obsoletum venezuelae Zimmer

Camptostoma obsoletum venezuelae Zimmer, Amer. Mus. Novitates No. 1109, May 15, 1941, p. 12 (La Cascabel, Río San Félix, Venezuela).

1 ♀, Caicara, March 15, 1953; gonads enlarged; skull well ossified; bird rather fat; iris brown; bill dark brown; feet black.

In our 1950 report we noted that the collector experienced difficulty in distinguishing the present form from *Phaeomyias murina incompta*. Further experience with both birds has greatly reduced the difficulty. The *Camptostoma* is an active little flycatcher, which may be readily observed in the upper portions of the leafless trees of March and April, repeatedly calling *swees-swees-sweesweeswees* on a descending scale. The *Phaeomyias*, on the other hand, is relatively quiet, preferring the lower bushes, often well inside the foliage. The call recorded was a thin, even *peeeet*.

Family Hirundinidae: Swallows

Pygochelidon cyanoleuca patagonica (Lafresnaye and d'Orbigny)

Hirundo patagonica Lafresnaye and d'Orbigny, Synopsis avium, pt. 1, *in* Mag. de Zool., vol. 7, cl. 2, 1837, p. 69 (Patagonia=Río Negro).

1, unsexed, Barcelona, May 25, 1951; bird rather fat; iris, bill, and feet dark brown; a bird in worn plumage, molting the body feathers.

This specimen was collected on the seacoast at Barcelona, out of a flock of over a hundred birds. During the second week of June

1954, at Naricual, Anzoátegui, about 15 kilometers from where the specimen was taken, a flock of over 500 of these swallows roosted on the telephone lines crossing the Neverí River; June 15 was the last day they were seen. Some of the birds were approaching breeding plumage. The flock did not remain in the area and was apparently a nomadic, if not migrant, flock similar to that from which our specimen was collected.

Family TROGLODYTIDAE: Wrens

Thryothorus rutilus rutilus Vieillot

Thryothorus rutilus Vieillot, Nouv. Dict. Hist. Nat., nouv. ed., vol. 34, 1819, p. 55 ("l'Amérique septentrionale," error, = Trinidad).

1 ♂, Caicara, June 6, 1950, gonads greatly enlarged; broad patch evident; iris chestnut; bill and feet blue-gray; gizzard contained insects.

This striking wren was present in favored, overgrown spots on the Guarapiche River at Caicara, especially where tiny feeder streams or springs gave rise to a growth of ferns or *Heliconia*. The song is very different from that of *Thryothorus rufalbus*. Rather than a series of hollow, placeless notes, this form had a gay, loud whistle, *oooeeeeherrr-tiddlier*, commencing low and slurring rapidly upwards, and down again, followed by a trill.

Family MIMIDAE: Mockingbirds, Thrashers

Mimus gilvus melanopterus Lawrence

Mimus melanopterus Lawrence, Ann. Lyc. Nat. Hist. New York, vol. 5, 1849, p. 35, pl. 2 (Venezuela).

We add to the detailed observations recorded in our 1950 paper the following data: An example was captured alive and marked with India ink. Judged by its actions later, it was a male. Its territory was found to be a square, approximately 200 by 200 feet, which it was never seen to leave. Its favorite song perches were all in the central part of this square. At times it defended the territory against almost all other mockingbirds, while at other times it allowed trespassing. During the first week of March it was observed nest-building, gathering the material (often at the very base of the bush) and constructing the nest. While the female (?) accompanied the male at the feeding station, she was not observed building the nest. This is at variance with our previous report on the nest-building habits of this form, where both male and female took part in the work. The nest was destroyed before the eggs were laid, so further observations were not possible.

Family TURDIDAE: Thrushes

Turdus fumigatus aquilonalis (Cherrie)

Planesticus fumigatus aquilonalis Cherrie, Mus. Brooklyn Inst., Sci. Bull., vol. 1, 1909, p. 387 (heights of Aripo, Trinidad).

1, unsexed, Caicara, November 16, 1952; skull well ossified; iris, feet, and bill dark brown. Adult bird in somewhat worn plumage.

Recorded only in the heavy woods along the Guarapiche River at Caicara. The collector examined with binoculars every thrush he saw in the hopes of collecting this form. Finally, hearing an unknown rapidly repeated wrenlike *chickity-reckity-rik*, he made a squeaking noise; the bird flew up and was taken. Like many other forms (*Ara ararauna*, and *Myrmeciza longipes*, for examples) this bird appears to be at the very edge of its habitat at Caicara, presumably becoming more common in the lowland seasonal forest toward Quiriquire and Caripito.

Family COEREBIDAE: Honeycreepers

Conirostrum bicolor bicolor (Vieillot)

Sylvia bicolor Vieillot, Histoire naturelle des oiseaux de l'Amérique septentrionale, vol. 2, 1807, p. 32, pl. 90 bis (Cayenne; suggested by Hellmayr, Catalogue of the birds of America, pt. 8, 1935, p. 318).

1, unsexed, Barcelona, October 28, 1951.

1, unsexed, Barcelona, January 26, 1952; iris russet; bill dark gray; feet flesh color; gizzard contained fine seeds.

This species was recorded only on the coast at Barcelona.

Family PARULIDAE: Wood Warblers

Seiurus noveboracensis noveboracensis (Gmelin)

Motacilla noveboracensis Gmelin, Systema naturae, vol. 1, pt. 2, 1789, p. 958 (based on the New York warbler, Latham, General synopsis of birds, vol. 2, pt. 2, p. 436). (In Louisiana, et Noveboraci sepibus=New York.)

1 ♀, Caicara, December 15, 1952; gonads small; skull not well ossified; bird thin, not fat; iris and bill brown; feet light brown.

Judging by the olive tone of the upper parts, the amount of yellow on the underparts, and the size of the specimen, our bird appears to belong to the nominate subspecies. Both this form and the race *notabilis* winter in Venezuela; the races are not distinguishable in the field, and hence all that the collector can say is that the species was recorded on the Guarapiche River at Caicara from December through the first week of April.

Family Icteridae: Troupials

Psomocolax oryzivorus oryzivorus (Gmelin)

Oriolus oryzivorus Gmelin, Systema naturae, vol. 1, pt. 1, 1788, p. 366 (based on the rice oriole, Latham, General synopsis of birds, vol. 1, pt. 2, p. 423 (Cayenne).)

1 ♂, Caicara, May 1, 1950; gonads greatly enlarged; iris orange; feet and bill black; gizzard contained corn.

A pair was seen at the edge of a cornfield, and one of them, the present specimen, was taken. The species was not otherwise observed, although the local farmers appeared to know the bird.

Molothrus bonariensis venezuelensis Stone

Molothrus venezuelensis Stone, Auk, vol. 8, 1891, p. 347 (Venezuela; type from Lago de Valencia).

Since our 1950 report was written, more has been learned of the habits of this cowbird. It is another form which has become much commoner during the last few years, apparently due to the abundance of water at the oil company camps. Flocks of more than 10 birds were not reported up to 1950, whereas in the succeeding years flocks of over 100 individuals were not rare.

The male often displays by flying in tight circles (about 15 feet in diameter) around the female (in one case, around a dead *Sicalis flaveola*). Usually, the female is on the ground, and the male's circle is described about 2 or 3 feet above the ground. The female inclines slightly, raising the tail and at times walking toward the male. At times the male sings while displaying, and often sings while in flight. The song is quite pleasing, weak but musical.

The collector reports that this cowbird parasitizes the grackle *Quiscalus lugubris*. This is interesting because the parasitism reported is on a large scale, and apparently, at least locally, the *Quiscalus* seems to be the exclusive host. In this case the host is the slightly larger bird and belongs to the same family as the parasite. The *Quiscalus* come to the feeding station with their young, about 25 percent of which are *Molothrus*; these flock with their foster parents for a time and then, still in the same dress, slowly leave to join the flocks of *Molothrus*. Unfortunately, no specimens were taken.

Agelaius icterocephalus icterocephalus (Linnaeus)

Oriolus icterocephalus Linnaeus, Systema naturae, ed. 12, vol. 1, 1766, p. 163 (based on "Le Carouge à teste jaune de Cayenne" Brisson, Ornithologia, vol. 2, 1760, p. 124, pl. 12, fig. 4 (Cayenne).)

1 ♂, Quiriquire, October 1, 1949; gonads small; iris dark; bill and feet black; plumage abraded.

Small flocks of less than 10 individuals were observed in marshes at Quiriquire, Monagas, and between Barcelona and San Mateo, Anzoátegui. There are no suitable marshes around Cantaura or Caicara.

Family THRAUPIDAE: Tanagers

Tanagra laniirostris crassirostris (Sclater)

Euphonia crassirostris Sclater, Proc. Zool. Soc. London, vol. 24 (1856), 1857, p. 277 (New Grenada, Bogotá).

1 ♂, Caicara, May 26, 1952; gonads enlarged; iris dark; feet black; bill black with base of mandible dull dark blue; gizzard contained very fine seeds (grass? or grains of pollen?), no mistletoe.

Previously recorded by us as apparently uncommon, this bird has been found subsequently to be quite common in the deciduous seasonal woods at Caicara. At Cantaura it was also present, but much less numerous. Its high whistled calls are very similar to those of *Tanagra chlorotica trinitatis*, and the two species are generally quite difficult to distinguish in the field.

A nest of this tanager was found at Caicara on April 25. It was a domed affair of fine twigs, placed about 6 feet up on the top of a fence post, a timber about 8 inches in diameter which had become sufficiently hollowed to allow the bird to build the nest on top. The bird was observed closely, for it remained in the immediate vicinity of the nest uttering its high whistled *feen feen* notes in protest. This is not the first time the collector has seen such nests in similar positions.

Ramphocelus carbo capitalis Allen

Ramphocoelus atrosericeus capitalis Allen, Bull. Amer. Mus. Nat. Hist., vol. 4, 1892, p. 51 (El Pilar, near Carupano, Sucre, Venezuela).

1 ♂, Caicara, May 15, 1952; gonads enlarged; iris red-brown; feet, maxilla, and top of mandible black, the rest of mandible blue-white.

Adult bird in somewhat worn plumage.

The collecting of an adult male makes it possible to identify the local population as definitely *capitalis;* in our 1950 report we were unable to be so definite as our only example was a young female.

This tanager was found only in or near the heavy lowland forest at Caicara, where it was locally fairly common.

Tachyphonus luctuosus luctuosus Lafresnaye and D'Orbigny

Tachyphonus luctuosus Lafresnaye and D'Orbigny, Synopsis avium, pt. 1, *in* Mag. de Zool., vol. 7, cl. 2, 1837, p. 29 (Guarayos, Bolivia).

1 ♀, Caicara, May 15, 1952; gonads small, but brood patch evident; iris brown; bill and feet dark blue-gray.

Due to lack of comparative material we are guided in our subspecific identification by the ranges given for this form and for the race *flaviventris* in Phelps and Phelps' (1950, pp. 335–336) list of the passerine birds of Venezuela.

A pair of these birds was seen and this one collected in a clearing in the heavy lowland seasonal forest at Caicara. This was the only time the species was encountered.

Family FRINGILLIDAE: Finches, Sparrows, and Buntings

Saltator coerulescens brewsteri Bangs and Penard

Saltator olivascens brewsteri Bangs and Penard, Bull. Mus. Comp. Zool., vol. 42, 1918, p. 91 (Caparo, Trinidad).

Although in our previous paper this form was reported absent at Cantaura, it has since proved to be rather common there, particularly in the oil company camps. Either the bird was overlooked previously, or else this is another example of greatly increased abundance concurrent with the increased supply of surface water at these localities. In August and again in the first days of November the two parent birds accompanied a single fledgling to the collector's feeding station where one or possibly both of the parents fed the young bird. The call of the fledgling is a single very characteristic loud *peeeep* quite similar to that of a lost chick.

Richmondena phoenicea (Bonaparte)

Cardinalis phoeniceus Bonaparte, Proc. Zool. Soc. London, vol. 5 (1837), 1838, p. 111 ("the country south of the Bay of Honduras"; error=Venezuela, apud Hellmayr, 1938, p. 74; Cumaná suggested as restricted type locality by Phelps and Phelps, 1950, p. 349).

1, unsexed, Barcelona, May 25, 1951; gonads small; iris brown; bill and feet pale gray; adult bird in worn plumage.

This cardinal was found only in the very sparse thorny woods bordering the seacoast at Barcelona. Its song and call note were quite similar to those of the North American cardinal *Richmondena cardinalis*.

Cyanocompsa cyanea minor Cabanis

Cyanocompsa minor Cabanis, Journ. Orn., vol. 9, 1861, p. 4 (Caracas, Venezuela).

1 ♂, Caicara, December 12, 1949; gonads small; skull well ossified; iris dark brown; bill and feet black.

1, unsexed (♂ by plumage), Caicara, November 10, 1951.

The November specimen has the forehead, superciliary and malar areas much lighter blue than the rest of plumage, while the December bird does not show any such local paleness. As a matter of fact, the latter bird is generally darker everywhere than the former example. If the two birds came from different places they would look as though they were distinct forms.

This blue grosbeak was recorded only at Caicara, and it was a rare bird there, an occasional single or pair being found in overgrown places at the savanna edge. The song began with a characteristic loud *chuwee*, followed by rambling, typically finchlike notes.

Tiaris bicolor omissa Jardine

Tiaris omissa Jardine, Ann. Mag. Nat. Hist., vol. 20, 1847, p. 332 (Isla de Tobago).

1 ♂, Barcelona, May 25, 1951; gonads greatly enlarged; iris dark; feet gray; bird in worn plumage.

The black-faced grassquit was common on the seacoast at Barcelona, but was not recorded further inland.

Sporophila nigricollis nigricollis (Vieillot)

Pyrrhula nigricollis Vieillot, Tabl. Enc. Méth., Orn., livr. 93, July, 1823, p. 1027 ("Brésil").

1 ♂, Cantaura, August 10, 1952; gonads very much enlarged; iris brown; bill pale blue; feet black; adult bird in fairly fresh plumage.

The yellow-bellied seedeater was rather common in the deciduous seasonal woods-edge habitat, especially where the small clearings had depressions which occasionally contained pools of surface water. The collector had overlooked this form for years, apparently having confused it with *Sporophila intermedia*, which it resembled in general appearance, call and song, and habitat, although the present species appeared to show preference for more heavily overgrown spots.

Sicalis flaveola flaveola (Linnaeus)

Fringilla flaveola Linnaeus, Systema naturae, ed. 12, vol. 1, 1766, p. 321 (Surinam).

Continued observation of this finch causes the junior author to consider that it has greatly increased in numbers around the oil company camps. A flight song was recorded in March and again in November, one a single male and once two males together. The singing bird rose almost vertically to a height of perhaps 80 feet, and still singing, fluttered down to the top of a tree, where the song was continued, the bird standing very upright, bill pointed straight up, wings still fluttering.

In the Anaco camp of the Socony-Vacuum Oil Co. this species was found nesting in the pipe crossarm of a clothesline support (see notes on *Forpus viridissimus*). The male and female gather nesting material, but the male often presents the material to the female for the actual construction. The nest is composed of grass lined with finer grasses and an occasional feather. The male commonly sings from 5 to 15 feet from the nest. Both parents feed the young, and by early November the insectlike *bzzzt* of the flocks of fledglings is to be heard on all the lawns in camp.

Sight records

In addition to the species in the foregoing list, a number of others were carefully observed, but, for one reason or another, not preserved as specimens. These must remain purely sight records for the present, but those that appear to have been adequately studied for purposes of identification may be listed here. It may be recalled that two perfectly unmistakable species have been referred to in our catalog even though neither was obtained for the collection. The additional birds tentatively recorded are as follows (in the absence of the possibility of subspecific determination binomials only are used).

Phimosus infuscatus (Lichtenstein)
Anas bahamensis (Linnaeus)
Accipiter superciliosus (Linnaeus)
Falco albigularis (Daudin)
Phaetusa simplex (Gmelin)
Dacnis cayana (Linnaeus)
Emberizoides herbicola (Vieillot)

Birds of the region

Inasmuch as field observing and collecting have now been pursued for over 8 years in the study area, we feel that the list of the birds inhabiting this portion of the tropical zone of northeastern Venezuela is faily well worked out. It seems worthwhile to tabulate here the monthly occurrence and the known breeding activities of this avifauna in order to make the data more readily available for comparative studies of other tropical American areas. Probably few, if any, other local regions in all of tropical America are as completely known, save for an exceptional case such as Barro Colorado Island in the Panama Canal Zone. The study area here reported, lies partly in the States of Anzoategui and partly in Monagas; the elevation varies from 350 to 1500 feet above sea level; the region comprises savanna, deciduous seasonal woods, and lowland seasonal woods. An X signifies that the bird has been recorded as present in the month in question; a dash (—), not present; B means breeding. Sight records are marked with an asterisk.

Species	*Month*											
	J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Tinamus major zuliensis †	--	--	--	--	--	--	--	--	--	--	--	X
Crypturellus noctivagus erythropus	X	B	B	B	B	B	B	X	X	X	X	X
Crypturellus noctivagus spencei	X	X	X	X	B	B	X	X	X	B	X	X
Crypturellus soui	X	X	X	B	X	X	X	B	X	X	X	X
Colymbus dominicus speciosus	--	--	--	X	X	B	X	X	X	X	X	--
Podilymbus podiceps antarcticus	--	--	--	--	X	X	X	X	X	--	--	--
Phalacrocorax olivaceus olivaceus	X	X	X	X	X	X	X	--	--	--	--	--
Anhinga anhinga anhinga	X	X	X	X	X	--	--	--	--	B	X	X
Ardea cocoi	X	X	X	X	X	--	X	--	X	X	X	X
Philherodias pileatus	--	--	X	X	X	--	--	--	--	--	X	X
Butorides striatus striatus	X	X	X	B	X	X	X	X	X	X	X	X
Florida caerulea caerulescens	X	X	X	X	X	X	X	X	X	X	X	X
Bubulcus ibis ibis	X	X	--	--	--	--	--	X	X	X	--	X
Casmerodius albus egretta	X	X	X	X	X	X	X	X	X	X	X	X

†Caprito.

Species	*Month*											
	J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Leucophoyx thula thula	X	X	X	X	X	X	X	X	X	X	X	X
Syrigma sibilatrix fostersmithi	X	X	X	X	X	--	X	X	X	--	--	X
Nycticorax nycticorax hoactli	--	--	X	X	X	X	--	--	--	--	--	---
Tigrisoma lineatum lineatum	--	--	X	B	--	--	--	--	--	--	--	---
Cochlearius cochlearius	--	X	--	--	--	--	--	--	--	--	--	---
Mycteria americana	X	X	X	X	X	X	X	X	X	X	--	---
Jabiru mycteria*	X	X	--	X	X	--	--	--	--	X	--	---
Exenura maguari	--	X	--	--	X	--	--	--	--	X	X	X
Theristicus caudatus caudatus	X	--	--	X	X	X	X	X	X	X	--	--
Ajaia ajaja	X	X	--	X	X	X	X	X	X	X	--	---
Phimosus infuscatus*	--	--	X	X	--	--	--	--	--	--	--	---
Dendrocygna viduata	X	--	--	X	X	B	X	X	X	X	--	---
Dendrocygna autumnalis discolor	X	--	X	--	X	X	X	X	X	B	--	---
Sarkidiornis sylvicola	--	--	--	X	--	B	B	X	X	--	--	---
Cairina moschata	--	--	X	X	--	--	X	X	X	--	--	---
Anas discors	X	X	X	X	--	X	--	--	X	X	X	X
Oxyura dominica	--	--	--	X	--	--	X	X	X	X	--	---
Anas bahamensis*	--	--	--	--	--	--	--	--	X	--	--	---
Coragyps atratus	X	X	B	B	X	X	X	X	X	B	X	X
Cathartes aura ruficollis	X	X	X	B	X	X	X	X	X	X	X	X
Cathartes burrovianus	X	X	X	X	X	X	X	X	X	X	X	X
Sacroramphus papa	X	--	X	--	X	X	--	--	--	--	X	---
Elanus leucurus leucurus	X	X	X	X	X	X	X	X	X	X	X	X
Elanoides forficatus yetapa	--	--	X	X	X	X	X	X	X	--	--	---
Chondrohierax uncinatus uncinatus	--	--	X	--	--	--	X	--	X	--	X	---
Ictinea plumbea	--	--	B	X	X	X	X	--	X	--	--	---
Gampsonyx swainsonii leonae	X	X	X	X	X	X	X	X	X	X	X	X
Accipiter bicolor bicolor	--	X	X	B	--	X	--	--	--	--	--	---
Heterospizias meridionalis meridionalis	X	X	B	X	X	X	X	X	X	B	X	X
Buteo albicaudatus colonus	X	X	X	X	X	B	B	X	X	X	X	X
Buteo albinotatus abbreviatus	X	X	X	B	X	X	X	X	X	X	X	X
Buteo magnirostris magnirostris	X	X	X	B	X	X	B	X	X	X	X	X
Buteo nitidus nitidus	X	X	X	X	B	X	X	X	X	X	X	X
Parabuteo unicinctus unicinctus	B	X	X	X	X	B	X	X	X	B	X	X
Hypomorphnus urubitinga urubitinga	X	X	X	X	X	X	X	X	X	X	X	X
Busarellus nigricollis nigricollis	X	X	X	X	X	--	--	--	--	--	--	X
Geranospiza caerulescens	X	X	X	X	X	X	X	X	X	X	X	X
Accipiter superciliosus*	--	--	X	--	--	--	--	--	--	--	--	---
Spizaëtus ornatus	--	--	X	X	X	--	--	--	--	X	--	---
Spizaëtus tyrannus	X	--	--	--	--	--	--	--	--	--	--	---
Circus brasiliensis	X	--	--	--	--	--	X	--	--	--	--	---
Leptodon cayanensis	X	X	X	X	X	--	--	--	--	--	--	---
Rostrhamus sociabilis	--	--	--	--	X	--	--	--	--	--	--	---
Pandion haliaetus carolinensis*	X	X	--	--	X	--	--	--	--	X	--	---
Herpetotheres cachinnans cachinnans	X	X	X	X	X	X	X	X	X	X	X	X
Daptrius ater	--	--	X	X	--	--	X	B	X	--	--	---
Daptrius americanus	--	--	--	X	X	X	--	--	--	--	X	X
Milvago chimachima cordatus	X	X	X	X	X	X	X	X	B	X	X	X
Polyborus cheriway cheriway	X	X	B	B	X	X	X	X	B	X	X	X
Falco femoralis femoralis	X	X	X	X	X	X	X	X	X	X	X	X
Falco columbarius columbarius	X	X	X	X	--	--	--	--	--	--	X	X
Falco spavarius isabellinus	B	B	B	B	X	X	X	X	X	X	X	X
Falco albigularis*	--	--	--	--	--	X	--	--	--	--	--	--
Ortalis ruficauda	X	X	X	B	B	B	X	X	X	X	X	X
Colinus cristatus mocquerysi	X	X	X	X	X	B	B	X	X	X	B	X
Opisthocomus hoazin	X	X	X	X	X	--	--	--	--	--	X	X
Aramus guarauna guarauna	--	--	X	X	X	X	X	--	X	--	--	---
Aramides cajanea cajanea	X	X	X	X	X	X	X	X	X	X	X	X
Neocrex erythrops olivascens	--	--	--	--	--	--	X	X	--	X	--	---
Gallinula chloropus pauxilla	--	--	--	X	X	X	X	X	--	--	X	---
Porphyrula martinica	--	--	--	--	--	--	--	X	X	--	X	---
Jacana spinosa intermedia	X	X	X	X	X	X	X	X	X	X	X	X

*Sight record.

Species	*Month*											
	J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Heliornis fulica	--	--	--	--	--	--	--	--	--	X	X	---
Belonopterus chilensis cayennensis	X	X	X	X	B	B	B	X	X	X	X	X
Pluvialis dominica dominica	--	--	--	--	--	--	--	--	X	X	X	X
Charadrius vociferus*	X	--	--	--	--	--	--	--	--	--	--	---
Charadrius hiaticula semipalmatus	X	X	--	--	--	--	--	--	--	X	X	---
Charadrius collaris	--	--	--	--	--	--	--	X	X	X	--	---
Hoploxypterus cayanus	--	--	--	--	--	X	X	X	--	--	--	---
Bartramia longicauda	--	--	X	X	--	--	--	--	X	X	--	---
Totanus flavipes	X	X	X	--	--	X	X	X	X	X	X	---
Totanus melanoleucus	X	X	X	X	--	--	X	X	X	X	X	X
Tringa solitaria	X	X	X	X	X	--	X	X	X	X	--	X
Actitis macularia	X	X	X	X	X	X	X	X	X	X	X	X
Capella gallinago	--	--	X	X	X	--	X	--	--	X	X	---
Ereunetes pusillus	X	--	--	--	--	--	--	--	X	X	--	---
Erolia minutilla	X	--	--	--	--	--	--	--	X	X	--	---
Erolia fuscicollis	--	--	--	X	--	--	--	--	X	X	X	---
Erolia melanotus	--	--	--	--	--	--	--	--	X	X	X	---
Phaetusa simplex*	--	--	--	X	X	--	--	--	--	--	--	---
Burhinus bistriatus vocifer	X	X	X	B	B	X	X	X	X	X	X	X X X
Sterna albifrons antillarum	--	--	--	X	X	--	--	--	--	--	--	--
Columba corensis	X	X	X	B	B	B	B	B	X	X	X	X
Columba cayenninsis pallidicrissa	X	X	X	B	B	B	B	B	X	X	X	X
Columba speciosa	--	--	X	B	B	X	--	--	--	--	--	---
Zenaidura auriculata stenura	X	X	B	B	B	B	B	B	B	B	B	X
Scardafella squammata ridgwayi	B	B	B	B	B	B	B	B	B	B	B	B
Columbigallina passerina albivitta	B	B	B	B	B	B	B	B	B	X	B	B
Columbigallina talpacoti rufipennis	X	X	B	X	X	B	B	B	B	B	B	X
Claravis pretiosa	X	X	X	X	X	X	X	X	X	X	X	X
Leptoptila verrauxi verrauxi	X	X	X	B	B	B	X	B	X	X	B	X
Ara manilata	--	--	--	--	--	--	--	X	--	X	X	---
Ara ararauna	--	X	X	X	X	--	X	X	X	X	X	---
Aratinga acuticaudata neoxena	X	X	X	X	X	X	X	X	X	X	X	X
Aratinga leucopthalmus leucopthalmus	X	X	X	X	X	X	--	--	--	X	--	X
Aratinga pertinax margaritensis	X	B	B	B	X	X	X	X	X	X	X	X
Forpus passerinus viridissimus	X	X	X	X	X	X	B	X	X	X	X	X
Pionus menstruus	--	--	--	--	X	X	--	X	X	X	--	---
Brotogeris chrysopterus chrysopterus†	--	--	--	--	--	--	--	--	X	--	--	---
Amazona ochrocephala ochrocephala	X	B	B	B	X	X	X	X	X	X	X	X
Amazona amazonica amazonica	X	X	X	X	X	X	X	X	X	X	X	X
Piaya cayana mehleri	X	X	X	B	X	X	X	X	X	X	X	X
Coccyzus melancoryphus	--	--	--	X	X	X	X	X	X	X	X	X
Crotophaga major	X	X	X	X	X	X	X	X	X	X	X	X
Crotophaga ani	X	X	X	X	X	X	B	B	B	X	X	X
Crotophaga sulcirostris	X	X	X	X	X	X	B	B	B	B	X	X
Tapera naevia naevia	--	X	X	X	X	X	X	X	X	X	X	---
Tyto alba stictica	--	X	X	--	--	X	X	X	X	B	B	X
Bubo virginianus scotinus	X	--	--	--	X	X	X	X	X	X	X	X
Glaucidium brasilianum phaloenoides	X	X	B	X	B	B	B	X	X	X	X	X
Pulsatrix perspicillata perspicillata	--	X	--	--	--	--	X	--	X	--	--	---
Speotyto cunicularia brachyptera	X	X	--	--	--	X	X	X	X	X	X	X
Rhinoptynx clamator clamator	--	--	X	X	X	--	X	--	--	--	--	---
Asio flammeus pallidicaudus	--	--	--	--	--	X	X	X	X	X	--	---
Otus choliba subsp	--	--	--	B	--	--	--	--	--	--	--	---
Nyctibius griseus griseus	--	X	X	X	B	B	X	X	X	X	X	---
Nyctibius grandis	--	--	--	--	--	--	--	--	--	--	--	X
Chordeiles pusillus septentrionalis	--	--	X	--	--	X	X	X	X	--	--	---
Chordeiles acutipennis acutipennis	X	X	X	X	B	B	X	X	X	X	X	X
Podager nacunda	--	--	--	--	X	X	X	X	X	X	X	---
Nyctidromus albicollis albicollis	X	X	B	B	B	B	X	X	X	X	X	X
Caprimulgus cayennensis cayennensis	X	X	X	X	X	X	X	X	X	X	X	X
Streptoprocne zonaris albicincta	--	X	X	X	X	X	X	X	X	X	X	X
Chaetura brachyura brachyura	X	X	X	X	X	X	X	X	X	--	X	X

*Sight record.
†Quiriquire.

Species	*Month*											
	J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Reinarda squamata squamata	X	X	X	B	X	X	X	B	X	X	X	X
Polytmus guainumbi	X	--	X	--	X	--	--	--	--	--	--	---
Glaucis hirsuta hirsuta	--	X	X	X	X	X	B	--	--	--	--	--
Phaethornis anthophilus anthophilus	X	X	--	X	X	X	--	--	--	--	--	X
Anthracothorax prevostii viridicordatus	--	--	--	--	--	--	X	--	--	--	--	--
Chrysolampis mosquitus	--	X	--	--	--	--	--	--	--	X	X	X
Chlorostilbon canivetii caribaeus	X	X	X	X	X	X	X	X	X	X	X	X
Amazilia fimbriata maculicauda	B	X	X	X	X	X	X	B	B	B	B	X
Amazilia tobaci aliciae	--	X	X	X	X	--	--	--	--	X	X	X
Amazilia chionopectus	--	--	--	--	--	X	--	--	--	X	X	---
Trogon viridis viridis	--	--	X	--	X	--	X	--	--	--	--	---
Ceryle torquata torquata	B	X	X	B	B	X	X	X	X	X	X	X
Chloroceryle amazona amazona	X	B	B	B	X	X	X	X	B	X	X	X
Chloroceryle americana americana	X	X	X	X	X	--	--	--	X	X	X	X
Galbula ruficauda ruficauda	X	X	B	B	X	X	X	X	X	X	X	X
Hypnelus bicinctus bicinctus	X	X	X	X	X	X	X	X	X	X	X	X
Chelidoptera tenebrosa tenebrosa	X	X	X	X	X	X	X	X	X	X	X	X
Ramphastos tucanus	X	X	X	X	X	X	B	X	X	X	X	X
Pteroglossus aracari roraimae	--	--	X	X	X	X	X	B	X	X	X	X
Melanerpes rubricapillus rubricapillus	X	X	X	X	X	X	X	X	X	X	X	X
Chrysoptilus punctigula punctipectus	X	X	X	X	X	X	X	X	X	X	X	X
Dryocopus lineatus lineatus	X	X	X	X	X	X	X	X	X	X	X	X
Veniliornis kirkii continentalis	--	--	--	X	X	--	--	--	--	--	--	---
Picumnus squamulatus röhli	X	X	X	X	X	X	X	--	--	--	X	---
Phloeocastes melanoleucos melanoleucos	--	--	--	--	--	--	--	--	--	X	X	---
Dendroplex picus phalara	X	X	X	B	B	B	X	X	X	X	X	X
Xiphorhynchus guttatus jardinei	--	--	--	--	--	--	--	--	--	X	X	--
Lepidocolaptes souleyetii littoralis	--	--	X	X	X	--	B	X	--	--	--	--
Campylorhamphus trochilirostris venezuelensis	--	--	--	--	X	--	--	X	--	--	--	X
Sittasomus griseicapillus griseus	--	--	--	X	--	--	--	--	--	--	--	--
Dendrocincla fuliginosa meruloides	--	--	--	--	X	X	--	--	X	X	X	--
Synallaxis albescens trinitatis	X	X	X	X	X	X	B	X	X	X	X	X
Phacellodomus rufifrons inornatus	B	X	X	X	X	X	X	X	X	B	X	X
Xenops rutilans heterurus	--	--	--	--	X	--	--	--	--	--	X	--
Taraba major semifasciatus	--	--	X	--	X	--	--	--	--	X	X	--
Sakesphorus canadensis trinitatis	X	X	X	X	X	X	X	X	X	X	X	X
Thamnophilus doliatus fraterculus	X	--	X	X	X	--	X	X	--	X	X	X
Formicivora grisea intermedia	X	X	X	X	X	X	X	X	X	X	X	X
Myrmeciza longipes longipes	--	--	--	--	--	--	--	--	--	X	--	X
Pachyramphus polychopterus tristis	--	--	--	--	X	--	--	--	--	X	--	--
Tityra cayana cayana	--	--	--	--	X	--	--	--	--	--	--	--
Tityra inquisitor erythrogenys	X	X	X	X	X	--	X	X	X	X	--	--
Chiroxiphia lanceolata	X	X	X	X	B	B	X	X	X	X	X	X
Fluvicola pica pica	X	X	X	X	X	--	B	--	X	X	X	--
Arundicola leucocephala	X	--	--	--	--	--	X	--	--	X	--	--
Pyrocephalus rubinus saturatus	B	X	B	B	B	X	X	X	X	B	B	X
Machetornis rixosa flavigularis	X	X	X	B	B	B	B	B	X	X	X	X
Muscivora tyrannus tyrannus	--	--	--	--	--	--	X	X	X	X	X	--
Muscivora tyrannus monachus	X	X	X	X	B	B	X	X	X	X	X	X
Tyrannus melancholicus chloronotus	X	X	X	X	B	B	X	X	B	X	X	X
Tyrannus dominicensis dominicensis	--	--	--	--	--	--	--	--	--	X	X	X
Empidonomus varius rufinus	X	--	--	X	X	X	X	--	X	--	X	--
Myiodynastes maculatus maculatus	X	X	X	X	X	X	X	X	X	X	X	X
Megarynchus pitangua pitangua	X	--	--	--	X	X	X	--	X	X	X	X
Myiozetetes cayannensis rufipennis	X	X	X	X	B	B	B	X	X	X	X	X
Myiozetetes similis columbianus	X	X	X	X	B	B	X	X	X	X	X	X
Pitangus sulphuratus rufipennis	X	X	B	B	B	X	X	X	X	X	X	B
Myiarchus tyrannulus tyrannulus	X	X	X	X	X	X	X	X	X	X	X	X
Platyrinchus mystaceus insularis	--	--	--	--	--	X	X	--	--	X	--	--
Tolmomyias sulphurescens exortinus	--	--	--	--	X	--	--	--	--	--	--	--
Tolmomyias flaviventris collingwoodi	X	X	X	--	B	--	--	--	--	X	X	X

Species	*Month*											
	J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Todirostrum cinereum cinereum	X	X	X	X	X	X	--	X	--	--	X	--
Euscarthmornis margaritaceiventer impiger	X	--	--	--	--	--	--	--	--	--	--	--
Atalotriccus pilaris venezuelensis	--	--	--	--	--	X	--	--	--	--	--	--
Euscarthmus meloryphus meloryphus	X	--	--	X	--	--	X	X	X	--	--	X
Xenopsaris albinucha minor	--	--	--	--	--	--	--	--	--	--	--	X
Elaenia parvirostris	--	--	--	--	X	X	X	--	--	--	--	--
Elaenia chiriquensis albivertex	--	--	--	--	X	X	X	X	X	--	--	--
Sublegatus arenarum orinocensis	X	X	X	X	X	X	X	X	X	X	X	X
Phaeomyias murina incomta	X	X	X	--	--	--	--	--	--	X	X	X
Camptostoma obsoletum venezuelae	X	--	X	B	--	--	--	--	--	--	X	--
Pipromorpha oleaginea chloronota	X	X	--	--	X	--	X	--	--	--	--	--
Progne chalybea chalybea	X	X	X	X	B	B	X	X	X	X	X	X
Phaeoprogne tapera tapera	--	--	--	--	--	--	--	X	--	--	--	--
Stelgidopteryx ruficollis aequalis	X	X	X	X	B	X	X	X	X	X	X	X
Atticora cyanoleuca patagonica	--	--	--	--	X	--	--	--	--	--	--	--
Hirundo rustica erythrogaster	--	--	--	X	X	--	--	X	X	X	X	--
Iridoprocne albiventer	X	X	X	X	--	X	X	--	--	X	X	X
Cyanocorax violaceus violaceus	X	X	X	X	B	X	X	X	X	X	X	X
Cyanocorax yncas guatimalensis	--	--	--	X	X	X	X	--	--	X	X	--
Campylorhynchus griseus minor	B	X	X	X	X	X	X	X	X	X	X	X
Campylorhynchus nuchalis brevipennis	X	X	X	X	B	B	B	X	X	X	X	X
Thryothorus rufalbus cumanensis	X	--	--	X	X	--	--	--	--	--	X	X
Thryothorus rutilus rutilus	X	--	X	X	X	X	--	--	--	--	--	--
Troglodytes musculus clarus	X	X	X	B	X	X	X	X	X	X	B	X
Mimus gilvus melanopterus	B	B	B	B	B	B	B	X	B	X	B	B
Turdus nudigenis nudigenis	X	X	X	X	B	B	B	X	X	X	X	X
Turdus fumigatus aquilonis	--	--	X	--	--	--	--	--	--	--	X	--
Turdus leucomelas albiventer	X	X	X	X	X	X	B	X	X	X	X	--
Polioptila plumbea plumbiceps	X	X	X	X	X	X	X	X	X	X	X	X
Ramphocaenus melanurus trinitatis	--	X	--	X	X	--	--	--	X	--	--	--
Anthus lutescens lutescens	--	--	X	X	X	B	X	X	X	X	--	X
Cyclarhis gujanensis flavipectus	X	X	X	X	X	X	X	X	X	X	X	X
Vireo virescens vividior	--	--	X	X	X	X	X	X	X	X	X	X
Hylophilus aurantifrons saturatus	--	--	--	--	--	--	--	--	--	--	X	--
Hylophilus flavipes acuticauda	X	X	X	--	--	--	--	--	--	X	X	X
Dacnis cayana*	--	--	--	X	--	--	--	--	--	--	--	--
Coereba flaveola luteola	B	B	B	B	X	X	X	X	X	X	X	X
Parula pitiayumi elegans	X	X	X	X	X	--	--	--	--	--	X	X
Dendroica petechia aestiva	X	X	X	X	--	--	--	--	X	X	X	X
Dendroica petechia rufopileata	X	X	--	--	X	--	B	--	--	--	--	--
Seiurus noveboracensis	X	--	X	X	--	--	--	--	--	--	--	X
Setophaga ruticilla ruticilla	--	--	X	X	X	--	--	--	--	--	--	--
Psarocolius decumanus decumanus	X	X	X	B	B	B	X	X	X	X	X	X
Psarocolius viridis viridis	--	--	X	--	X	B	X	--	--	--	--	--
Cacicus cela cela	X	X	X	B	B	B	B	X	X	X	X	X
Psomocolax oryzivorus oryzivorus	--	--	--	--	B	--	--	--	--	--	--	--
Molothrus bonariensis venezuelensis	X	X	X	B	B	B	B	X	X	X	X	X
Quiscalius lugubris lugubris	B	B	B	B	B	B	B	B	B	B	X	X
Icterus auricapillus	X	--	--	--	----	----		----		----	--	X
Icterus nigrigularis nigrigularis	X	X	B	B	B	B	B	B	B	B	X	X
Icterus icterus icterus	X	X	B	X	X	X	B	X	X	X	X	X
Gymnomystax mexicanus	X	X	X	X	X	X	X	X	X	B	X	X
Agelaius icterocephalus icterocephalus	--	--	X	--	--	--	--	X	--	--	--	---
Leistes militaris militaris	--	--	--	X	X	X	B	B	B	--	X	---
Sturnella magna praticola	X	X	X	B	B	X	X	X	X	X	B	X
Tanagra chlorotica trinitatis	X	X	B	X	X	X	X	X	X	X	X	X
Tanagra laniirostris crassirostris	--	--	X	--	B	B	--	--	--	--	--	X
Tanagra cayana cayana	--	--	--	B	X	X	--	X	--	--	--	---
Thraupis virens cana	--	--	--	X	--	--	--	--	--	X	--	X
Thraupis sayaca glaucocolpa	X	X	X	X	X	X	B	X	X	X	X	X
Thraupis palmarum melanoptera	--	X	X	X	X	--	--	--	X	X	--	X

*Sight record.

Species	*Month*											
	J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Ramphocelus carbo capitalis	--	--	X	X	--	--	B	--	X	--	X	---
Tachyphonus rufus	X	X	X	X	X	X	X	X	X	X	X	X
Tachyphonus luctuosus luctuosus	--	--	--	--	X	--	--	--	--	--	--	---
Nemosia pileata pileata	X	X	X	X	X	--	--	--	--	X	X	X
Hemithraupis guira nigrigula	--	--	--	X	--	--	--	--	--	X	--	---
Saltator coerulescens brewsteri	X	X	X	X	X	X	B	B	X	B	X	X
Saltator orenocensis orenocensis	X	X	X	X	X	X	X	X	X	X	X	X
Cyanocompsa cyanea minor	--	--	X	--	--	X	--	--	--	X	X	X
Spiza americana	X	X	X	X	--	--	--	--	--	X	X	X
Sporophila intermedia intermedia	X	X	X	X	X	X	X	X	B	B	X	X
Sporophila nigricollis nigricollis	--	--	--	--	--	--	--	X	X	X	--	---
Sporophila lineola	--	--	--	--	--	--	X	--	--	--	--	---
Sporophila bouvronides	--	--	--	X	X	X	X	X	X	--	--	---
Sporophila minuta minuta	X	X	X	X	X	X	X	X	X	X	X	X
Volatinia jacarina splendens	X	X	X	X	X	X	X	X	X	X	X	X
Spinus psaltria columbianus	X	X	X	X	X	X	B	X	B	B	X	X
Sicalis flaveola flaveloa	X	X	X	X	X	X	B	B	B	B	B	X
Sicalis luteola luteola	--	--	--	--	X	X	B	B	X	--	--	---
Coryphospingus pileatus brevicaudus	X	X	X	X	X	X	X	B	X	X	X	X
Myiospiza humeralis humeralis	X	X	X	X	X	X	X	X	X	X	X	X
Emberizoides herbicola*	--	--	--	--	--	--	--	--	--	--	X	---

*Sight record.

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MODIFICATIONS OF PATTERN IN THE AORTIC ARCH SYSTEM OF BIRDS AND THEIR PHYLOGENETIC SIGNIFICANCE

By Fred H. Glenny [1]

Introduction

My interest in the aortic arch system in birds was stimulated by the discovery of a functional left radix aortae in the belted kingfisher during a routine dissection of that bird in 1938. Subsequent studies on several other species of birds produced interesting anatomical information, and, with continued studies, a semblance of order in occurrence of carotid patterns became more and more evident.

After a reasonably large series of families and orders of birds had been examined, it appeared that further studies might produce information which could be of value in avian taxonomy. As a result, a series of systematic studies of the main arteries of the neck and thorax of birds was initiated and carried out over a period of about 12 years.

During the past 2 or 3 years important implications with respect to the evolution of the aortic arch system in the birds became more apparent, and the present treatise deals primarily with this aspect of my accumulated studies.

The classification of birds used in this study follows the arrangement of Wetmore and Peters, with only a minor revision in the listing of the parrots in the subfamily Psittacinae. In my opinion, the Wetmore and Peters classification of the birds of the world is more in accord with the natural relationships than are the schema employed by many of the European taxonomists.

Insofar as possible the names of birds as used by earlier and even contemporary writers have been checked as to synonymy with Peters' (1931–51) checklist. Since Peters' checklist is not complete

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for the Passeriformes, only the authority for the species listed can be given.

The British Museum catalog of birds and Sharpe's hand-list have been freely consulted in an effort to obtain information essential to the establishment of the names of species and subspecies synonymous with those in the Peters checklist.

Unless otherwise noted, only single specimens were studied; in instances where more were studied the number is noted after the species name.

I wish to express sincere gratitude to the following individuals and institutions for their generous assistance in making available materials used in the study, and for their many helpful suggestions and criticisms in the preparation of this paper: American Museum of Natural History; Chicago Natural History Museum; Cleveland Museum of Natural History; Fan Memorial Institute of Biology; Meems Brothers and Ward, Inc.; Royal Ontario Museum of Zoology; Sudan Government Museum, Natural History; United States National Museum; and Ward's Natural Science Establishment, Inc.; Dr. John W. Aldrich, Dr. Dean Amadon, Dr. Doris Cochran, Mr. J. W. Cowland, Dr. E. Horne Craigie, Dr. David E. Davis, Mr. Dwight D. Davis, Dr. Charles A. Dambach, Mr. R. N. Deaton, Dr. E. H. Dustman, Dr. Herbert Friedmann, Dr. Ira N. Gabrielson, Dr. D. L. Gamble, Mrs. M. E. Glenny, Mr. W. Earl Godfrey, Dr. Walter C. Kraatz, Mr. W. J. Leach, Mr. Ben H. Morgan, Mrs. C. P. Mountz, Dr. Harry C. Oberholser, Dr. John W. Price, Dr. Loren S. Putnam, Dr. D. P. Quiring, Mr. Tsen-Hwang Shaw, and Dr. Alexander Wetmore.

Review of the literature

From shortly after the turn of the 19th century until its end, European anatomists and ornithologists evinced a considerable interest in the arterial system of birds. Among the earliest writers on this subject were Bauer, Meckel, Nitzsch, and Hahn, followed by Owen and Barkow. With the rapid expansion of interest in comparative morphology during the middle of the 19th century, other workers soon became engaged in numerous and very revealing investigations to which they tried to give some semblance of order and meaning. Prominent among this group of workers were Boas, Rathke, Sabatier, and Garrod.

During the middle of the 19th century, the theory of ontogenetic recapitulation was developed and became of considerable importance in the fields of comparative and human anatomy and organic evolution. It was during this time that the study of anatomy received its greatest impetus and achieved the peak of respectability in science.

Garrod, of all the workers of his time, was least successful in interpreting his findings, with the result that the significance of his contributions on the carotid arteries in birds was overlooked by most workers. Even Forbes and Beddard failed to interpret Garrod's studies satisfactorily, but Boas, Rathke, and Sabatier were better received by most of their contemporaries, with the result that many of their contributions and writings have been passed on to the present time. With respect to their interpretations of the arrangement in birds of the arteries and, especially, the aortic arches, they were incorrect in certain important details. Although Brenner had questioned Rathke's and Sabatier's placement of the subclavian artery as early as 1883, most textbooks in comparative anatomy still carry plates of the Rathke-Boas type of schematic diagrams.

In spite of correct information presented by Gadow, Hertwig, Hochstetter, and others, only a few textbook writers have made an effort to present the facts in preference to the presentation of a plan of organization or a pattern of evolution in the aortic arch system of the vertebrates.

A great deal of research was necessary even after the end of the 19th century in order to clarify the true nature of the aortic arch system and the changes which these and associated vessels undergo during embryonic development. The greatest single contribution of this kind was made at Northwestern University under the direction of W. A. Locy. Significant contributions on the embryonic development of arteries in birds were made during the first 6 years of the 20th century by Rabl, Sabin, Locy, and Twining. Thereafter, little work of importance reached the literature until 1934 when Hughes published his very important studies on the development of the cephalic blood vessels in the chick.

Despite these studies, a great gap still exists insofar as the development of the coracoid or sternoclavicular, thoracic or intercostal (internal mammary), and pectoral arteries of birds are concerned. I have been unable to find a single reliable account of the exact development of these vessels. Most anatomical references allude to the mammalian condition insofar as it is known, but actual accounts for birds appear to be lacking.

Apparently, there was little interest in the arterial system of adult birds (for well over a quarter of a century) until I began systematic studies of the arteries of the neck and thorax. Shortly thereafter Bhaduri and Biswas began a similar series of studies in India, and a few other incidental papers have appeared from time to time, treating largely with anomalous occurrence of vestiges of embryonic vessels.

As a result of these studies, I feel that it is well to summarize the findings of earlier and present-day workers in such a way that future workers may be better able to interpret their findings. It is with this in mind that I propose to discuss the significant changes in the aortic arch system and associated vessels with respect to their ultimate fate in birds.

It must be recognized that much of the present interpretation cannot be entirely resolved without further and extensive embryological studies on the nature of the origin and development of these vessels in the various orders, families, and species of birds. The complexities arising from important differences in the final arrangement-patterns of the arteries in the neck and thorax add considerably to the difficulties of interpretation. As a result, much of the interpretation will of necessity be quite generalized. Furthermore, this interpretation is based largely upon the studies made on the chick embryo, and since there probably are a great many important differences to be encountered in other orders of birds, the present interpretations may not be entirely accurate in at least some of the details.

It is suggested that renewed efforts be made to carry out embryological studies on the development of birds other than the chick, and that the development of the aortic arch system be given especial attention. Among the more critical aspects of this study are the manner and time of fusion of the anterior dorsal radices aortae (dorsal carotids), the manner in which the proximal portion of the dorsal radix, anterior to the carotid arch, atrophies, and the changes in and the fate of the ventral radices aortae (ventral carotids).

Another factor which should be taken into consideration is that of interpretation of the diagrammatic representations of structure, especially since there are apparent changes in the spatial relationships of portions of the aortic arch system in the different vertebrate groups, and these changes may be brought about as a result of other structural changes or modifications. Some of these structural modifications appear to produce an anterior-posterior compression or contraction of the aortic arch system with corresponding changes in the definitive spatial relationships of the early embryonic system. In the amniotes, and especially in birds and mammals, the ventral aorta appears to be lost, and the ventral radices aortae or ventral carotids are greatly modified. Such a modification in the structural-spatial relationship is rather advanced in the human embryo, with the result that interpretation of true homologies is sometimes very difficult.

Too frequently schematic or diagrammatic representations are or may be misleading as a result of faulty interpretation of both the diagrams and the actual condition as critically observed in study materials. Interpretation of the materials under study, however, should be facilitated by a careful study and analysis of the schematic diagrams. When this has been done, barring the lack of important embryological facts, there should be little difficulty in making adequate and correct interpretations.

As an aid in the interpretation of the adult avian aortic arch derivatives, it is well to make comparisons with the aortic arch derivatives in the other tetrapod vertebrates, and to attempt to show homologies such as do exist.

Early development of the avian vascular system

In discussing the early development of the vascular system of the chick, Patten (1929) states that the early vessels are formed from mesodermal cells that lie in the path of their development and that the walls of these early vessels are one cell-layer in thickness. As a result, no clear structural differences between the precursors of both arteries and veins arise until a much later period in development. Balfour (1873) has stated that the blood vessels of the chick arise not as spaces or channels between the mesoblast cells but as a network formed by united processes of the mesoblast cells, and that it is through these processes that the blood flows. He also stated that first traces of blood vessels are to be found in the pellucid area at about 30 hours of incubation.

Hyman (1942) states that the blood and blood vessels arise from mesenchyme cells of the mesoderm by forming patches of cells and that the central cells become modified into blood corpuscles, while the peripheral cells become oriented so as to form tubes, the early blood vessels. Essentially all these views represent the same concept, but expressed in slightly different ways.

The vitelline veins are the earliest vessels to form in the embryo and are found to develop on the surface of the yolk sac in the splanchnic hypomere and then pass to the embryo in the gut mesentery and finally come to enter the heart at its caudal end.

The ventral aorta is observed to arise at the cephalic end of the heart, with which it then becomes connected. The ventral aorta then extends anteriorly to the anterior end of the pharynx, at which point it bifurcates to form the anlagen of the ventral radices aortae, which then turn laterally and dorsally and pass around the pharynx, on either side, and curve posteriorly, dorsal to the pharynx, as the dorsal radices aortae which carry the blood backwards to the vitelline arteries which in turn pass to the yolk sac. Thus the first aortic arch which now lies within the mass of the mandibular visceral arch comes to be the first of the true aortic arches formed. Subsequently five additional pairs of vessels communicating between the ventral and dorsal radices aortae come into existence for a varying length of time, depending upon their ultimate fate in the adult bird and the function which they serve in the embryo or in the adult. Later, the two dorsal radices aortae, posterior to the pharyngeal region, come to fuse, thus forming the single median dorsal aorta (abdominal aorta) of the adult vertebrate.

Jolly (1940) has pointed out that the origin and mode of formation of the large embryonic vessels is still a matter in question and cloaked in obscurity, but he supports the view that the aortic vessels form *in situ* and are not the result of a "budding" or outgrowth from the heart nor a product of "migration," but rather are independent in origin and formation from the heart. Hyman (1942) asserts that a tubular cavity arises on either side (in the embryo) in the splanchnic

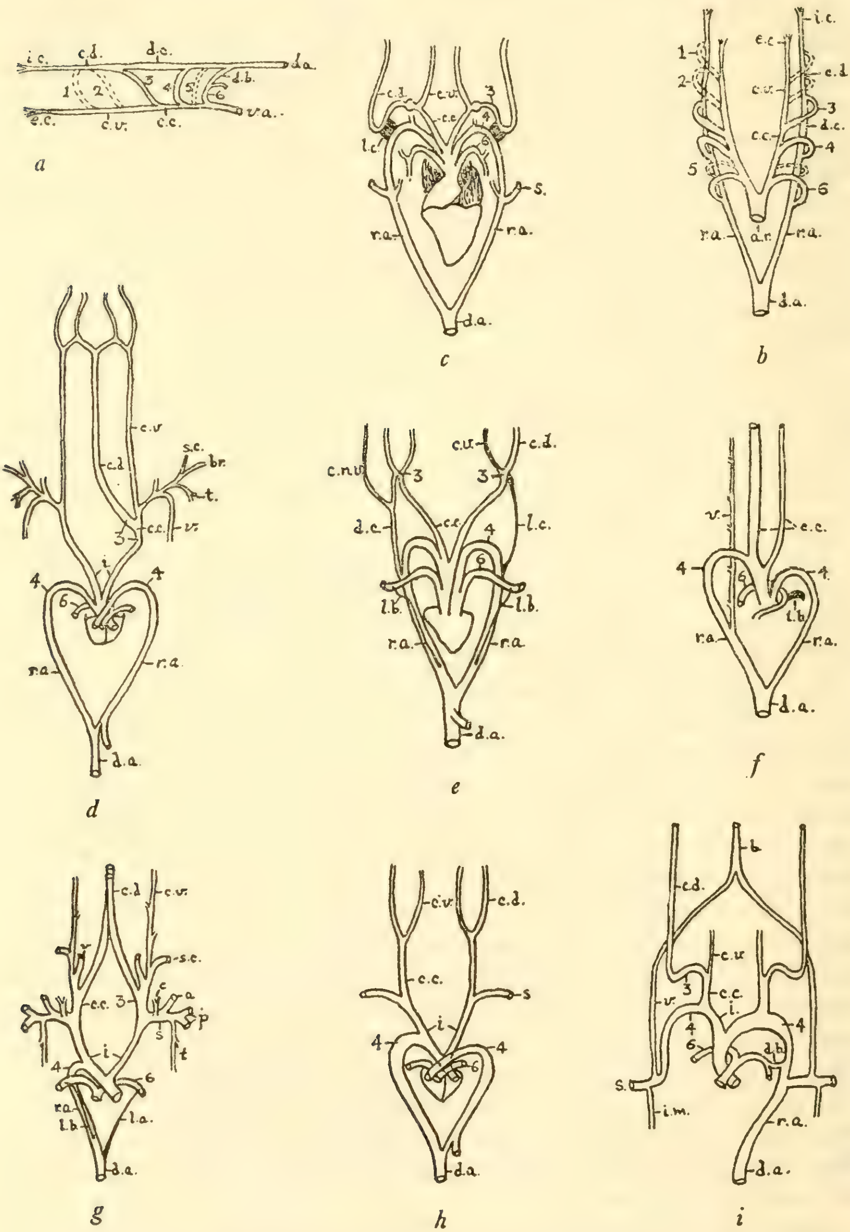

FIGURE 108.—For explanation see facing page.

mesoderm of the hypomere, and is of the same nature as the blood vessels, and that, as the hypomere closes below in the median ventral line, the two cavities are brought together and fuse to form the heart. With the disappearance of the ventral mesocardium the heart comes to lie free in the coelom.

Patten (1939) points out that the paired ventral aortic roots extend anteriorly from the bulbo-conus arteriosus (anterior heart chamber), and that the ventral aortic roots and the omphalomesenteric veins constitute direct continuations of the paired endocardial primordia of the heart. This is not in contradiction to Jolly's view of vessel formation within the embyro.

At about the 44-hour stage of incubation the heart begins regular contraction, thus establishing the circulation of the blood.

In birds and mammals the ventricle is divided into left and right compartments by the interventricular septum. The atrium is likewise divided by the interatrial septum, and the sinus venosus, still recognizable, is incorporated into the wall of the right auricle according to Quiring (1933). The systemic or aortic root and the pulmonary root form by a splitting of the conus arteriosus into two main trunks. The aortic or systemic root passes from the left ventricle to the body, while the pulmonary root passes from the right ventricle to the lungs. Thus the bird heart is comprised of two embryonic chambers, each of which is secondarily divided into two compartments, while the other two heart chambers of the lower vertebrates and the chick embryo are lost through incorporation and further structural and functional modifications. The atrium and ventricle of the early embryonic heart alone persists as the primary heart chambers, and the valves of the conus arteriosus persist in the pulmonary and systemic roots at the point of junction of these vessels with the ventricles.

As reported by Twining (1906), Lillie (1908, 1919), Patten (1929), Hughes (1934), and others, the aortic arches make their appearance (in the chick embryo) in order and at approximately the following levels of development or incubation: (1) first aortic arch appears in

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FIGURE 108.—*a*, Amniote aortic arch arrangement, lateral view; *b*, same, ventral view; *c-i*, ventral views of main cervical and thoracic arteries; *c*, in *Bufo melostictus* (modified after Bhaduri); *d*, in *Alligator mississippiensis* (modified after Reese); *e*, in *Sphenodon punctatus* (USNM 19260); *f*, in *Boa constrictor* (after Hafferl); *g*, in birds (generalized); *h*, in *Emys* (modified after Hafferl); *i*, in mammals (modified after Patten). Explanation of symbols: 1–6, aortic arches; a., axillary artery; a.r., aortic root; b., basilar artery; br., brachial artery; c., coracoid artery; c.c., common carotid artery; c.d., dorsal carotid artery; c.v., ventral carotid artery; c.n.v., comes nervi vagi; d.a., dorsal (abdominal) aorta; d.b., ductus botalli; d.c., ductus caroticus; e.c., external carotid artery; i., innominate artery; i.c., internal carotid artery; i.m., internal mammary artery; l.a., ligamentum aortae; l.b., ligamentum botalli; l.c., ligamentum caroticum; p., pectoral arteries; r.a., radix aortae; s., subclavian artery; s.c., subscapular artery; t., thoracic artery; v., vertebral artery; v.a., ventral aorta.

from 33 to 38 hours of incubation and disappears about the third or fourth day, or by the 32-somite stage; (2) second aortic arch appears at about the end of the second day and at least by the end of 50 to 55 hours of incubation, and disappears during the fourth day or by about the 32-somite stage; (3) third aortic (carotid) arch is usually present by the end of the second day or by the end of 50 hours of incubation, and this vessel usually remains throughout the life of the bird, although it may be modified in part in the adult where it forms, at least in part, the common carotid artery; (4) fourth aortic (systemic) arch arises in the embryo during the third day of incubation and is present by the end of 72 hours of incubation; the right arch alone (normally) remains and serves as the functional systemic arch connecting the systemic root with the dorsal radix aortae on the right side; the left arch is reduced by about 6½ days of incubation, and usually entirely obliterated by 7½ days of incubation; (5) fifth aortic arch is a transient vessel which makes its appearance during the first half of the fourth day of incubation and disappears by about the end of the fifth day; (6) sixth aortic (pulmonary) arch makes its appearance usually by the end of the fourth day and persists, at least in part, for the duration of the animal's life; the proximal ends of both vessels remain but become connected with the new pulmonary artery, which forms *de novo in situ* and supplies the lung; the distal portion atrophies and the left ductus arteriosus (botalli) usually completely disappears, while the right remains in many birds as the ligamentum botalli or it may fuse with the ventral face of the right radix aortae where it appears as a white streak (linea botalli) along the ventral face of the radix; (7) internal carotid artery appears at about the beginning of the third day of incubation as an anterior prolongation of the dorsal radix aortae from which point it extends into the head region, in rather close association with the brain.

Early changes in aortic arches

As has already been noted, the first, second, and fifth aortic arches become obliterated at an early stage in the embryonic life of the bird. According to Lillie (1908), these deletions occur on the third and fourth days of incubation in the case of the first two aortic arches, and, as has been pointed out by Hughes (1934), the fifth arch tends to disappear during the fifth day of incubation.

During the sixth to seventh day of incubation the fourth aortic arch of the left side loses its connection with the truncus. At this same time the dorsal connection between the fourth and third left arch (ductus caroticus) becomes reduced and soon loses its attachment with the left fourth aortic arch. By the 7½-day stage there is no trace of the left systemic arch except in instances of anomalous retention such as those cited by Biswas (1946) and Pohlman (1920). The dorsal radix aortae of the left side then anastomoses, medial to the ductus botalli, to the proximal portion of the pulmonary arch. As has been demonstrated (Glenny, 1943b, 1943d, 1944d), this secondary attachment precedes atrophy of the ductus botalli of the left side, and the left radix aortae posterior to the left fourth aortic arch begins to take over the function of the ductus botalli of that side.

No accurate account of the loss of the ductus caroticus of the right side could be located. It may be assumed that this occurs first as a disconnection at the level of the right systemic arch and perhaps may occur much later than has been suspected. Bhaduri (1939), Finn (1891), Glenny (1944a), Mathew (1944), and Subhapradha (1944) have reported the persistence of the ductus caroticus on the right side of several birds. Rarely, however, the otherwise functionally modified ductus caroticus may retain a short ligamentous connection with the right systemic arch (Glenny, 1944a). It has been inferred that the ductus shawi represents a functionally modified ductus caroticus which comes to serve as the supply to the bronchi, and sends off branches to the syrinx, lung substance, and the oesophagus (Hafferl, 1933). Not altogether satisfactory studies have been made on the exact changes which take place in the ductus caroticus.

The fact that the right dorsal radix aortae remains as the functional vessel carrying blood to the abdominal aorta does influence the subsequent history of the right ductus botalli. This vessel remains functional almost throughout the embryonic life of most birds, and undergoes further atrophy subsequent to hatching. While most orders of birds retain at least a ligamentous vestige of this embryonic vessel, many families show a greater degree of atrophy of this structure than do others. In some species where obliteration is nearly complete there is frequently evidence of its persistence as a linea botalli along the ventral face of the dorsal radix, with which structure it may fuse.

With the atrophy of the right ductus botalli, the left radix aortae begins to atrophy. This process continues in most birds until only a small ligamentum aortae remains as the vestige of this once prominent vessel. Rarely, the left radix aortae may remain as a functionally modified vessel (Glenny, 1939) or, more frequently, with a short lumen. In general it may be stated that almost without exception extremely careful examination of the adult bird will reveal a minute ligamentous vestige of the left radix aortae. The difficulty encountered in determining its presence arises from the fact that the ligament may become so much reduced that it is difficult to differentiate it from the surrounding fascia, and in smaller birds it is still more difficult to find.

When the right ligamentum botalli is much reduced, its distal attachment to the radix aortae may be determined by the presence of a small ligamentous button on the ventral face of the right radix.

The systemic arches in birds are paired structures only during early embryonic stages. Biswas (1946), however, reported the anomalous occurrence of both left and right systemic arches in a specimen of *Ploceus philippinus philippinus.*

Normally, atrophy of the left systemic arch follows shortly after the disconnection of the ductus caroticus from the posterior portion of the dorsal radices aortae. This results in the retention of the right systemic arch as a functional vessel which then passes diagonally lateral and dorsad to join the remaining functional right dorsal radix aortae which then passes diagonally toward the midline to the point of union with its complementary vessel of the left side. The latter vessel is usually found in the adult as the ligamentum aortae. The functional radix then forms a connection with the abdominal aorta.

In the respect that birds present but one of the pair of systemic arches, they differ from mammals. On the other hand, the right dorsal radix aortae in birds and the left dorsal radix aortae in mammals are the sole functional vessels which are responsible for the distribution of the blood to the abdominal viscera and posterior appendages.

As is well known, the ventral or proximal portion of the embryonic sixth aortic arch remains as the functional portion of this embryonic vessel which, along with the embryonic pulmonary artery that joins it, comes to serve as the definitive pulmonary artery of the adult.

The left ductus botalli usually undergoes atrophy shortly after the complete atrophy of the left systemic arch, by which time the left radix forms an anastomosis with the pulmonary arch proximal to the normal dorsal (ductus botalli–radix aortae) connection. As a result of this secondary connection, the left dorsal radix aortae serves the same function as the ductus botalli (Glenny, 1943d, 1944d). This is not the case in anomalous retention of the left systemic arch as reported by Biswas (1946). In this rather singular case, the distal portion of the left radix atrophied and the connection was maintained by way of the left systemic arch, and the left ligamentum botalli remained as the vestige of the embryonic vessel, whereas in most cases the left ligamentum botalli completely atrophies, or at best becomes fused with the left radix aortae either prior to or at the same time as the radix undergoes atrophy.

In instances of functional modification of the left radix aortae, the left ligamentum botalli may or may not be completely lost; but this is extremely difficult to ascertain since so few species or individuals may retain a functional left radix aortae and atrophy of the ligamentum botalli has usually progressed to such a stage that determination of its presence is difficult.

The distal portion of the right sixth aortic arch undergoes atrophy and becomes the ligamentum botalli or it may rarely maintain a small lumen. In such instances where it does not appear to be present it may fuse with the radix and be completely lost or remain as a linea botalli, or it may be partially resorbed and remain as an incomplete ligament or as a ligamentous button on the ventral surface of the radix aortae.

Atrophy of the right ductus botalli and the left radix aortae occurs at approximately the same time and at about the same rate. It appears that, as in many species of birds, there may be a continued progressive atrophy of both of these structures for quite a time after hatching. The rate and level of atrophy of these structures may differ in different species, but particularly between families and orders of birds. It appears that, in a few orders and families of birds, atrophy of these two structures may be independent of each other. This assumption is based on observations on many species within a family or order in which the ligamentum aortae may be of considerable size, while the right ligamentum botalli is almost entirely or completely lacking or remains as a linea botalli.

Much confusion and misunderstanding is encountered in the literature with respect to the carotid arteries. This is in part due to the lack of uniformity in terminology and to the failure to recognize some definitive vessels which are embryonic derivatives. Incomplete series for study, along with inadequate techniques, account in part for the failure of earlier workers to fully comprehend the significant changes which occur during the first week or 10 days of incubation. Furthermore, many of the earlier workers probably were greatly influenced in their views and interpretations by the dominant concept of ontogenetic recapitulation which so strongly influenced the studies of morphologists during the 19th century.

Some authors refer to the dorsal and ventral radices aortae simply as the dorsal and ventral carotids. This may have led to some misinterpretation, since the internal and external carotids are sometimes referred to as the dorsal and ventral carotids. Interpretation is difficult because direct comparisons cannot be made between birds and reptiles on the one hand or between birds and mammals on the other hand since the development of these vessels differs somewhat in details in each of the three classes of amniotes.

According to Twining (1906), the third aortic arch gives rise to a dorsal carotid and a ventral carotid; the former is well developed and easily traced anteriorly, while the latter, which he regards as the basal remnant of the first and second aortic arches, arises from the base of the third arch. At this early stage no trace is found of a vessel connecting the dorsal and ventral carotids, the entire blood supply to the jaw anlagen being produced by the ventral carotids. Anastomosis of the dorsal and ventral carotids occurs during a later stage in the embryonic development.

Increase in length of the dorsal and ventral carotids results from elongation of the cervical region, and this is followed by many complex changes in the arrangement and orientation of the other associated vessels.

In the 5½-day chick a vessel arises *de novo* from the dorsal carotid at a point about halfway between the third arch and posterior border of the eye. At a later stage this vessel comes to communicate with the ventral carotid, thus forming the fork of the external carotid.

Mackay (1887) maintains that the ventral carotid does not contribute to the formation of the external carotid, but Twining (1906) and Hughes (1934) have shown that Mackay's conclusions were incorrect.

With elongation of the carotid arch, the ventral carotid comes to assume a somewhat more dorsal position, and in the 6½-day chick embryo the secondary subclavian artery forms an anastomosis with the third arch somewhat ventral to the ventral carotid. Consequently, Mackay's contention that the definitive subclavian and the ventral carotid join in a common stalk is not substantiated by Twining's study.

The dorsal carotid and anterior branches of the ventral carotid undergo an anastomosis between the sixth and seventh days of incubation. This connection results in a dual blood supply to the upper and lower jaws. The portion of the dorsal carotid anterior to the anastomosing branch is referred to by Twining as the internal carotid.

In the chick embryo of 7 to 8 days, the ventral carotid is reported to lose its anterior connection. The carotid arch elongates anteriorly, and with this there is a dorsal and anterior migration of the thyroid gland.

Twining states that the vertebral is generally a branch of the common carotid. Glenny, in a long series of systematic studies, has shown that the vertebrals may vary considerably in the point of origin (dorsal radix anterior to the third arch, the common carotid, or as a branch of the superficial cervical or ventral carotid).

With the interruption of the ventral carotid at a point about midway between the basal portion of the third arch and the cephalic end of the external carotid (Hughes, 1934; Twining, 1906) the entire blood supply to the head (other than that carried by the vertebrals) traverses the dorsal carotids. The earlier communicating vessel, which connects the dorsal and ventral carotids, then comes to supply the vessels which were previously connected with the ventral carotid. Both Twining and Hughes have demonstrated that the anterior or cephalic portion of the ventral carotids function as descending oesophageal arteries. This corresponds with Glenny's (1944d) findings on the Canada goose. Thus the shunt which develops between the dorsal and ventral carotids during the sixth and seventh days of incubation in the chick embryo serves to carry the cephalic blood supply previously carried by the ventral carotid.

While Twining considered the proximal portion of the ventral carotid to degenerate or atrophy, Hughes, in his studies on the 9-day chick and subsequent stages, points out that this portion of the ventral carotid becomes functionally modified to form the ascending oesophageal artery. This view is likewise shared by Glenny (1944d). It should be pointed out that in several orders of birds this functionally modified vessel may be short and greatly reduced, with the result that during its development it may be readily overlooked and even in the adult bird may be detected only after the most careful examination or upon injection with colored materials. Bhaduri and Biswas (1945, 1947, 1954) have shown that it may be continuous, and retain its natural connection. I have observed the superficial cervical artery to be continuous and uninterrupted for the entire length of the neck in several orders of birds. This is probably the basic or ancestral arrangement, whereas the discontinuity of these ventral carotids is probably a modification rather than the usual condition.

At about the eighth to ninth day of incubation the innominate artery may be recognized as originating from the basal portion of the third aortic arch.

Therefore, it may be seen that (1) the innominate arteries are derived from the basal portion of the third arch; (2) the vessel from the point of junction with the subclavian to the region of the thyroid gland represents, for the most part, the dorsal portion of the third arch; and (3) the vessel lying beyond this point up to the base of the head represents the dorsal radix aortae, anterior to the third arch.

The origin and development of the cephalic branches of both the internal and external carotid arteries are extremely well treated by Bauer (1825), Hughes (1934), Ottley (1879), Twining (1906), and others in both general and specific studies on the vascular system of birds. Hughes has pointed out that there are several important differences in the connection of the cephalic branches of the external and internal carotids between birds and mammals and, as a result, there cannot be a direct transfer of information from one group to the other. An exposition of these differences is of no great significance in this study.

The ventral radices aortae (ventral carotids), as has been noted, may become functionally modified to form the ascending oesophageal artery from the posterior portion of the ventral carotids and the descending oesophageal artery from the anterior portion of this same vessel after disjunction. The external carotid, as a result, receives blood by way of the dorsal carotid artery subsequent to the disjunction. It is possible that extensive reduction of the proximal portion of the ventral carotid may result in a very short and much reduced ascending oesophageal artery in many families of birds, while in still others it is a prominent structure.

Hafferl (1933) points out that the subclavian artery in birds is not the primary blood vessel which is formed at first in the embryo but that it arises from the ventral part of the third aortic arch, so that in the adult animal a common trunk with the carotid artery exists as the innominate artery.

The axillary artery is derived from the distal portion of the primary subclavian artery.

Hochstetter (1890) has shown that the definitive subclavian arises from the ventral ends of the carotid arches, as had previously been announced by Mackay (1887), but that the primary arteries to the wing-bud have their source directly from the dorsal aorta, as segmental vessels, and that the primary subclavian then completely disappears. This primary vessel was regarded by Hochstetter as the mammalian homologue. Sabatier (1874), Rathke (1850), and others tended to add confusion to the matter by misplacing or improperly

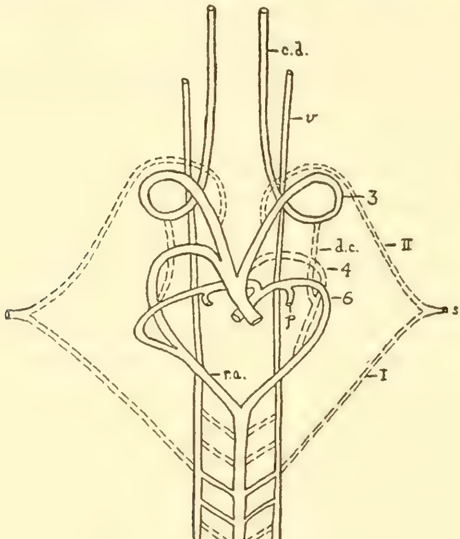

FIGURE 109.—Aortic arch system in *Gallus*, showing primary and secondary subclavians (ventral view, modified after Krassnig). Explanation of symbols: I, primary subclavian artery; II, secondary subclavian artery; 3, carotid arch; 4, systemic arch; 6, pulmonary arch; c.d., dorsal carotid artery; d.a., abdominal aorta; d.c., ductus caroticus; r.a., radix aortae; s, subclavian artery; v, vertebral artery.

locating the definitive subclavian, and it was not until Mackay and Hochstetter published the results of their studies that any true light was thrown upon the problem. In 1883, Brenner challenged the views of Rathke and Sabatier by pointing out that owing to the difference in the relative position of the vagus nerve, superior vena cava, and subclavian, the latter in birds could not correspond in a dorsal mode of origin with the subclavian of mammals.

Hochstetter's work demonstrated that, although the definitive vessel arises as a branch from the ventral part of the carotid arch, there is also present a branch from the dorsal aorta to the anlage of the wing, and that this latter vessel precedes the appearance of the secondary or definitive subclavian artery. The secondary subclavian makes its appearance on or about the sixth day of incubation, while the primary subclavian appears on about the fifth day according to Hochstetter.

Evans (1909b) has shown that the segmental subclavians commonly occur in the 16th to 19th intersomitic spaces. Hughes (1934) later pointed out that the segmental subclavian of the first intersegmental space enlarges at the expense of the others, and soon becomes the single dorsal subclavian artery although considerable variability in the primary subclavian development exists. Fleming's (1928) studies are largely confirmatory of Hughes' observations.

The two independently derived vessels (primary and secondary subclavians) come to form a junction on about the sixth day of incubation with the result that the limb-bud receives its blood supply from two separately derived vessels until about the eighth day, at which time the primary subclavian atrophies and finally disappears. Confirmatory studies on the origin and development of the subclavians in the chick were carried out by C. G. Sabin (1905). He reports that the primary subclavian begins to make its appearance at about 72 hours of incubation, and that by the first half of the fourth day the primary circulation is well established. He points out that the wing vessel is given off in common with the segmental artery on each side from a short dorsal branch of the aorta. Development of the secondary subclavian appears to take place from the primary subclavian forward and from the carotid arch backward. During the early part of the sixth day, Sabin reports the beginning of the formation of the ultimate subclavian from the carotid arch, where it arises from the anterior surface.

At the time of junction of the two subclavians the forelimb occupies a position posterior to the heart, with the result that the secondary subclavian has a comparatively long course to the limb. The major blood supply to the wing is still provided by the primary vessel until about the seventh day of incubation, at which time the heart begins to retrogress into the thorax, thus shortening the course of the secondary subclavian. During the latter part of the seventh day and early part of the eighth day of incubation the primary subclavian atrophies, although a distal vestige may remain for a short time as a small spur extending dorsally into the base of the wing from the secondary subclavian.

As the heart migrates posteriorly it gradually comes to lie in a position posterior to the wing. Consequently, the definitive subclavian becomes shortened and laterally directed. By the ninth day the condition in the embryo is similar to that in the adult.

As Hughes has emphasized, the metamerism of the nervous, muscular, and vascular systems serves as an aid in following changes which subsequently occur during the course of embryonic development. The first and second aortic arches are metamerically associated with the second and third pro-otic segments while the third aortic arch is associated with the first post-otic segment of the early embryo. Since the basal portion of the carotid arch in the adult is located at a position many segments behind the auditory capsule, it is considered that the aortic arches migrate posteriorly during the period of early development.

Prior to this migration, the embryo is a metamerically arranged structure with the segmental organs of the cephalic end in an undisturbed relationship (central nervous system with its nerve roots, somites, and aortic arches). At this time segmentally arranged intersomitic arteries and veins are to be found; however, with a change in this early segmental relationship and the caudad migration of the aortic arches, the roots of the intersomitic blood vessels become severed from the aorta and these vessels then anastomose longitudinally with one another to form the longitudinal vertebral artery. The newly formed vertebral artery later acquires new connections with the dorsal aorta; thus, its formation is dependent upon the posterior migration of the heart and the ultimate position of the aortic arches.

Formation of the subclavians and vertebrals are, as a result of the caudad migration of the heart and aortic arches, intimately related and it is likewise possible that the formation of the secondary external carotid may be closely dependent upon this same modification.

As noted by Hughes, the third aortic arch has migrated backward through 20 segments by the first half of the seventh day of incubation. The carotid arch in its final position lies opposite the 15th cervical ganglion, and the root of the common cervical artery (Fleming, 1926) lies opposite the 18th interspace, where it joins with the persistent intersomitic artery of this interspace. As a result, the distal portion of the vertebral root is derived from the same position as the primary subclavian artery.

Anteriorly the vertebral artery becomes connected with the external carotid by way of a deep branch of the occipital artery which runs between the occipital arch and the atlas.

In the pig, the internal mammary artery is formed by longitudinal anastomosing of the more cephalic of the thoracic intersegmental arteries caudad to the subclavian artery, and subsequent deletions of the proximal parts of the other intersegmentals leave it to arise from the subclavian. The origin is quite similar to that of the vertebral artery anterior to the subclavian. In the bird, however, the so-called internal mammary (thoracic or intercostal) artery does not appear to form in the same manner as in the mammal. Insofar as I can determine, no specific study has been made of the origin and development of this vessel and the other pectoral arteries.

Anterior intercostal supply is derived from the ventrally located vessels, variously named, that arise as branches of the subclavian arteries. There are no segmentally arranged vessels arising from the right posterior radix aorta as in mammals. Posteriorly, the intercostal muscles are supplied by segmentally arranged arteries which arise as branches of the abdominal aorta. No connection with posteriorly located arteries could be established, and it is presumed that the so-called internal mammary is not homologous with that of mammals but is an intercostal artery not homologous with the intercostals of mammals.

The above observations were made possible by materials especially prepared for this study by Ward's Natural Science Establishment. Three-day chicks were doubly injected with colored plastic and the entire birds were then treated with corrosive solutions. As a result of this treatment, it was found that the left radix aortae could be injected for about half of its normal length.

Changes in arrangement of thoracic and cervical arteries

In birds, several significant changes may take place during the course of embryonic development of the individual aside from and in addition to (1) loss of the first, second, and fifth aortic arches, (2) loss or functional modification of the ductus caroticus, (3) loss of the left fourth aortic arch, (4) atrophy or functional modification of the left radix aortae, (5) atrophy or loss of the ductus botalli, (6) the shunt anastomosis between the dorsal and ventral carotids (anterior radices aortae), and (7) the accompanying functional modification of the posterior end of the ventral carotid into an ascending oesophageal or superficial cervical artery and the anterior end of this same vessel into a descending oesophageal or superficial cervical artery.

The dorsal carotids usually migrate to a median ventral position along the long axis of the cervical vertebrae and, with the development of the ventral cervical musculature, soon become enclosed within the hypapophysial canal. These vessels then follow the course of this canal to a point near the site of articulation between the third and fourth cervical vertebrae, where they emerge and send off branches comparable to those which join the internal and external carotid arteries.

It should be noted that in most orders and families of birds the right dorsal carotid artery comes to lie in a position dorsad to the left dorsal carotid artery, within the hypapophysial canal. This particular orientation of the carotids may be attained as a result of the growth of the ventral cervical muscles and their encroachment upon

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the space occupied by the carotids within the hypapophysial canal. Further reduction in size of the hypapophysial canal, by the encroachment of the aforementioned cervical muscles, may account, in part, for the fusion of the two carotid arteries and the resulting formation of the unicarotid arrangement.

While I have noted this orientation of left and right carotids within the hypapophysial canal many times, Bhaduri and Biswas (1954) have made particular mention of the condition.

Commonest of the modifications which occur because of the position of the dorsal radices (dorsal carotids) is that of fusion of these vessels between the third arch and the base of the head. As a result of this fusion of the two primary dorsal carotids, a single vessel traverses the length of the neck. In some orders of birds the basal portion of both vessels are present, while in other orders or families only the basal portion of one of the conjugate vessels is present. In still other instances, a vestige of the atrophied vessel remains as evidence of its earlier embryonic relationship in the system. When both basal portions of the conjugate vessel are present they may be equal or one side may be reduced in diameter. At the cephalic end of the conjugate carotid both left and right carotids are given off before they further divide into the several internal and external branches. These branches, as Hughes (1934) has pointed out, are not the same for birds as for mammals.

Reduction in the lumen of the basal portion of the dorsal carotids may occur on either side, and still further alteration in this portion of the carotid may occur in the form of atrophy, with retention of either a complete or an incomplete ligament. Insofar as I can determine, this ligament has never been described in any of the literature heretofore, and no name has as yet been assigned to it. Ottley (1879) described the presence of two white imperforate cords lying within the hypapophysial canal of *Bucorvus abyssinicus*. These he believed to be the remnants of the dorsal carotids. In recent studies I have had the opportunity of observing the same or similar structures which are definitely the ligamentous vestiges of the dorsal carotids. Since these structures were originally noted by Ottley, it would be well to refer to them as the ligamenti ottleyi. In forms which present ligaments on both sides (ligamenti ottleyi), the blood supply to the head is carried by enlarged vertebral and superficial cervical arteries.

When the paired dorsal radices aortae (anterior) do not enter the hypapophysial canal, the dorsal carotids may become further modified and may be reduced in size. In both *Zanclostomus javanicus javanicus* and *Phaenicophaeus pyrrhocephalus* the dorsal carotids were found to be superficial vessels, much reduced, and functionally modified as oesophageal arteries in addition to the normal function of cephalic blood supply. In *Rhamphococcyx curvirostris erythrognathus* the left dorsal carotid was superficial and modified to form an oesophageal blood supply while the right vessel was reduced to a ligamentum ottleyi. Both dorsal carotids have been found to be present as ligamenti ottleyi in *Bucorvus abyssinicus* and in *Rhopodytes viridirostris.*

Another variation in the arrangement of the dorsal carotids results from the superficial position of one of these vessels while the complimentary vessel lies within the hypapophysial canal. This is observed most commonly among the Psittaciformes, in which order the right carotid enters the hypapophysial canal while the left carotid is superficial and lies in close association with the vagus nerve of that side.

Some of the aberrancies noted among related species and genera emphasize the importance of geographical and ecological distribution of species, with the resultant specific and subspecific isolation as factors in the selection of successful types which may be found to present these anatomical variations. In addition to other factors, anatomical variations may, in conjunction with studies of geographical distribution, serve to show more clearly possible lineage within a family or order of birds on the one hand and possible routes of movement and dispersal in the course of evolution on the other hand.

The exact site of origin of the coracoid or sternoclavicular artery varies somewhat in different families of birds. Generally this vessel is found as a branch of the subclavian just medial to the axillary artery, but in a few orders it arises from different points on either the subclavian or the pectoral stem, and in some instances two, or rarely three, pairs of these vessels are present. In order to facilitate the classification of these vessels the following scheme is proposed:

Type A: coracoid artery is medial to the axillary.
Type B: coracoid artery is opposite the base of the axillary.
Type C: coracoid artery is lateral to the axillary.
Type D: two coracoids are present; one is medial or opposite the base of the axillary, the other is lateral to the axillary.
Type E: two coracoids are present; both are medial or opposite the base of the axillary.
Type F: two coracoids are present; both are lateral to the base of the axillary.

The thoracic, intercostal, or internal mammary artery of birds likewise is found to arise at slightly different relative positions—from a point at the base of the inferior pectoral artery to a point near the base of the coracoid or sternoclavicular artery, and in some instances both of these vessels have a common root from the subclavian artery. Such differences are found to be of common occurrence within several orders of birds. In the Galliformes and the Passeriformes there appears to be a graded series in the sites of attachment of the thoracic artery from a lateral to a medial position. As a result of these observations, numerical values can be assigned to the site of attachment of the intercostal or thoracic artery, and these values may come to be used as an index in specific levels of evolution. The following scheme is proposed for the classification of the thoracic arteries in birds:

Type 1: attachment to the pectoral stem lateral to the axillary.
Type 2: attachment to the subclavian between the axillary and coracoid.
Type 3: attachment to the subclavian at the base of the coracoid.
Type 4: attachment to the subclavian, but with a common root for both the coracoid and thoracic.
Type 5: attachment to the subclavian medial to both the axillary and coracoid.
Type 6: two separate thoracic arteries are present; the primary thoracic is the same as type 1 above, while the secondary thoracic is the same as type 3 or type 4 above.

The medial migration of the thoracic artery appears to have some phylogenetic significance as yet not understood.

Arrangements of dorsal carotid arteries

Insofar as the early embryonic stages in the development of the dorsal carotids are concerned, all birds may be considered to be bicarotid, but during subsequent stages in development many parts are deleted or functionally modified in an orderly sequence of events. As a result, higher-level deletions may be regarded as significant as indices of more recent derivation or of higher levels of species evolution, and with particular respect to the aortic arch system. Most recent evolutionary changes in the aortic arch system are related to the adult condition of the anterior dorsal radices aortae or dorsal carotid arteries.

Since the bicarotid condition is more primitive than the unicarotid condition, the former is to be considered as representing a lower level in the evolution of the system, and any variation of the unicarotid condition may be considered to represent an advance over the bicarotid condition. Within each of the main groups, however, there are certain special arrangements or modifications which may be regarded to be of additional value in determining relative positions within a family or order with respect to the evolution of the organ system.

A description of each of the known and anticipated arrangements of the dorsal carotid arteries is essential, and to clarify the classification of the carotid arrangement it is proposed that the bicarotid condition be referred to as Class A and the unicarotid condition be referred to as Class B. In addition, certain numerical values are assigned to the variations within each of these classes, and these numerical values may serve as indices of levels of evolution or specialization. Further, the letters *d* and *s* serve to indicate right or left side.

Bicarotid arrangements

1. Bicarotidinae normales: Both dorsal carotids enter the hypapophysial canal and pass anteriorly to the head without fusing. This arrangement is found in most orders of birds and is to be regarded as the basic arrangement.

2. Bicarotidinae abnormales: One of the dorsal carotids enters the hypapophysial canal, while the complimentary vessel of the opposite side remains as a superficial vessel. This condition is of infrequent ordinal occurrence but is very common among the parrots, in which group the right vessel enters the hypapophysial canal in most instances.
3. Bicarotidinae infranormales: Both dorsal carotids are superficial and lie along the ventral face of the neck. This condition is of rare occurrence. Despite the fact that it had been presumed to exist (Meckel, 1826), it was not discovered until 1952 when Glenny observed it in *Zanclostomus* and *Phaenicophaeus* and a further modification of it in *Ramphococcyx*. These vessels were found to send small branches to the oesophagus.

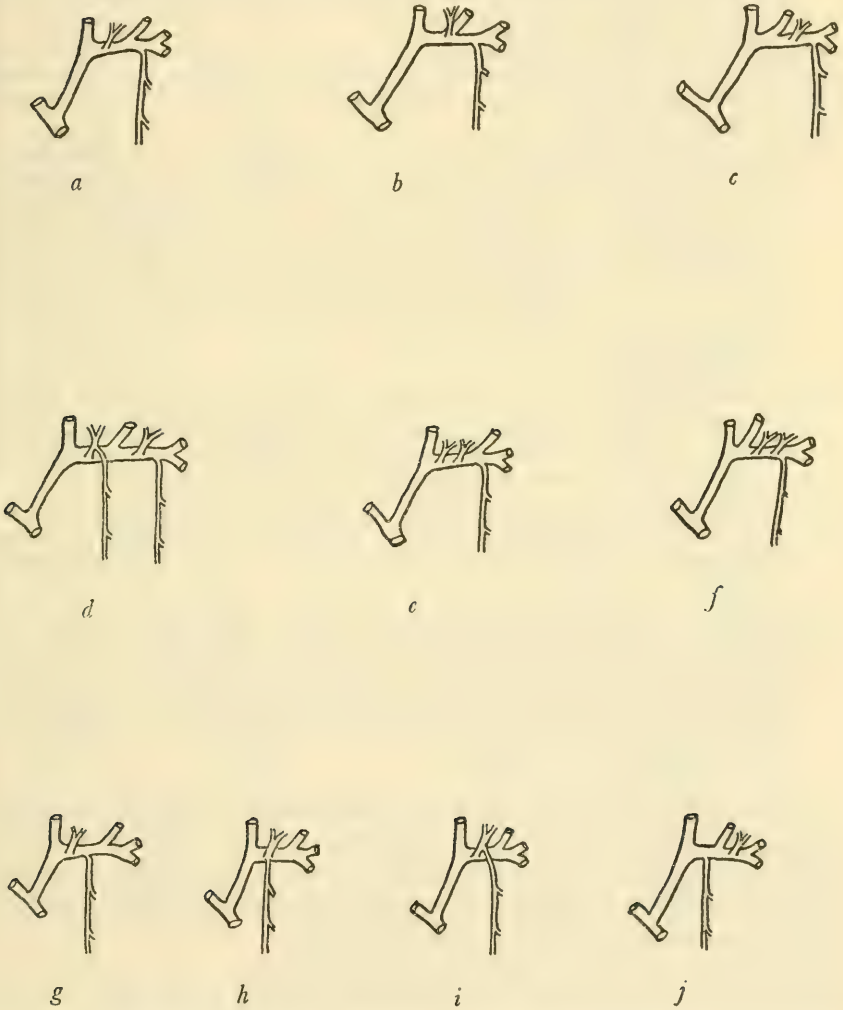

FIGURE 110.—Points of origin and types of the coracoid or sternoclavicular and thoracic or intercostal arteries (ventral views, left side only). Type of coracoid indicated by capital letter, type of thoracic indicated by numeral (for code see pp. 543, 544): *a*, A–1; *b*, B–1; *c*, C–1; *d*, D–6; *e*, E–1; *f*, F–1; *g*, A–2; *h*, A–3; *i*, A–4; *j*, C–5.

4. Ligamenti carotidinae normales (ligamenti ottleyi): Both anterior dorsal radices aortae (dorsal carotids) atrophy, but remain as the ligaments of Ottley and enter the hypapophysial canal. This is a condition of rare occurrence and has been observed in *Bucorvus* and *Rhopodytes.* This condition represents the culmination of the bicarotid evolution except for the unicarotid arrangements.

Unicarotid arrangements

1. Conjuncto-carotidinae normales: A single carotid artery enters the hypapophysial canal, but this is supplied by a pair of vessels of equal size from the common carotids of both left and right sides. This arrangement is quite common among the Ciconiiformes.
2. Conjuncto-carotidinae abnormales: The same as in 1, above, except that the basal vessel is reduced in diameter on one side. This is the first level in the modification of the conjugate carotid arrangement and is found in the flamingos and herons.
3. Ligamentum carotidinae-conjuncti: As in 2, above, or further modified except that the lumen of the reduced vessel is not complete and the distal portion of the basal vessel is reduced to a ligament. This condition is found to exist at two levels of atrophy: (1) second level modification results from atrophy at the anterior end of one of the basal vessels, but with a lumen for nearly half of its length, and (2) third level modification results from complete closure of the basal vessel with retention of a ligamentous vestige. This ligament may be entire or partial. The degree of resorption appears to vary in different species.
4. Laevo-carotidinae or dextro-carotidinae normales: The same as in 3, above, except that there is no remaining vestige of the ligamentous connection from the opposite side. This is the fourth level modification of the unicarotid arrangement and is commonly found in many orders of birds.
5. Laevo-carotidinae or dextro-carotidinae infranormales: The same as 4, above, except that the functional carotid is superficial and does not enter the hypapophysial canal. This has been reported in a single passerine genus, *Orthonyx.*
6. Ligamentum unicarotidinae (ligamentum ottleyi): The culmination of the unicarotid evolution results in atrophy of the single dorsal carotid artery. This may be at either of two levels: (1) retention of the ligamentous vestige, or (2) partial or complete resorption of the ligament. In such a case, the vertebrals and superficial cervical arteries will take over the function of supplying the blood to the head.

To simplify and codify the above classification of carotid arrangements, the following scheme is suggested; it may serve to indicate more nearly those close similarities and gross dissimilarities which may be presumed to exist and to indicate which orders of birds may be undergoing important anatomical evolution:

Class A

A–1	Bicarotidinae normales.
A–2–d	Bicarotidinae abnormales: right vessel superficial.
A–2–s	Bicarotidinae abnormales: left vessel superficial.
A–3	Bicarotidinae infranormales.
A–4	Ligamenti carotidinae normales (ligamenti ottleyi).

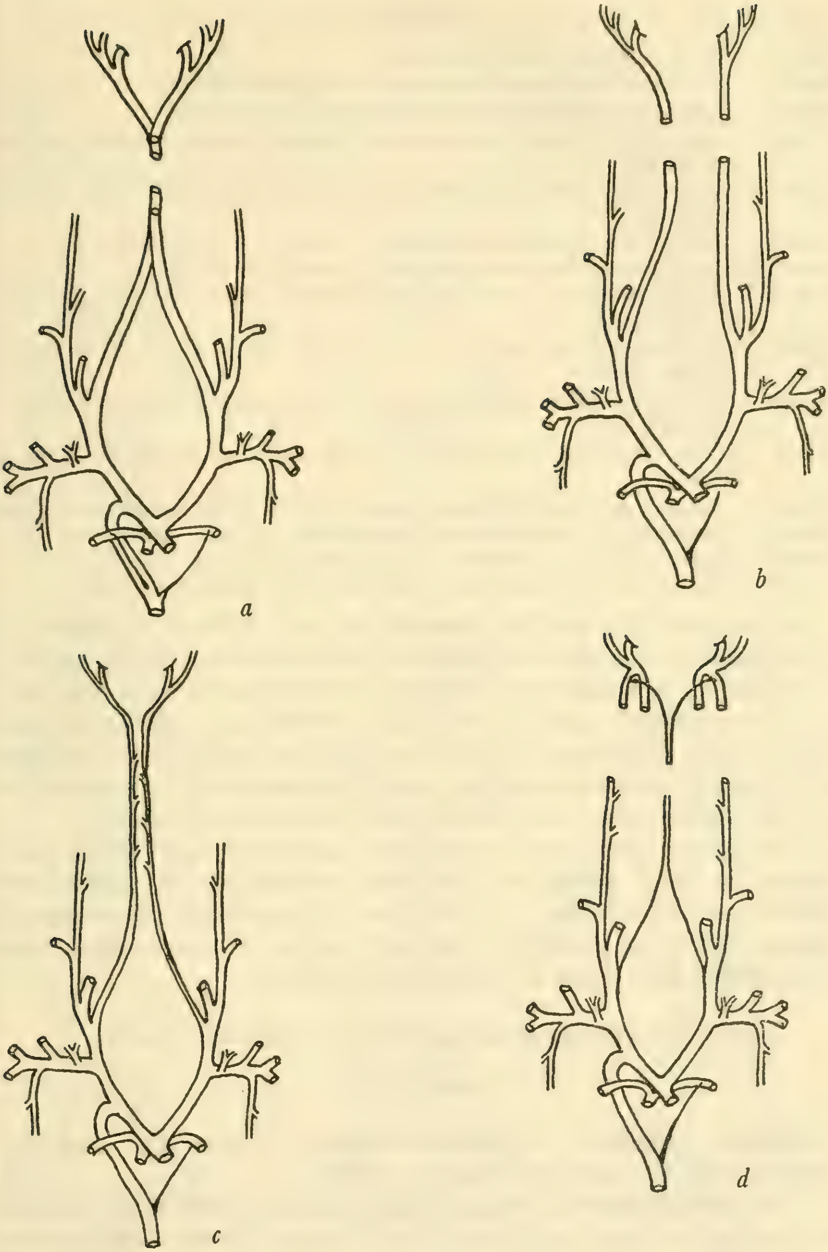

FIGURE 111.—Arrangements of the dorsal carotid arteries and the associated cervical and thoracic arteries in Aves Bicarotidinae (ventral views). Types (for code see pp. 544–546): *a*, A–1; *b*, A–2–s; *c*, A–3; *d*, A–4.

Class B

B–1	Conjuncto-carotidinae normales.
B–2–d	Conjuncto-carotidinae abnormales: right side reduced.
B–2–s	Conjuncto-carotidinae abnormales: left side reduced.
B–3a–d	Ligamentum carotidinae-conjuncti: partial lumen; ligament on the right side.
B–3a–s	Ligamentum carotidinae-conjuncti: partial lumen; ligament on the left side.
B–3b–d	Ligamentum carotidinae-conjuncti: entire, on right side.
B–3b–s	Ligamentum carotidinae-conjuncti: entire, on left side.
B–4–d	Dextro-carotidinae normales: right carotid alone enters the hypapophysial canal.
B–4–s	Laevo-carotidinae normales: left carotid alone enters the hypapophysial canal.
B–5–d	Dextro-carotidinae infranormales: right carotid is superficial (left is lacking).
B–5–s	Laevo-carotidinae infranormales: left carotid is superficial (right is lacking).
B–6a–d	Ligamentum unicarotidinae (ligamentum ottleyi): entire, right side.
B–6a–s	Ligamentum unicarotidinae (ligamentum ottleyi): entire, left side.
B–6b–d	Ligamentum unicarotidinae: incomplete or lacking, right side.
B–6b–s	Ligamentum unicarotidinae: incomplete or lacking, left side.

By means of this codified classification, all birds can be placed in one of two major groups with respect to the adult carotid arrangement, and these in turn may then be further subdivided to show their apparent value with respect to levels of evolution and possible phyletic relationships. Furthermore, this carotid classification may be used to show both species evolution and, ontogenetically, the course of changes which took place during embryonic development.

This scheme has the advantage of being able to show where large (macro) or small (micro) steps in avian evolution of the aortic arch system has taken place. It also has the particular advantage of demonstrating the probable ontogenetic course of events which took place within any single or individual specimen.

Arterial arrangement-patterns in neck and thorax

Class AVES

Basically bicarotid. Several functional and structural modifications are found in both families and orders.

As in other amniotes, the carotid, systemic, and pulmonary arches alone remain as functional derivatives of the embryonic aortic arches. The left ligamentum botalli atrophies and may become incorporated into the ligamentum aortae or it may be completely resorbed. The right ligamentum botalli may remain as a persistent vestige of the ductus botalli or it may be reduced to a ligamentous "button"; it may be incorporated into the wall of the right radix aortae or be completely resorbed.

The right systemic arch alone remains as the functional vessel carrying blood from the aortic root to the functional radix aortae. Biswas (1946) has reported the occurrence of both a left and right systemic arch in a specimen of *Ploceus philippinus philippinus*, along with a patent left radix aortae which was occluded at the posterior end. A left ligamentum botalli was present in this specimen.

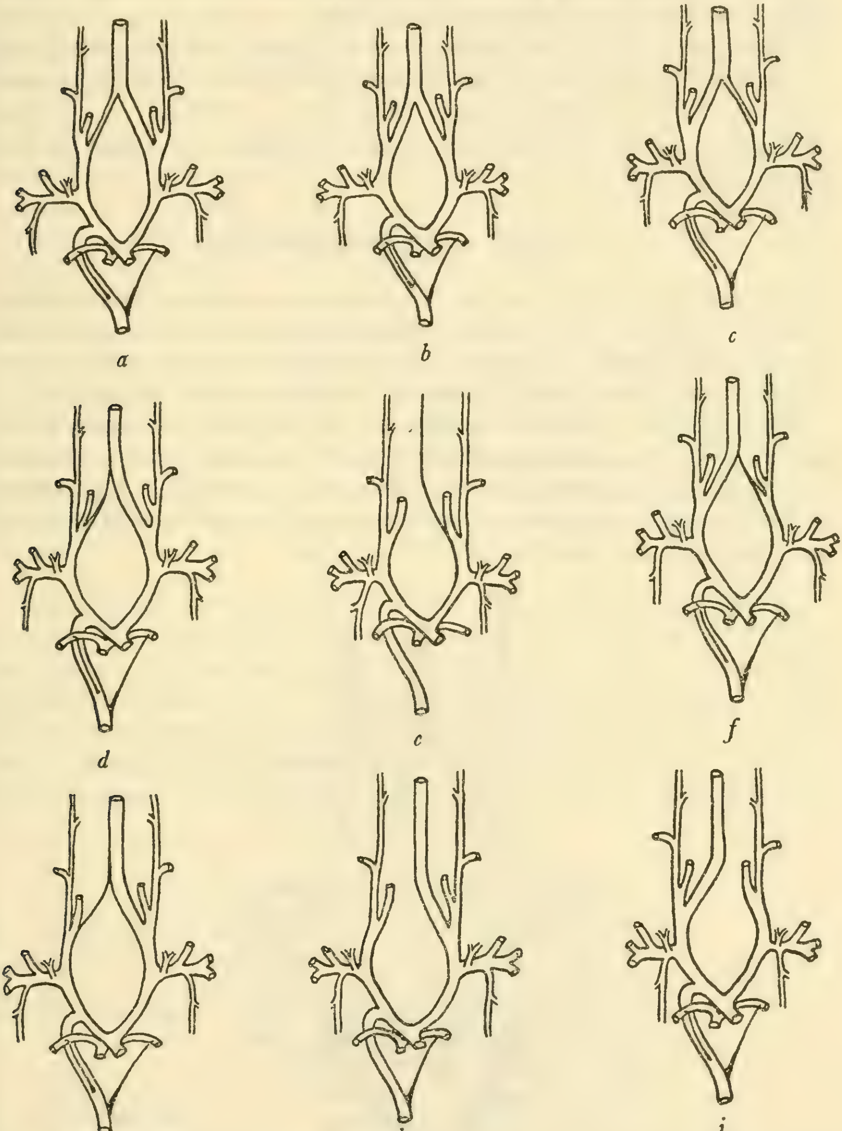

FIGURE 112.—Arrangements of the dorsal carotid arteries and the associated cervical and thoracic arteries in Aves Unicarotidinae (ventral views). Types (for code see pp. 546, 548–549): *a*, B–2–d; *b*, B–1; *c*, B–2–s; *d*, B–3a–d; *e*, B–6–s; *f*, B–3a–s; *g*, B–3b–d; *h*, B–4–s; *i*, B–4–d.

The left radix aortae usually persists throughout most of its length as a ligamentum aortae.

The ducti carotici are usually functionally modified, although the right ductus caroticus frequently is found as a persistent ductus in several species of birds, and may be expected to occur in any species of bird as an anomaly (Bhaduri, 1939; Finn, 1891; Glenny, 1940b, 1944a; Mathew, 1944; Subhapradha, 1944).

The anterior dorsal radices aortae or dorsal carotids usually lie within the hypapophysial canal, although exceptions to this have been reported (Beddard, 1898; Garrod, 1873; Glenny, 1954b).

Modifications of the dorsal carotids have been discussed in the previous chapter.

Subclass ARCHAEORNITHES

Ancestral birds, which are as yet unknown, were in all probability bicarotid. In the short-necked forms these vessels may have been superficial, although it is more than probable that they entered the hypapophysial canal as is the case in the alligator and crocodile.

The relatively close relationship to the crocodilians seems to be confirmed by the arrangement of the cervical and thoracic arteries in both birds and the alligator. The latter presents a laevo-carotidinae normales arrangement, with the single dorsal carotid entering the hypapophysial canal.

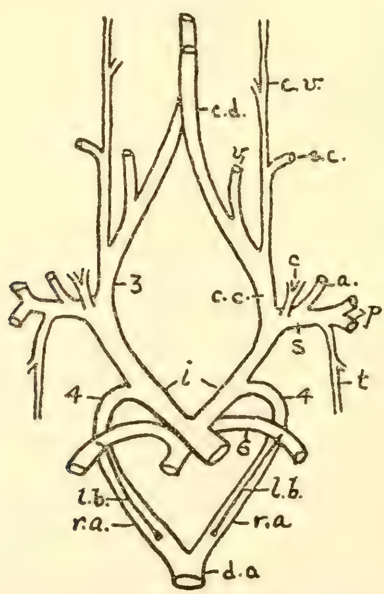

FIGURE 113.—Main cervical and thoracic arteries as postulated for the Archaeornithes, ventral view. (For explanation of symbols see facing page.)

It is possible that the left systemic arch arose at the base of the left innominate artery and continued to function as in reptiles. In some forms, the left systemic arch may have become somewhat reduced. Both ducti botalli were probably reduced to ligamentous vestiges, although either may have presented a lumen from time to time.

The subclavian, pectoral stem, and branches were possibly variable, but essentially similar to those of most present-day orders of birds. The vertebrals and superficial cervicals either had a common root or arose separately but in the same general location, near the thyroid gland.

The ventral carotids probably maintained their anterior cephalic connections. The condition of uniform bilaterality probably persisted in most of the earliest forms. It is possible that in these early avian ancestral forms there may have been reduction in diameter of both the left systemic arch and the left radix aortae.

The ventricle was probably completely divided into left and right chambers, and the pulmonary root emerged from the right ventricle while the aortic root emerged from the left ventricle. One essential difference exists between the crocodilian heart and the avian heart—that is, the left systemic arch probably arose from the aortic root or from the innominate artery instead of having a separate root arising or emerging from the right ventricle as in the crocodilian heart.

Subclass NEORNITHES

Most of the ancestral forms were probably bicarotid, although some may have been undergoing evolutionary changes toward the unicarotid condition. For the most part, there probably was a great similarity in the aortic arch system of the early Neornithes to that of the true avian archaeornithial ancestors. Certain advances resulting from both structural and functional modifications, including atrophy and deletion of parts, undoubtedly took place. Among these early modi-

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Explanation of symbols on figures 113–118

3.	Third aortic (carotid) arch.
4.	Fourth aortic (systemic) arch.
6.	Sixth aortic (pulmonary) arch.
4x.	Functional ductus caroticus serving as the right fourth aortic (systemic) arch.
a.	Axillary artery.
c.	Coracoid artery.
c.c.	Common carotid artery.
c.d.	Dorsal carotid artery.
c.v.	Ventral carotid or superficial cervical artery.
d.a.	Dorsal (abdominal) aorta.
d.c.	Ductus caroticus.
d.s.	Ductus shawi.
g.	Arteria gallinae (supplies trachea).
i.	Innominate arteries.
l.a.	Ligamentum aortae.
l.b.	Ligamentum botalli.
oe.	Oesophageal arteries.
p.	Pectoral arteries.
r.a.	Radix (radices) aortae.
s.	Subclavian artery.
s.c.	Subscapular artery.
t.	Thoracic or intercostal artery.
v.	Vertebral artery.

fications was the loss of the left systemic arch with the reduction to a ligament of the left radix aortae. This may have been accompanied by further atrophy and reduction in the vestiges of the ducti botalli. The site of junction of the vertebrals with the carotids probably underwent considerable change with the result that there was considerable variation within the several major groups of birds.

For the most part, the bicarotid condition persisted in most of the major groups of birds. But, as evolution of the aortic arch system progressed, there was considerable variation in the arrangement of the dorsal carotids. During the process both left and right configurations probably arose, but the widespread occurrence of the bicarotid and laevocarotid conditions may have led to the present dominance of these two main arrangement-patterns.

Evidence that this process is continuing may be found in several families of extant birds, noted below.

Order STRUTHIONIFORMES

Family Struthionidae

Carotids A–1; type A coracoid artery; type 1 thoracic artery; ligamentum aortae and ligamentum botalli prominent; vertebrals and superficial cervicals arise from the common carotids either separately or from a common root.

Garrod (1873) reported *Struthio camelus* to be bicarotidinae normales.

References: Fleming, 1926; Garrod, 1873.

Species studied

By Garrod	By Glenny
Struthio camelus Linné	*Struthio camelus australis* Gurney

Order RHEIFORMES

Family Rheidae

Carotids B–4–s; type A coracoid artery; type 1 thoracic artery; ligamentum aortae and ligamentum botalli present; vertebrals and superficial cervicals arise from the common carotids separately but in close association with each other.

F. P. Evans (1883) stated that the right carotid is evidently present, though much smaller than the left and instead of converging to meet the left, which enters the hypapophysial canal, it continues onwards as a superficial vessel in close association with the right vagus nerve and jugular vein.

Glenny (1943d) observed much the same condition in a rhea embryo, but difficulty in dissection made it impossible to follow the superficial vessel to the head. Further studies are necessary to make clear the relationships of these vessels in the rheas.

References: F. P. Evans, 1883; Garrod, 1873; Glenny, 1943d.

Species studied

By Evans	By Glenny
Rhea americana (Linné)	*Rhea americana intermedia* Rothschild and Chubb
By Garrod	
Rhea americana (Linné)	

Order CASUARIIFORMES

Family Casuariidae

Carotids typically A–1, but may vary; type A coracoid artery; type 1 thoracic artery; vertebrals and superficial cervicals are variable in origin from the common carotid arteries.

Garrod reported two species of *Casuarius* to be bicarotidinae normales (A–1). In a dissection of a zoo specimen of *Casuarius*, I found that the left dorsal carotid alone entered the hypapophysial canal (B–4–s).

It is possible that in the course of evolution of these birds some specific or subspecific variation in the carotid arteries may have taken place. It might be quite profitable to make an extensive study of the arteries in the different species and subspecies of the cassowaries and to correlate these findings with their geographical distribution.

References: Garrod, 1873; Glenny, 1942c.

Species studied

By Garrod	By Glenny
Casuarius bicarunculatus P. L. Sclater	*Casuarius* sp. (zoo specimen)
Casuarius bennetti Gould	

Family Dromiceiidae

Carotids A–1; no other details available.

Species studied

By Garrod

Dromiceius n.-hollandiae (Latham)

Order APTERYGIFORMES

Family Apterygidae

Carotids B–4–s; coracoid artery arises from the subclavian medial to the thoracic artery; no axillary artery could be observed; ligamentum aortae and ligamentum botalli both present; pectoral branches greatly modified, and somewhat similar to those observed in *Casuarius* sp.; vertebrals and superficial cervicals arise variously and independent of each other from the common carotids; thyroids arise from the innominate arteries near the base of the common carotid arteries.

Further study of the thoracic and cervical arteries of the kiwis should be carried out in an effort to obtain as much information as possible about these birds.

References: Garrod, 1873; Glenny, 1942b; Owen, 1841.

Species studied

By Garrod

Apteryx australis mantelli Bartlett
Apteryx owenii Gould

By Glenny

Apteryx australis mantelli Bartlett

By Owen

Apteryx australis Shaw

Order TINAMIFORMES

Family Tinamidae

Carotids A–1; type A coracoid artery; type 1 to type 4 thoracic artery; both the ligamentum aortae and the ligamentum botalli are usually present; vertebrals and superficial cervicals arise variously from the common carotid, either separately or from a common root. Considerable variability in the secondary arteries of the neck and thorax exists.

References: Garrod, 1873; Glenny, 1946a.

Species studied

By Garrod

Crypturus sallaei=*Crypturellus cinnamomeus goldmani* (Nelson)
Rhynchotus rufescens (Temminck)

By Glenny

Tinamus major (Gmelin)
Crypturellus sp.
Crypturellus cinnamomeus (Lesson)
Nothoprocta perdicaria (Kittlitz)
Nothura maculosa boliviana Salvadori
Eudromia elegans d'Orbigny and Geoffroy, (2)

Order SPHENISCIFORMES

Family Spheniscidae

Carotids A–1; type A coracoid artery; type 1 thoracic artery; ligamentum aortae present and prominent; ligamentum botalli usually present; vertebrals arise variously from the common carotids, but usually not in common with the superficial cervical arteries.

References: Garrod, 1873; Glenny, 1944c, 1947a; Jullien, 1878; Müller, 1908.

SPECIES STUDIED

By Garrod

Aptenodytes pennantii=*Aptenodytes patagonica* J. F. Miller
Spheniscus demersus (Linné)
Spheniscus humboldti Meyen

By Glenny

Aptenodytes forsteri G. R. Gray
Pygoscelis papua (Forster)
Eudyptes crestatus (J. F. Miller)
Spheniscus demersus (Linné) (2)
Spheniscus humboldti Meyen
Spheniscus mendiculus Sundevall

By Jullien

Aptenodytes patagonica J. F. Miller

Order GAVIIFORMES

Family GAVIIDAE

Carotids A–1; type A coracoid artery; type 1 thoracic artery; ligamentum aortae and ligamentum botalli present; vertebrals and superficial cervicals arise separately from the common carotids; oesophageal arteries variable in number and site of origin.

References: Garrod, 1873; Glenny, 1945e.

SPECIES STUDIED

By Garrod

Colymbus glacialis=*Gavia immer* (Brünnich)

By Glenny

Gavia stellata (Pontoppidan) (2)
Gavia immer (Brünnich) (2)

Order COLYMBIFORMES

Family COLYMBIDAE

Carotids B–4–s; type A and type E coracoid arteries; type 1 to type 4 thoracic arteries; ligamentum aortae present; ligamentum botalli may be present or lacking; vertebrals and superficial cervicals arise variously from the common carotid; oesophageal blood supply highly variable and in some species extensive.

References: Garrod, 1873; Glenny, 1946b.

SPECIES STUDIED

By Garrod

Podiceps minor=*Poliocephalus ruficollis* (Pallas)
Podiceps cristatus=*Colymbus cristatus* Linné

By Glenny

Colymbus chilensis (Lesson)
Colymbus occipitalis (Garnot)
Colymbus auritus Linné (2)
Colymbus nigricollis californicus (Heermann)
Colymbus grisegena holböllii (Rheinhardt)
Aechmorphorus major (Boddaert)
Podilymbus podiceps podiceps (Linné) (2)

Order PROCELLARIIFORMES

Typically bicarotid (A–1) or rarely unicarotid; type A coracoid artery; type 1 thoracic artery; ligamentum aortae present, but sometimes much reduced; ligamentum botalli frequently present; vertebrals and superficial cervicals variable in origin from the common carotid arteries.

Reference: Garrod, 1873.

Family Diomedeidae

Right ligamentum botalli present.

Species studied

By Glenny

Diomedea immutabilis Rothschild

Family Procellariidae

Subfamily Fulmarinae

Ligamentum botalli usually present (reduced or lacking in *Pachyptila desolata*); vertebrals arise separately from the carotid at or near the base of the cervicals.

Subfamily Puffininae

Ligamentum botalli usually present (reduced or lacking in *Bulweria bulweria, Pterodroma lessonii, Puffinus lherminieri subalaris*); origin of vertebrals highly variable.

Priocella antarctica (USNM 321474), carotids: B–3a–d.

Species studied

By Garrod

Prion vittata=*Pachyptila forsteri* (Latham)
Aestrelata lessoni=*Pterodroma lessonii* (Garnot)
Thalassidroma bulweri=*Bulweria bulwerii* (Jardine & Selby)

By Glenny

Daption capensis (Linné)
Fulmarus glacialis (Linné) (2)
Halobaena caerulea (Gmelin)
Pachyptila desolata (Gmelin) (2)
Priocella antarctica (Stephens)
Procellaria aequinoctialis Linné
Puffinus griseus (Gmelin)
Puffinus nativitatis Streets
Puffinus opisthomelas Coues
Puffinus lherminieri subalaris Ridgway
Pterodroma lessonii (Garnot)
Pterodroma leucoptera hypoleuca (Salvin) (2)
Bulweria bulwerii (Jardine and Selby)

Family Hydrobatidae

Ligamentum aortae usually reduced; ligamentum botalli usually lacking, or when present only as a linea botalli; superficial cervical arteries variable in number but more are present in *Oceanodroma* than in other genera studied.

SPECIES STUDIED

By Garrod

Thalassidroma pelagica=*Hydrobates pelagicus* (Linné)
Thalassidroma fregata=*Pelagodroma marina* (Latham)

By Glenny

Oceanites oceanicus (Kuhl)
Oceanites gracilis galapagoensis Lowe
Oceanodroma leucorhoa (Vieillot)
Oceanodroma macrodactyla W. E. Bryant
Oceanodroma monorhis socorroensis C. H. Townsend
Oceanodroma hornbyi (G. R. Gray)
Halocyptena microsoma Coues

Family PELECANOIDIDAE

Ligamentum aortae prominent; ligamentum botalli lacking or reduced to a linea botalli; vertebrals and cervicals usually arise separately from the common carotid; superficial cervicals variable, but usually two pairs are present.

In *Pelecanoides exsul* the ligamentum aortae may present a lumen for a short distance. The left dorsal carotid alone enters the hypapophysial canal in *Pelecanoides garnotii* (USNM 344806): B–4–s.

SPECIES STUDIED

By Glenny

Pelecanoides exsul Salvin (2)
Pelecanoides garnotii (Lesson)

Order PELECANIFORMES

Both bicarotid and unicarotid arrangements occur within the order; type A coracoid artery; type 1 thoracic artery except in *Morus bassanus* (type 2 or type 3); ligamentum aortae present; ligamentum botalli either present or absent; origin of vertebrals and superficial cervicals variable.

Reference: Garrod, 1873.

Family PHAËTHONTIDAE

Carotids A–1; presence of ligamentum botalli variable.

SPECIES STUDIED

By Glenny

Phaëthon lepturus dorotheae Mathews
Phaëthon rubricauda rothschildi (Mathews)

By Garrod

Phaëthon sp.

Family PELECANIDAE

Carotids B–3b–d; ligamentum botalli generally present.

The unicarotid condition in this family is clearly a further step in the modification of the conjugate carotid condition of the dorsal carotid arteries.

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Species studied

By Glenny

Pelecanus erythrorhynchos Gmelin

Pelecanus occidentalis carolinensis Gmelin

Family Sulidae

Carotids B–4–s (*Sula* spp.) and A–1 (*Morus bassanus*); type 1 thoracic artery (*Sula* spp.) and type 2 or type 3 thoracic artery (*Morus bassanus*); ligamentum botalli lacking.

Species studied

By Garrod

Sula bassana=*Morus bassanus* (Linné)

By Glenny

Morus bassanus (Linné)

Sula sula sula (Linné)

Sula dactylatra personata Gould

Sula leucogaster etesiaca Thayer and Bangs

Sula leucogaster plotus (Forster)

Family Phalacrocoracidae

Carotids A–1; ligamentum botalli lacking; vertebrals and superficial cervicals usually have separate points of origin from the common carotid arteries.

Species studied

By Glenny

Phalacrocorax auritus floridanus (Audubon)

Phalacrocorax pelagicus pelagicus Pallas

Phalacrocorax urile (Gmelin)

Phalacrocorax verrucosus (Cabanis)

By Garrod

Phalacrocorax carbo (Linné)

Family Anhingidae

Carotids B–4–s; ligamentum botalli is reduced to a linea botalli.

Species studied

By Glenny

Anhinga anhinga (Linné)

Family Fregatidae

Carotids A–1 and B–4–s; ligamentum botalli absent.

Garrod (1873) reported the bicarotid condition in *Fregata aquila*, while I found the laevocarotid condition in *Fregata minor palmerstoni*.

Species studied

By Garrod

Fregata aquila Linné

By Glenny

Fregata minor palmerstoni (Gmelin)

Order CICONIIFORMES

The arrangement of the dorsal carotids is highly variable, but basically bicarotid (see list of species studied); type A coracoid artery;

type 1 thoracic artery; ligamentum aortae present; presence of the ligamentum botalli variable; vertebrals and superficial cervicals usually arise separately from the common carotids.

This order appears to be in a state of flux insofar as evolution of the aortic arch system is concerned. This evolution is not restricted to a single family, although the greatest evidence of carotid evolution is to be observed in the Ardeidae. It has been found that, even within the same species, both the bicarotid and conjugate carotid conditions may occur, and that within a species which is normally conjugate carotid, both the B–1 and the B–2 condition may exist. It may be presumed, therefore, that further variation in the carotids may take place, and that any apparent deviation in a condition as reported may be accounted for on the basis of individual levels in the evolution of this system.

References: Finn, 1891; Garrod, 1873; Glenny, 1940a, 1945c, 1953a.

Family Ardeidae

Carotids variable; presence of the ligamentum botalli variable.

The high degree of variation in the dorsal carotids of this family seems to indicate that these birds are undergoing further speciation, at least with respect to the aortic arch system.

Species studied

By Finn

Nycticorax violaceus = *Nyctanassa violacea* (Linné) (A–1)

By Garrod

Ardea goliath Cretzschmar (A–1)
Ardea cinerea Linné (A–1)
Ardea purpurea Linné (A–1)
Ardea alba = *Casmerodius albus albus* (Linné) (A–1)
Ardea egretta = *Casmerodius albus egretta* (Gmelin) (A–1)
Ardea garzetta = *Egretta garzetta* (Linné) (A–1)
Ardea candidissima = *Leucophoyx thula* (Molina) (A–1)
Nycticorax europaeus = *Nycticorax nycticorax* (Linné) (A–1)
Botaurus stellaris (Linné) (B–1)

By Glenny

Ardea herodias treganzai Court (B–1)
Ardea herodias herodias Linné (A–1)
Butorides virescens virescens (Linné) (B–1)
Butorides sundevalli Reichenow (A–1)
Florida caerulea (Linné) (A–1)
Ardeola speciosa (Horsfield) (B–2–s)
Bubulcus ibis ibis (Linné) (A–1)
Bubulcus ibis coromandus (Boddaert) (A–1)
Dichromanassa rufescens (Gmelin) (A–1)
Casmerodius albus albus (Linné) (A–1)
Leucophoyx thula brewsteri (Thayer and Bangs) (B–1)
Hydranassa tricolor ruficollis (Gosse) (A–1)
Nyctanassa violacea pauper (Sclater and Salvin) (A–1)
Ixobrychus minutus minutus (Linné) (A–1)
Ixobrychus sinensis sinensis (Gmelin) (B–1)
Ixobrychus sinensis bryani (Seale) (A–1)
Botaurus lentiginosus (Montagu) (2) (B–1 and B–2–s)

Family Cochleariidae

Carotids A–1; ligamentum botalli reduced to a linea botalli.

Species studied

By Glenny

Cochlearius cochlearius zeledoni (Ridgway) (A–1)

Family Balaenicipitidae

Carotids B–4–s; the right dorsal carotid appears to have become functionally modified as a superficial cervical artery (comes nervi vagi), and to have lost its anterior connection with the carotids of the head region; a pair of arteries which arise from the innominate arteries near the base of the subclavian arteries supply the oesophagus.

Species studied

By Glenny

Balaeniceps rex Gould (B–4–s)

Family Scopidae

No information is available for this family of birds.

Family Ciconiidae

Carotids A–1; ligamentum botalli reduced to a linea botalli.

Species studied

By Garrod

Ciconia alba=*Ciconia ciconia* (Linné) (A–1)
Ciconia nigra (Linné) (A–1)
Leptoptilos crumeniferus (Lesson) (A–1)

By Glenny

Ciconia ciconia (Linné) (A–1)

Family Threskiornithidae

Carotids A–1; ligamentum botalli present, at least in part.

Species studied

By Garrod

Ibis melanocephala=*Threskiornis melanocephala* (Latham) (A–1)
Ibis strictipennis=*Threskiornis molucca strictipennis* (Gould) (A–1)
Ibis nippon=*Nipponia nippon* (Temminck) (A–1)
Ibis rubra=*Guara rubra* (Linné) (A–1)
Platalea leucorodia Linné (A–1)

By Glenny

Guara alba (Linné) (A–1)
Plegadis guarauna (Linné) (A–1)

Family PHOENICOPTERIDAE

Carotids B–2–s; ligamentum botalli present; vertebrals arise from the common carotids posterior to the origin of the superficial cervicals.

SPECIES STUDIED

By Garrod	By Glenny
Phoenicopterus antiquorum Temminck (B–2–s)	*Phoenicopterus ruber* Linné (B–2–s)
Phoenicopterus ruber Linné (B–2–s)	

ORDER ANSERIFORMES

Typically bicarotid (A–1); ligamentum aortae present; ligamentum botalli rarely reduced or absent; types A and E coracoid arteries; type 1 thoracic artery; vertebrals and superficial cervicals highly variable in points of origin, with considerable variation within a species—not a stable pattern in the Anatidae, and evolution of the cervical arteries appears to be undergoing considerable and wide deviation; a complex oesophageal supply is usually encountered.

Occurrence of a patent ductus caroticus in *Anas spinicauda* was reported by Finn (1891).

There are no apparent significant or characteristic differences in the basic arterial patterns of the Anhimidae and Anatidae, aside from the several minor differences which are found to occur within the Anatidae.

In the Anhimidae, the vertebrals appear to arise independently from the common carotid, while the vertebrals and superficial cervicals, in the Anatidae, generally have a short, common root arising from the common carotid artery.

References: Bauer, 1825; Finn, 1891; Garrod, 1873; Glenny, 1944d; Hahn, 1830; Rabl, 1906a.

Family ANHIMIDAE

Carotids A–1; ligamentum botalli prominent.

SPECIES STUDIED

By Glenny

Chauna torquata (Oken)

Family ANATIDAE

Carotids A–1; ligamentum botalli usually present; superficial cervical arteries variable in number and points of origin.

SPECIES STUDIED

By Finn

Dafila spinicauda=*Anas spinicauda* Vieillot

By Garrod

Cygnus buccinator Richardson
Cygnus nigricollis=*Cygnus melancoriphus* (Molina)
Anser segetum=*Anser fabalis* (Latham)
Bernicla canadensis=*Branta canadensis* (Linné)
Chloëphaga sp.
Dendrocygna fulva=*Dendrocygna bicolor* (Vieillot)
Dendrocygna viduata (Linné)
Dendrocygna autumnalis (Linné)
Tadorna rutila=*Casarca ferruginea* (Pallas)
Querquedula crecca=*Anas crecca* Linné
Dafila spinicauda=*Anas spinicauda* Vieillot
Mareca penelope (Linné)
Aix galericulata=*Dendronessa galericulata* (Linné)
Metopiana peposaca (Vieillot)
Fuligula cristata=*Nyroca fuligula* (Linné)
Mergus albellus=*Mergellus albellus* (Linné)
Mergus castor=*Mergus serrator* Linné

By Glenny

Cygnus columbianus (Ord) (2)
Cygnus olor (Gmelin)
Chen caerulescens (Linné)
Chen atlantica Kennard
Anser albifrons albifrons (Scopoli)
Branta canadensis canadensis (Linné)
Branta canadensis leucopareia Brandt
Alpochen aegyptiaca (Linné)
Coscoroba coscoroba (Molina)
Nyroca collaris (Donovan) (2)
Nyroca marila nearctica (Stejneger)
Bucephala clangula americana (Bonaparte)
Bucephala albeola (Linné)
Clangula hyemalis (Linné) (2)
Oidemia nigra americana Swainson
Melanitta fusca deglandi (Bonaparte) (3)
Melanitta perspicillata (Linné) (2)
Mergus merganser americanus Cassin
Mergus serrator Linné (3)

Order FALCONIFORMES

Carotids A-1; type A coracoid artery; type 1 thoracic artery; ligamentum aortae present; ligamentum botalli usually present, but may be reduced in length or more rarely remain as a linea botalli; vertebrals and superficial cervicals usually arise separately—the latter posterior to the vertebrals, but in some instances these vessels may have a common root from the common carotid artery.

References: Bauer, 1825; Beddard, 1898; Garrod, 1873; Glenny, 1941a.

Family CATHARTIDAE

SPECIES STUDIED

By Garrod

Cathartes atratus=*Coragyps atratus* (Bechstein)
Gyparchus papa=*Sarcoramphus papa* (Linné)

By Glenny

Gymnogyps californianus (Shaw)
Cathartes aura septentrionalis Wied

Family SAGITTARIIDAE

SPECIES STUDIED

By Garrod

Sepentarius reptilivorus=*Sagittarius serpentarius* (J. F. Miller)

Family ACCIPITRIDAE

SPECIES STUDIED

By Beddard

Spizaëtus sp.

By Garrod

Milvus ictinus=*Milvus milvus* (Linné)
Astur palumbarius=*Accipter gentilis* (Linné)
Buteo vulgaris=*Buteo buteo* (Linné)
Archibuteo lagopus=*Buteo lagopus* (Pontoppidan)
Meliërax monogrammicus=*Kaupifalco monogrammicus* (Temminck)
Thrasaëtus harpyia=*Harpia harpyja* (Linné)
Aquila audax=*Uroaëtus audax* (Latham)
Haliaeetus vocifer (Daudin)
Haliaeetus albicilla (Linne)
Aquila naevioïdes=*Aquila rapax* (Temminck)
Gyps fulvus (Hablizl)
Neophron percnopterus (Linné)
Circus cineraceus=*Circus cinereus* Vieillot
Helotarsus ecaudatus=*Terathopius ecaudatus* (Daudin)
Spilornis cheela (Latham)

By Glenny

Buteo jamaicensis borealis (Gmelin) (3)
Buteo lagopus s.-johannis (Gmelin) (3)
Aquila chrysaëtos (Linné) (2)
Necrosyrtes monachus monachus (Temminck)
Circus cyaneus hudsonius (Linné)

By Hochstetter

Aquila naevia=*Aquila pomarina* C. L. Brehm
Circus cineraceus=*Circus cinereus* Vieillot

FAMILY PANDIOINDAE

SPECIES STUDIED

By Glenny

Pandion haliaetus carolinensis (Gmelin)

Family FALCONIDAE

SPECIES STUDIED

By Garrod

Polyborus braziliensis=*Polyborus plancus braziliensis* (Gmelin)
Falco peregrinus Tunstall
Falco melanogenys=*Falco peregrinus macropus* Swainson
Hypotriorchis subbuteo=*Falco subbuteo* Linné
Tinnunculus alaudarius=*Falco moluccensis* (Bonaparte)

By Glenny

Falco sparvarius sparvarius Linné

Order GALLIFORMES

Carotids A–1, except for the Megapodidae which are unicarotid; origin of the coracoid and thoracic arteries varies within the order and within the families; ligamentum aortae present; ligamentum botalli usually present, but may be absent in many of the Megapodidae; vertebrals and superficial cervicals usually have a common root from the common carotid artery.

References: Bakst and Chafee, 1928; Balfour, 1873; Barkow, 1843; Beddard, 1898; Bremer, 1928; Buell, 1922; H. Evans, 1909a, 1909b; Fleming, 1926; Garrod, 1873; Glenny, 1951a; H. Hahn, 1909; Hughes, 1934; Kashchenko, 1887; Krassnig, 1913a; Lillie, 1908, 1919; Locy, 1906; Mackay, 1887; Mall, 1887; Patten, 1929; Pohlman, 1920; Quiring, 1933; C. G. Sabin, 1905; F. R. Sabin, 1917; Squier, 1916; Tonge, 1869; Twining, 1906; Vialleton, 1892.

Family Megapodiidae

Unicarotid (see list of species below); coracoid artery usually type A, but if more than one pair is present one may be opposite or lateral to the axillary artery (type D); type 1 thoracic artery; ligamentum botalli greatly reduced or absent.

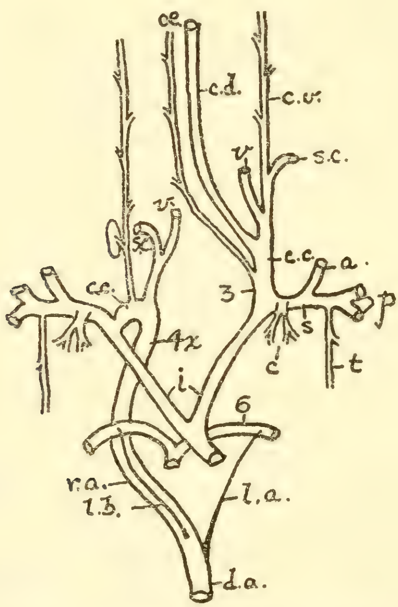

Figure 114.—Main cervical and thoracic arteries in *Megapodius freycinet layardi*, ventral view. (For explanation of symbols see p. 551.)

In a single specimen of *Megapodius layardi* (AMNH specimen), the right systemic arch was absent, the ductus caroticus serving to carry the blood from the carotid arch to the right radix aortae (fig. 114). While this is the first such instance to be reported, it may well be found to occur in other species.

SPECIES STUDIED

By Garrod

Talegalla lathami=*Alectura lathami* J. E. Gray (B–4–s)
Megacephalon maleo=*Macrocephalon maleo* S. Müller (B–4–s)

By Glenny

Megapodius sp. (B–4–s)
Megapodius nicobariensis Blyth (B–2–s)
Megapodius eremita eremita Hartlaub (2) (B–4–s)
Megapodius layardi Tristram (B–4–s)
Megapodius pritchardii G. R. Gray (2) (B–3b–d)

Family CRACIDAE

Carotids A–1; types 1, 2, and 4 thoracic artery; ligamentum botalli persistent; the arteria ventralis gallinae is present and arises variously from the base of the subclavian artery or from the common carotid artery.

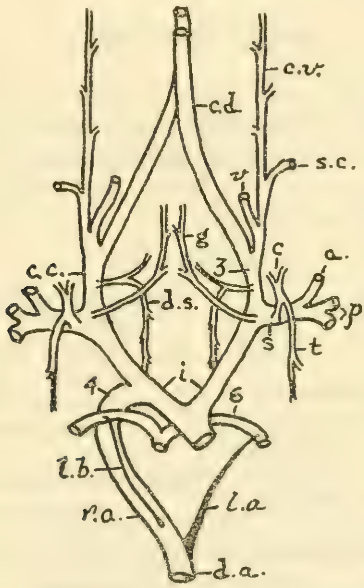

FIGURE 115.—Main cervical and thoracic arteries in *Penelope argyrotis argyrotis*, ventral view. (For explanation of symbols see p. 551.)

SPECIES STUDIED

By Garrod

Crax incommoda=*Crax pinima* Pelzeln
Crax globicera=*Crax rubra* Linné
Penelope cristatus=*Penelope purpurascens aequatorialis* Salvadori and Festa
Ortalida albiventris=*Ortalis araucuan* (Spix)

By Glenny

Crax sp.=? *Crax nigra* Linné
Pipile cumanensis (Jacquin)
Penelope argyrotis argyrotis (Bonaparte)

Family TETRAONIDAE

Carotids A–1; type A coracoid artery; type 1 thoracic artery; ligamentum botalli usually much reduced or lacking; vertebrals and superficial cervicals have a common root from the common carotid artery; arteria ventralis gallinae arises variously from the subclavian or common carotid.

SPECIES STUDIED

By Garrod

Tetrao urogallus Linné
Tetrao tetrix=*Lyrurus tetrix* (Linné)

By Glenny

Lagopus lagopus (Linné)
Lagopus lagopus alleni Stejneger
Lagopus mutus hyperboreus Sundevall
Bonasa umbellus umbellus (Linné) (3)
Tympanuchus cupido cupido (Linné)
Tympanuchus cupido pinnatus (Brewster)

Family PHASIANIDAE

Carotids A–1; type A and type D coracoid arteries; type 1 to type 4 thoracic artery; ligamentum botalli usually present; vertebrals and superficial cervicals generally have a common root arising from the common carotid artery; the arteria ventralis gallinae arises as a branch of the subclavian artery.

SPECIES STUDIED

By Garrod

Ortyx virginianus=*Colinus virginianus* (Linné)
Eupsychortyx cristatus=*Colinus cristatus* (Linné)
Odontophorus dentatus=*Odontophorus capueira* (Spix)
Caccabis chukar=*Alectoris graeca chukar* (J. E. Gray)
Francolinus vulgaris=*Francolinus francolinus* (Linné)
Francolinus gularis (Temminck)
Francolinus pondicerianus (Gmelin)
Francolinus clappertoni Children
Francolinus afer=*Pternistis afer* (P. L. S. Müller)
Perdix cinerea=*Perdix perdix* (Linné)
Coturnix communis=*Coturnix coturnix* (Linné)
Arboricola torqueola=*Arborophila torqueola* (Valenciennes)
Rollulus coronatus=*Rollulus rouloul* (Scopoli)
Ceriornis temminckii=*Tragopan temminckii* (J. E. Gray)
Euplocamus albo-cristatus=*Gennaeus leucomelanos hamiltonii* (J. E. Gray)
Euplocamus horsfieldii=*Gennaeus horsfieldii* (G. R. Gray)
Euplocamus vieilloti=*Lophura rufa* (Raffles)
Euplocamus pyronotus=*Houppifer erythrophthalmus pyronotus* (G. R. Gray)
Euplocamus erythrophthalmus=*Houppifer erythrophthalmus pyronotus* (G. R. Gray)
Gallus bankiva=*Gallus gallus bankiva* Temminck
Phasianus colchicus Linné
Phasianus versicolor=*Phasianus colchicus versicolor* Vieillot
Phasianus reevesii=*Syrmaticus reevesii* (J. E. Gray)
Thaumalia picta=*Chrysolophus pictus* (Linné)
Thaumalia amherstiae=*Chrysolophus amherstiae* (Leadbeater)
Argus giganteus=*Argusianus argus argus* (Linné)
Pavo nigripennis=*Pavo cristatus* Linné (melanistic phase)
Pavo muticus Linné

By Glenny

Oreortyx picta (Douglas)
Lophortyx californica (Shaw)
Colinus virginianus (Linné)
Colinus virginianus cubanensis (G. R. Gray)
Odontophorus columbianus (Gould)
Alectoris graeca chukar (J. E. Gray)
Arborophila brunneopectus henrici (Oustalet)
Crossoptilon mantchuricum Swinhoe
Gallus gallus domesticus Darwin
Catreus wallichii (Hardwicke)
Phasianus colchicus torquatus Gmelin
Chrysolophus pictus (Linné)
Pavo cristatus Linné (white phase)

Family NUMIDIDAE

Carotids A–1; type B coracoid artery; type 1 thoracic artery; ligamentum botalli much reduced; vertebrals and superficial cervicals have a common root from the common carotid; the arteria ventralis gallinae arises from the base of the subclavian artery.

SPECIES STUDIED

By Garrod	By Glenny
Numida meleagris (Linné)	*Numida meleagris* (Linné)

Family MELEAGRIDIDAE

Carotids A–1; type A or type B coracoid artery; type 1 thoracic artery; ligamentum botalli much reduced; vertebrals and cervicals have a common root from the common carotid; the arteria ventralis gallinae arises as a branch from the base of the subclavian artery.

SPECIES STUDIED

By Garrod	By Glenny
Meleagris gallopavo Linné	*Meleagris gallopavo* Linné

Family OPISTHOCOMIDAE

Carotids A–1; type 2 thoracic artery; coracoid artery is medial to the thoracic artery; ligamentum botalli present; vertebrals and superficial cervicals have a common root from the common carotid artery; the arteria ventralis gallinae is absent or greatly reduced.

SPECIES STUDIED

By Glenny

Opisthocomus hoazin (P. L. S. Müller) (2)

Order GRUIFORMES

Carotids A–1 and B–4; coracoid artery usually type A, but rarely type E is present; type 1 to type 4 thoracic artery; ligamentum aortae present; ligamentum botalli may be present or absent; vertebrals and superficial cervicals arise either separately or from a common root from the common carotid arteries.

References: Beddard, 1898; Garrod, 1873; Glenny 1940a, 1945d, 1947b; Wetmore, 1951.

Family Mesoenatidae

Carotids A–1; type 1 thoracic artery; ligamentum botalli remains as a linea botalli; vertebrals and superficial cervicals have a common root in *Monias benschi* and *Mesoenas unicolor*, but are separate in *Mesoenas variegata*.

The clavicles in these birds are reduced to a small bone, the epicleidum, and a ligamentous vestige of the corpus claviculi (class 3 clavicle) (Glenny and Friedmann, 1954).

Species studied

By Glenny

Mesoenas variegata (Goeffroy)
Mesoenas unicolor (Des Murs)
Monias benschi Oustalet and Grandidier

Family Turnicidae

Carotids B–4–s; type 1 thoracic artery; ligamentum botalli absent; vertebrals and superficial cervicals have a common root from the common carotid artery.

Species studied

By Garrod

Hemipodius tachydromus = *Turnix sylvatica* (Desfontaines)

By Glenny

Turnix tanki blanfordi Blyth (2)
Turnix suscitator suscitator (Gmelin)

Family Pedionomidae

Carotids A–1, according to Wetmore (1951).

Family Gruidae

Carotids A–1; type A and type E coracoid artery; type 1 thoracic artery; ligamentum botalli reduced to a linea botalli or absent; vertebrals and superficial cervicals arise separately from the common carotid arteries.

Species studied

By Glenny

Grus antigone (Linné)
Anthropoïdes paradisea (Lichtenstein)

Family Aramidae

Carotids A–1; type B coracoid artery; type 1 thoracic artery; ligamentum botalli present or reduced to a linea botalli; origin of the vertebrals and superficial cervicals variable.

SPECIES STUDIED

By Glenny

Aramus scolopaceus pictus (F. A. A. Meyer)

Family PSOPHIIDAE

Carotids A–1; type 1 thoracic artery; type A coracoid artery; ligamentum botalli present or reduced to a linea botalli; vertebrals and superficial cervicals arise separately from the common carotid artery, but may have a common root in some instances.

SPECIES STUDIED

By Glenny

Psophia leucoptera Spix

Family RALLIDAE

Carotids A–1; types 2, 3, and 4 thoracic artery; type A coracoid artery; ligamentum botalli present or reduced in a few species, but generally lacking; vertebrals and superficial cervicals arise separately from the common carotid, or rarely from a short common root from the common carotid.

SPECIES STUDIED

By Garrod

Rallus aquaticus Linné
Ocydromus sylvestris = *Tricholimnas sylvestris* (Sclater)
Aramides cayennensis = *Aramides cajanea* (P. L. S. Müller)
Crex pratensis = *Crex crex* (Linné)
Porzana americana = *Porzana flaviventer* (Boddaert)
Porzana carolinensis = *Porzana carolina* (Linné)
Gallinula chloropus (Linné)
Porphyrio madagascariensis (Latham)
Porphyrio poliocephalus melanotus Temminck

By Glenny

Rallus longirostris saturatus Ridgway
Atlantisia rogersi Lowe
Tricholimnas sylvestris (Sclater)
Ortygonax rytirhynchos (Vieillot)
Cyanolimnas cerverai Barbour and Peters
Aramides cajanea (P. L. S. Müller)
Limnocorax flavirostra (Swainson)
Porzana carolina (Linné)
Porzanula palmeri Frohawk
Coturnicops noveboracensis (Gmelin)
Neocrex erythrops (Sclater)
Poliolimnas cinereus (Vieillot)
Amaurornis phoenicurus javanica (Horsfield)
Gallinula chloropus cachinnans Bangs
Porphyrula martinica (Linné) (2)
Porphyrio porphyrio (Linné)
Porphyrio poliocephalus melanotus Temminck
Fulica americana Gmelin (3)

Family HELIORNITHIDAE

No information available.

Family RHYNOCHETIDAE

Carotids A–1; type 1 thoracic artery; type A coracoid artery; ligamentum botalli complete; vertebrals and superficial cervicals arise separately from the common carotid.

Species studied

By Glenny

Rhynochetos jubatus J. Verreaux and Des Murs (2)

Family Eurypygidae

Carotids A–1; type 1 thoracic artery; type A coracoid artery; ligamentum aortae greatly reduced; ligamentum botalli absent; vertebrals and superficial cervicals arise separately from the common carotid artery.

Species studied

By Glenny

Eurypyga helias helias (Pallas)

Family Cariamidae

Carotids A–1; type 1 thoracic artery; type A coracoid artery; ligamentum botalli absent or reduced to a linea botalli; vertebrals and superficial cervicals arise separately from the common carotid artery.

Species studied

By Glenny	By Garrod
Chunga burmeisteri (Hartlaub) *Cariama cristata* (Linné)	*Cariama cristata* (Linné)

Family Otidae

Information incomplete. Garrod (1873) notes the A–1 condition in *Houbara macqueeni*, while Beddard (1898) reports that two species of *Eupodotis* are B–4–d.

Presence of the ligamentum botalli may vary; the thoracic artery is probably type 1, and the vertebrals and superficial cervicals probably have separate points of origin from the common carotid arteries.

Species studied

By Garrod	By Beddard
Houbara macqueeni=*Chlamydotis undulata macqueenii* (J. E. Gray) (A–1)	*Eupodotis* spp. (2) (B–4–d)

Order CHARADRIIFORMES

Carotids A–1, except in two species of the Alcidae; type A coracoid artery; type 1 thoracic artery, except for type 2 in *Phalaropus fulicarius* and type 3 in *Jacana spinosa intermedia;* ligamentum aortae present; ligamentum botalli variable in presence and degree of reduction; vertebrals and superficial cervicals vary in points of origin from the common carotid arteries.

References: Beddard, 1898; Garrod, 1873; Glenny, 1947c, 1948, 1952a, 1952b; Hafferl, 1921.

Family Jacanidae

Ligamentum botalli reduced to a linea botalli or may be entirely lacking; vertebrals and cervicals generally arise separately from the

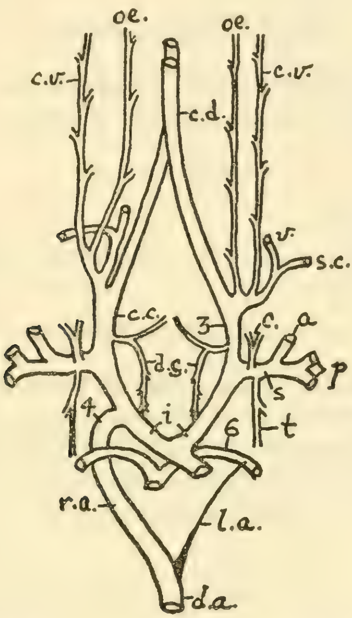

Figure 116.—Main cervical and thoracic arteries in *Jacana spinosa*, ventral view. (For explanation of symbols see p. 551.)

common carotid; an accessory oesophageal artery arises as a branch of the left common carotid artery.

Species studied

By Glenny

Actophilornis africana (Gmelin)
Hydrophasianus chirurgus (Scopoli)
Jacana spinosa gymnostoma (Wagler) (2)
Jacana spinosa intermedia (Sclater)

By Garrod

Parra africana = *Actophilornis africana* (Gmelin)

Family Rostratulidae

Ligamentum botalli is reduced to a linea botalli or completely lacking and vertebrals and superficial cervicals arise separately in *Rostratula benghalensis*.

Ligamentum botalli greatly reduced, ligamentum aortae broad, and vertebrals and superficial cervicals have a short common root from the common carotid in *Nycticryphes semicollaris.*

SPECIES STUDIED

By Glenny

Rostratula benghalensis (Linné) (2)

Nycticryphes semi-collaris (Vieillot) (2)

Family HAEMATOPODIDAE

Ligamentum botalli very small; vertebrals and superficial cervicals have a common root from the common carotid.

SPECIES STUDIED

By Garrod

Haematopus niger=*Haematopus ostralegus bachmani* Audubon

By Glenny

Haematopus ostralegus malacophaga Salomonsen

Family CHARADRIIDAE

Ligamentum botalli seldom present; vertebrals and superficial cervicals have a common root from the common carotid; accessory oesophageal artery arises either as a branch of the left common carotid or from the ventral superficial cervical artery. There is considerable variation in the number and arrangement of the superficial cervical arteries.

SPECIES STUDIED

By Garrod

Vanellus cristatus=*Vanellus vanellus* (Linné)
Charadrius pluvialis=*Pluvialis apricaria* (Linné)
Charadrius hiaticula Linné

By Glenny

Belonopterus chilensis lampronotus (Wagler)
Stephanibyx coronatus (Boddaert)
Hoplopterus spinosus (Linné)
Hoplopterus duvaucelii (Lesson)
Zonifer tricolor (Vieillot)
Squatarola squatarola (Linné)
Pluvialis dominica fulva (Gmelin)
Charadrius hiaticula semipalmatus Bonaparte
Charadrius melodus Ord
Charadrius alexandrinus hesperius Bates
Charadrius alexandrinus nivosus (Cassin)
Charadrius alexandrinus tenuirostris (Lawrence)
Charadrius sanctae-helenae (Harting)
Charadrius vociferus vociferus Linné
Charadrius vociferus ternominatus Bangs and Kennard
Charadrius wilsonia beldingi (Ridgway)
Charadrius wilsonia cinnamominus (Ridgway)
Oreopholus ruficollis (Wagler)

Family Scolopacidae

Thoracic and cervical arterial arrangement is similar to that of the Charadriidae.

Species studied

By Garrod

Numenius phaeopus (Linné)
Numenius arquata (Linné)
Limosa lapponica (Linné)
Cambetta flavipes = *Tringa flavipes* (Gmelin)
Totanus solitarius = *Tringa solitaria* Wilson
Strepsilas interpres = *Arenaria interpres* (Linné)
Gallinago scolopacina = *Capella gallinago* (Linné)
Gallinago gallinula = *Lymnocryptes minima* (Brünnick)
Scolopax rusticola Linné
Totanus calidris = ? *Tringa totanus* (Linné)
Tringa canutus = *Calidris canutus* (Linné)
Machetes pugnax = *Philomachus pugnax* (Linné)
Tringa cinctus = *Eriola alpina* (Linné)

By Glenny

Bartramia longicauda (Bechstein)
Numenius borealis (J. R. Forster)
Numenius tahitiensis (Gmelin)
Numenius arquata (Linné)
Numenius americanus Bechstein
Limosa haemastica (Linné)
Limosa lapponica baueri Naumann
Tringa flavipes (Gmelin)
Tringa melanoleuca (Gmelin)
Tringa solitaria cinnamomea (Brewster)
Tringa solitaria solitaria Wilson
Tringa glareola Linné
Actitis hypoleucos (Linné)
Actitis macularia (Linné) (2)
Catoptrophorus semipalmatus (Gmelin)
Heteroscelus brevipes (Vieillot)
Heteroscelus incanus (Gmelin)
Arenaria interpres (Linné)
Arenaria interpres morinella (Linné)
Arenaria melanocephala (Vigors)
Limnodromus griseus (Gmelin)
Capella stenura (Bonaparte)
Capella delicata (Ord)
Philohela minor (Gmelin)
Calidris canutus rufus (Wilson)
Crocethia alba (Pallas)
Erueunetes pusillus (Linné)
Erueunetes mauri Cabanis
Erolia subminuta (Middendorff)
Erolia minutilla (Vieillot)
Erolia fuscicollis (Vieillot)
Erolia bairdii (Coues)
Erolia melanotos (Vieillot)
Erolia maritima (Brünnich)
Erolia ptilocnemis (Coues)
Erolia alpina sakhalina (Vieillot)
Micropalama himantopus (Bonaparte)
Tryngites subruficollis (Vieillot)
Philomachus pugnax (Linné)

Family Recurvirostridae

Ligamentum botalli usually reduced or absent; ductus shawi, vertebral and superficial cervical arteries arise from a common root or branch from the common carotid.

Species studied

By Glenny

Himantopus himantopus himantopus (Linné)
Himantopus himantopus mexicanus (P. L. S. Müller)
Himantopus himantopus melanurus Vieillot
Recurvirostra americana Gmelin

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Family Phalaropodidae

Ligamentum botalli absent; vertebrals and superficial cervicals arise separately from the common carotid; type 2 thoracic artery in *Phalaropus fulicarius.*

Species studied

By Glenny

Phalaropus fulicarius (Linné)
Steganopus tricolor Vieillot
Lobipes lobatus (Linné)

Family Dromadidae

Ligamentum botalli reduced to a linea botalli or lacking; vertebrals and superficial cervicals arise separately from the common carotid arteries.

Species studied

By Glenny

Dromas ardeola Paykull

Family Burhinidae

Carotids A–1; no additional information available.

Species studied

By Garrod

Oedicnemus bistriatus=*Burhinus bistriatus* (Wagler)
Oedicnemus grallarius=*Burhinus magnirostris* (Latham)

Family Glareolidae

Ligamentum botalli absent; vertebrals and superficial cervicals have a common root from the common carotid; the accessory oesophageal artery arises as a branch of the left common carotid artery.

Species studied

By Glenny

Cursorius sp.
Glareola maldivarum J. R. Forster (2)

By Garrod

Glareola sp.

Family Thinocoridae

Ligamentum botalli absent; vertebrals and superficial cervicals may or may not have a common root from the common carotid artery; an accessory oesophageal artery arises from the base of the superficial cervical (left side) in *Thinocorus* but was not observed in *Attagis.*

Species studied

By Glenny

Attagis malouinus malouinus (Boddaert)
Thinocorus rumicivorus rumicivorus Eschscholtz (2)

Family Chionididae

Ligamentum botalli prominent; vertebrals and superficial cervicals separate in origin from the common carotid artery; left common carotid gives off an accessory oesophageal artery.

Species studied

By Glenny

Chionis minor minor Hartlaub (2)

Family Stercorariidae

Carotids A–1; no additional information available.

Species studied

By Garrod

Lestris antarcticus = *Catharacta skua antarctica* (Lesson)

Family Laridae

Ligamentum botalli usually absent, but may be present at least in part; vertebrals and superficial cervicals usually have a common root, but this is variable; the left common carotid usually sends off an accessory oesophageal artery. The number and origin of the cervical arteries vary somewhat within the family.

Species studied

By Garrod

Larus argentatus Pontoppidan
Larus glaucus = *Larus hyperboreus* Gunnerus
Sterna hirundo Linné

By Glenny

Larus heermanni Cassin
Larus argentatus Pontoppidan
Larus hyperboreus Gunnerus
Larus philadelphia (Ord)
Rissa tridactyla tridactyla (Linné)
Rissa tridactyla pollicaris Ridgway
Xema sabini (J. Sabine)
Sterna hirundo Linné
Sterna paradisaea Pontoppidan
Sterna vittata Gmelin
Sterna forsteri Nuttall
Sterna albifrons antillarum (Lesson)
Thalasseus bergii (Lichtenstein)
Anoüs stolidus pileatus (Scopoli)
Anoüs minutus melanogenys G. R. Gray
Gygis alba candida (Gmelin)

Family Rynchopidae

Ligamentum botalli greatly reduced or lacking; vertebrals and superficial cervicals have a common root from the common carotid; the left common carotid sends off an accessory oesophageal artery.

Species studied

By Glenny

Rynchops nigra nigra Linné (2)

Family Alcidae

Ligamentum botalli may be present, but more frequently is absent or reduced; vertebrals and superficial cervicals usually have a common root, but this is somewhat variable; the left common carotid generally sends off an accessory oesophageal artery.

Except for two species (noted below), the alcids are bicarotid (A–1).

Species studied

By Garrod

Arctica alle=*Plautus alle* (Linné) (B–4–s)
Alca torda Linné
Uria troile=*Uria aalge aalge* (Pontoppidan)

By Glenny

Alca torda Linné
Uria lomvia arra (Pallas)
Uria aalge inornata Salomonsen
Cepphus grylle (Linné)
Cepphus columba Pallas
Synthliboramphus antiquus (Gmelin) (2) (A–1)
Synthliboramphus antiquus (Gmelin) (5) (B–4–s)
Synthliboramphus wumizusume (Temminck) (2) (A–1)
Cyclorrhynchus psittacula (Pallas) (3)
Aethia cristatella (Pallas)
Aethia pusilla (Pallas)
Aethia pygmaea (Gmelin)
Lunda cirrhata (Pallas)

Order COLUMBIFORMES

Carotids A–1; type 1 thoracic artery; type A and type D coracoid artery—one, two, or rarely three pairs of coracoid arteries may be present; ligamentum aortae present, but may be reduced in size (not observed in a single specimen of *Syrrhaptes paradoxus*); ligamentum botalli usually absent, but when present it may be reduced to a thin ligament, ligamentous button, or a linea botalli; there is considerable variation in the arrangement of the vertebral and superficial cervical arteries—there being no uniformity in the members of this order or within a single species, insofar as the present study can ascertain; an accessory oesophageal artery arises as a branch of the left common carotid or one of the superficial cervical arteries and primarily supplies the crop. There is considerable variation in the cervical arteries in the Columbidae.

References: Beddard, 1898; Bhaduri, 1939; Bhaduri and Biswas, 1954; Gadow, 1891; Garrod, 1873; Glenny, 1940b, 1941a; Glenny and Amadon, 1955; Mathew, 1944; Subhapradha, 1944.

Family Pteroclidae

Ligamentum botalli absent; type A coracoid artery in *Pterocles* sp. and type D coracoid artery observed in *Syrrhaptes paradoxus*.

Species studied

By Garrod

Pterocles arenarius=*Pterocles orientalis* (Linné)
Pterocles alchata (Linné)

By Glenny

Syrrhaptes paradoxus (Pallas)
Pterocles sp.

Family Raphidae

Extinct; no information available.

Family Columbidae

Ligamentum botalli usually absent; ductus caroticus (right side) frequently persistent; three pairs of coracoid arteries are found in *Otidiphaps nobilis*, normally one or two pairs may be found.

Species studied

By Bhaduri

Columba livia intermedia Strickland

By Bhaduri and Biswas

Columba livia Gmelin
Streptopelia tranquebarica tranquebarica (Herman)
Streptopelia chinensis suratenis (Gmelin)
Streptopelia senegalensis cambayensis (Gmelin)
Chalcophaps indica indica (Linné)
Treron bicincta bicincta (Jerdon)
Treron phoenicoptera phoenicoptera (Latham)

By Garrod

Treron calva (Temminck)
Ptilonopus mariae=*Ptilinopus perousii mariae* (Jacquinot and Pucheran)
Ptilonopus melanocephalus=*Ptilinopus melanospila melanauchen* (Salvadori)
Carpophaga globicera=*Ducula myristicivora* (Scopoli)
Carpophaga aenea=*Ducula aenea* (Linné)
Tympanistria bicolor=*Tympanistria tympanistria* (Temminck)
Lopholaemus antarcticus=*Lopholaimus antarcticus* (Shaw)
Columba livia Gmelin
Columba oenas Linné
Columba leucocephala Linné
Columba picazuro Temminck
Columba maculosa Temminck
Turtur aldabranus=*Streptopelia picturata aldabrana* (Sclater)
Columba vinacea=*Streptopelia vinacea* (Gmelin)
Turtur senegalensis=*Streptopelia senegalensis* (Linné)
Geopelia humeralis (Temminck)
Geopelia striata (Linné)
Geopelia placida=*Geopelia striata placida* Gould
Geopelia cuneata (Latham)
Metriopelia melanoptera (Molina)
Chamaepelia talpacoti=*Columbigallina talpacoti* (Temminck)
Chalcopelia chalcospilos=*Turtur chalcospilos* (Wagler)
Chalcopelia puella=*Turtur brehmeri infelix* Peters
Chalcophaps indica chrysochlora (Wagler)
Phaps chalcoptera (Latham)
Ocyphaps lophotes (Temminck)
Leptoptila jamaicansis (Linné)
Phlogoenas cruentata=*Gallicolumba luzonica* (Scopoli)
Caloenas nicobarica (Linné)
Goüra coronata=*Goüra cristata* (Pallas)
Goüra victoria (Fraser)
Didunculus strigirostris (Jardine)

By Glenny

Sphenurus oxyura (Temminck)
Treron curvirostra (Gmelin)
Phapitreron leucotis nigrorum (Sharpe)
Ptilinopus perousii Peale
Alectroenas pulcherrima (Scopoli)
Megaloprepia magnifica (Temminck)
Ducula pacifica (Gmelin)
Columba livia Gmelin
Columba fasciata Say
Macropygia ruficeps (Temminck)
Ectopistes migratoria (Linné) (2)
Zenaidura macroura carolinensis (Linné) (2)
Zenaida asiatica mearnsi (Ridgway)
Nesopelia galapagoensis (Gould)
Streptopelia sp.
Streptopelia orientalis (Latham)
Streptopelia chinensis (Scopoli)
Geopelia striata (Linné)
Columbina picui (Temminck)
Columbigallina passerina insularis Ridgway

Oena capensis (Linné)
Turtur sp.
Chalcophaps indica (Linné)
Ocyphaps lophotes (Temminck)
Geophaps smithii (Jardine and Selby)
Leptotila verreauxii (Bonaparte)
Oreopeleia caniceps leucometopius Chapman
Gallicolumba xanthonura (Temminck)
Otidiphaps nobilis Gould (2)
Caloenas nicobarica (Linné)
Goüra cristata (Pallas)
Didunculus strigirostris (Jardine)

Order PSITTACIFORMES

Carotids A–1, A–2–s, B–2–s, B–3b–d to B–4–s; type A coracoid artery; type 1 thoracic artery; ligamentum aortae present; ligamentum botalli usually absent, or when present much reduced or remains as a linea botalli; vertebrals and superficial cervicals have a common root from the common carotid artery, with but a few individual exceptions; an accessory oesophageal artery from the left carotid may be present, but not necessarily so in all of the species.

References: Beddard, 1898; Bhaduri and Biswas, 1945; Garrod, 1873; Glenny, 1940a, 1951c; Mackay, 1887; Meckel, 1826.

Family Psittacidae

Subfamily Strigopinae

Carotids A–1; no additional information available.

Species studied

By Garrod

Strigops habroptilus G. R. Gray

Subfamily Nestorinae

Carotids A–2–s; accessory oesophageal artery from the left common carotid artery.

Species studied

By Garrod

Nestor notabilis Gould
Nestor hypopolius = *Nestor meridionalis* (Gmelin)

By Glenny

Nestor meridionalis (Gmelin)

Subfamily Loriinae

Carotids A–1, except in *Lathamus discolor* (A–2–s). A notable ductus caroticus was observed in a specimen of *Trichoglossus haematod forsteni* (USNM 319456) (fig. 117).

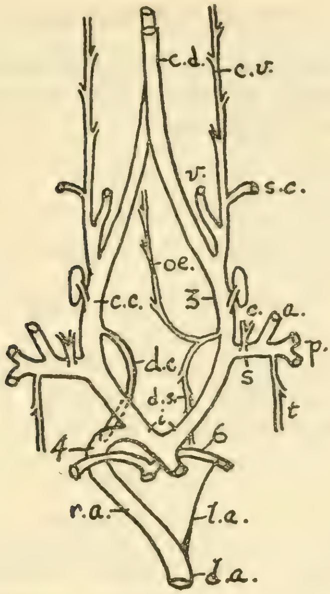

FIGURE 117.—Main cervical and thoracic arteries in *Trichoglossus haematod forsteni*, ventral view. (For explanation of symbols see p. 551.)

SPECIES STUDIED

By Garrod

Lorius cardinalis = *Chalcopsitta cardinalis* (G. R. Gray)
Eos indica = *Eos histrio* (P. L. S. Müller)
Trichoglossus concinnus = *Glossopsitta concinna* (Shaw)
Lathamus discolor (White) (A–2–s)

By Glenny

Chalcopsitta sintillata (Temminck)
Eos cyanogenia Bonaparte
Eos squamata guenbyensis (Scopoli)
Eos bornea (Linné)
Trichoglossus ornatus (Linné)
Trichoglossus haematod moluccanus (Gmelin)
Trichoglossus haematod forsteni Bonaparte
Trichoglossus chlorolepidotus (Kuhl)
Pseudeos fuscata (Blyth)
Domicella hypoinochroa devittata (Hartert)
Domicella lory (Linné)
Domicella chlorocercus (Gould)
Domicella garrula (Linné)
Phigys solitarius (Suckow)
Vini australis (Gmelin) (2)
Vini kuhlii (Vigors)
Vini stepheni (North)
Vini peruviana (P. L. S. Müller)
Glossopsitta concinna (Shaw)
Glossopsitta porphyrocephala (Dietrichsen)
Charmosyna placentis subplacens (Sclater) (2)
Charmosyna pulchella G. R. Gray
Opopsitta sp.
Lathamus discolor (White) (A–2–s)

Subfamily Micropsittinae

Carotids A–1; ligamentum aortae greatly reduced; ligamentum botalli absent; vertebrals and superficial cervicals have a common root from the common carotid artery.

SPECIES STUDIED

By Glenny

Micropsitta pusio pusilla (Ramsay)

Micropsitta finschii (Ramsay)

Subfamily Kakatoeinae

Carotids A–1 and unicarotid (see list of species below); ligamentum botalli present in *Calyptorhynchus magnificus* and *Kakatoe galerita;* ligamentum aortae almost completely absent in *Nymphicus hollandicus.*

SPECIES STUDIED

By Garrod

Cacatua galerita=Kakatoe galerita (Latham) (laevo-carotid)

Cacatua cristata=Kakatoe sulphurea citrino-cristata (Fraser) (laevo-carotid)

Eolophus roseicapillus=Kakatoe roseicapilla (Vieillot) (bicarotid: A–1)

Calopsitta novae-hollandiae=Nymphicus hollandicus (Kerr) (bicarotid)

By Glenny

Calyptorhynchus magnificus (Shaw) (A–1)

Callocephalon fimbriatum (Grant) (A–1)

Kakatoe galerita (Latham) (2) (B–3b–d)

Kakatoe leadbeateri (Vigors) (B–3b–d)

Kakatoe sanguinea (Gould) (B–3b–d)

Nymphicus hollandicus (Kerr) (A–1)

By Mackay

Cacatua sulphurea=Kakatoe sulphurea (Gmelin) (B–2–s)

By Meckel

Kakatoe sulphurea (Gmelin) (B–2–d)

It is my opinion that the Meckel report is more accurate, although the Mackay report could be true. It is possible that a typographical error may have been made in the reporting of Mackay's work. The B–2–d arrangement is to be expected in the *Kakatoe* series.

Subfamily Psittacinae

Carotids A–1 and A–2–s. All South American parrots have the A–2–s arrangement.

SPECIES STUDIED

By Bhaduri and Biswas

Psittacula krameri manillensis (Bechstein) (A–1)

Psittacula cyanocephala cyanocephala (Linné) (A–1)

By Garrod

(Species with A–2–s carotid)

Ara macao (Linné)

Conurus holochlorus=Aratinga holochlora (Sclater)

Conurus jandaya=Aratinga jandaya (Gmelin)

Conurus petzi=Aratinga canicularis (Linné)

Conurus cruentatus=Pyrrhura cruentata (Wied)

Psittacula passerina=*Forpus passerinus flavissimus* Hellmayr
Brotogerys tiriacula=*Brotogeris tirica* (Gmelin)
Brotogerys virescens=*Brotogeris versicolurus* (P. L. S. Müller)
Brotogerys tui=*Brotogeris chrysopterus tuipara* (Gmelin)
Caïca melanocephala=*Pionites melanocephala* (Linné)
Pionus menstruus (Linné)
Chrysotis festiva=*Amazona festiva* (Linné)
Chrysotis levaillantii=*Amazona ochrocephala oratrix* Ridgway
Chrysotis ochrocephala=*Amazona ochrocephala* (Gmelin)
Conurus xantholaemus=*Aratinga pertinax* (Linné)
Psittacus erithacus Linné
Platycercus eximius (Shaw)
Platycercus pallidiceps=*Platycercus adsciyus palliceps* Lear
Psephotus haematogaster=*Northiella haematogaster* (Gould)
Cyanoramphus novaezelandiae (Sparrmann)
Cyanoramphus auriceps (Kuhl)

(Species with A–1 carotid)

Prioniturus sp.
Palaeornis alexandri=*Psittacula alexandri* (Linné)
Aprosmictus scapulatus=*Alisterus scapularis* (Lichtenstein)
Agapornis roseicollis (Vieillot)
Loriculus sp.
Euphema pulchella=*Neophema pulchella* (Shaw)
Euphema splendida=*Neophema splendida* (Gould)
Euphema bourkii=*Neophema bourkii* (Gould)
Melopsittacus undulatus (Shaw)

By Glenny

(Species with A–2–s carotid)

Ara ararauna (Linné)
Ara auricollis Cassin
Aratinga guarouba (Gmelin)
Aratinga holochlora (Sclater)
Aratinga auricapillus (Kuhl)
Aratinga nana (Vigors)
Aratinga canicularis (Linné)
Aratinga pertinax (Linné) (2)
Aratinga aurea (Gmelin)
Nandayus nenday (Vieillot)
Conuropsis carolinensis carolinensis (Linné)
Rhynchopsitta pachyrhyncha (Swainson)
Cyanoliseus patagonus (Vieillot)
Microsittace ferruginea (P. L. S. Müller) (2)
Myiopsitta monachus cotorra (Vieillot)
Bolborhynchus lineola (Cassin)
Forpus passerinus viridissimus (Lafresnaye) (2)
Forpus sclateri eidos Peters
Forpus coelestis (Lesson)
Brotogeris tirica (Gmelin)
Brotogeris versicolurus versicolurus (P. L. S. Müller)
Brotogeris versicolurus chiriri (Vieillot)
Brotogeris jugularis (P. L. S. Müller) (3)
Brotogeris cyanoptera (Pelzeln)
Pionites melanocephala (Linné)
Pionopsitta pileata (Scopoli)
Graydidascalus brachyurus (Kuhl)
Pionus menstruus (Linné) (2)
Amazona ventralis (P. L. S. Müller)
Amazona agilis (Linné)
Amazona barbadensis rothschildi (Hartert)
Amazona ochrocephala oratrix Ridgway
Amazona ochrocephala ochrocephala (Gmelin)
Amazona amazonica amazonica (Linné)
Deroptyus accipitrinus (Linné)
Poicephalus senegalus (Linné)
Poicephalus meyeri (Cretzschmar)
Psittacus erithacus Linné (2)
Coracopsis vasa drouhardi Lavauden
Psittrichas fulgidus (Lesson)
Prosopeia tabuensis tabuensis (Gmelin)
Prosopeia tabuensis splendens (Peale)
Psephotus chrysopterygius Gould
Platycercus elegans (Gmelin)
Platycercus caledonicus flaveolus Gould
Platycercus eximius (Shaw)
Platycercus zonarius barnardi Vigors and Horsfield
Northiella haematogaster haematorrhous (Gould)
Cyanoramphus novaezelandiae (Sparrman)
Cyanoramphus auriceps (Kuhl)

(Species with A–1 carotid)

Lorius roratus (P. L. S. Müller)
Tanygnathus lucionensis (Linné)
Psittacula longicauda longicauda (Boddaert)
Psittacula longicauda tytleri (Hume)
Polytelis anthopeplus (Lear)
Alisterus scapularis (Lichtenstein)
Agapornis cana (Gmelin)
Agapornis cana ablectanea Bangs
Agapornis taranta (Stanley)
Agapornis fischeri Reichenow
Agapornis personata Reichenow
Agapornis lilianae Shelley
Loriculus beryllinus (J. R. Forster)
Loriculus galgulus (Linné) (2)
Melopsittacus undulatus (Shaw) (2)

Order CUCULIFORMES

Carotids chiefly A–1, but A–3, A–4, and A–3–s/A–4–d also observed; type A coracoid artery; type 1 thoracic artery; ligamentum aortae present, but may be reduced; ligamentum botalli usually lacking, or much reduced when present; vertebrals and superficial cervicals vary in origin from the common carotid arteries.

References: Bhaduri and Biswas, 1945; Garrod, 1873; Glenny, 1941b.

Family Musophagidae

Vertebrals and superficial cervicals have separate points of origin from the common carotid arteries; an accessory oesophageal artery arises as a branch from the left common carotid artery or from the left superficial cervical artery.

Both the ligamentum aortae and the ligamentum botalli are prominent in *Tauraco leucotis donaldsoni*, whereas in *Tauraco macrorhynchus verreauxii* and *Crinifer leucogaster* the ligamentum aortae is much reduced and the ligamentum botalli is absent.

Species studied

By Garrod

Musophaga violacea Isert
Corythaix albocristata = *Tauraco corythaix* (Wagler)
Schizorhis africana = *Crinifer africanus* (Latham)

By Glenny

Tauraco leucotis donaldsoni (Sharpe)
Tauraco macrorhynchus verreauxii (Schlegel)
Crinifer leucogaster (Rüppell)

Family Cuculidae

Carotids A–1, with but a few exceptions (see list of species below).

Bhaduri and Biswas (1945) reported that both left and right ascending oesophageal arteries arise in common with the superficial cervical (comes nervi vagi) arteries as a branch of the vertebrals in *Eudynamys scolopaceas*, and the ascending oesophageal is shown to connect anteriorly with the cephalic external carotids. This is further evidence that the ascending oesophageal arteries are functionally modified ventral carotids and is in accord with Hughes' (1934) observations in the chick embryo.

In *Zanclostomus javanicus* and *Phaenicophaeus pyrrhocephalus* both dorsal carotids are superficial and do not enter the hypapophysial canal (infranormales), but lie on either side of the oesophagus to which organ they supply blood (A–3). Meckel (1826) suggested that this arrangement of the carotids might be expected in some species of bird.

A still further modification in the arrangement of the dorsal carotids is found in a specimen of *Rhamphococcyx curvirostris erythrognathus* (USNM 223471). In this specimen the left dorsal carotid serves as a much-reduced ascending oesophageal artery, while the right dorsal carotid is reduced to a small ligament which enters the hypapophysial canal (A–3–s/A–4–d); the right superficial cervical artery sends off branches to the oesophagus.

Yet another modification of the bicarotid arrangement is found in *Rhopodytes viridirostris*. In this species, both dorsal carotids are reduced to ligamenti ottleyi which enter the hypapophysial canal (A–4).

In each of the above mentioned species, the vertebrals and superficial cervicals were notably enlarged and appeared to carry an increased amount of blood to the head region.

Species studied

By Bhaduri and Biswas

Eudynamis s. scolopaceus = *Eudynamys s. scolopacea* (Linné)

By Garrod

Cuculus canorus Linné
Cacomantis variolosus sepulcralis (S. Müller)
Chrysococcyx sp.
Phaenicophaes sp. = *Phaenicophaeus pyrrhocephalus* (Pennant)
Guira piririgua = *Guira guira* (Gmelin)
Centropus senegalensis (Linné)

By Glenny

Cuculus sp.
Cacomantis pyrrophanus schistaceigularis Sharpe
Chrysococcyx cupreus intermedius Hartlaub
Chalcites lucidus layardi (Mathews)
Surniculus lugubris (Horsfield)
Urodynamis taitensis (Sparrmann)
Coccyzus erythrophthalamus (Wilson)
Coccyzus cinereus Vieillot
Coccyzus americanus (Linné) (2)
Piaya rufigularis (Hartlaub)
Saurothera merlini d'Orbigny (2)
Ceuthmochares aereus (Vieillot)
Rhopodytes viridirostris (Jerdon) (A–4)
Rhinortha chlorophaea (Raffles)
Zanclostomus javanicus (Horsfield) (A–3)
Rhamphococcyx curvirostris erythrognathus (Bonaparte) (A–3–s/A–4–d)
Phaenicophaeus pyrrhocephalus (Pennant) (A–3)
Crotophaga ani Linné (3)
Guira guira (Gmelin) (2)
Tapera naevia chochi (Vieillot)
Geococcyx californiana (Lesson)
Neomorphus geoffroyi salvini Sclater
Coua caerulea (Linné)
Centropus bengalensis javanensis (Dumont)

Order STRIGIFORMES

Carotids A–1; type C coracoid artery usually, but type A occurs more rarely; type 1 thoracic artery; ligamentum aortae usually prominent; ligamentum botalli present, but may be greatly reduced; vertebrals and superficial cervicals arise separately from the common carotid; an accessory oesophageal artery arises as a branch of the left common carotid artery.

References: Garrod, 1873; Glenny, 1943c.

Family Tytonidae

Species studied

By Glenny

Tyto alba (Scopoli) (2)

Family Strigidae

Species studied

By Garrod

Bubo fasciolatus=*Bubo poensis* Fraser
Scops zorca=*Otus scops* (Linné)
Otus vulgaris=*Asio otus* (Linné)
Bubo maximus=*Bubo bubo* (Linné)
Bubo virginianus (Gmelin)
Bubo bubo bengalensis (Franklin)
Bubo capensis A. Smith
Bubo poensis Fraser
Ketupa javanensis=*Ketupa ketupa* (Horsfield)
Pulsatrix torquata=*Pulsatrix perspicillata* (Latham)
Surnia funerea=*Surnia ulula* (Linné)
Glaucidium sp.
Athene passerina=*Glaucidium passerinum* (Linné)
Athene noctua (Scopoli)
Athene brama (Temminck)
Phaleoptynx cunicularia=*Speotyto cunicularia* (Molina)
Syrnium aluco=*Strix aluco* Linné
Syrnium nebulosum=*Strix nebulosa* J. R. Forster
Strix flammea=*Asio flammeus* (Pontoppidan)

By Glenny

Otus asio (Linné) (3)
Bubo virginianus (Gmelin) (2)
Nyctea scandiaca (Linné) (4)
Strix varia Barton (2)
Rhinoptynx clamator (Vieillot)
Asio otus wilsonianus (Lesson) (2)
Asio flammeus (Pontoppidan)
Aegolius acadicus (Gmelin) (2)

Order CAPRIMULGIFORMES

Both bicarotid and unicarotid arrangements are found; coracoid artery types A, B, C, and D occur; type 1 thoracic artery; ligamentum aortae present; presence of the ligamentum botalli variable; origin of the vertebrals and superficial cervicals variable.

References: Garrod, 1873; Glenny, 1953c.

Family Steatornithidae

Carotids A–1; type A coracoid; ligamentum botalli present; vertebrals and superficial cervicals have a short common root from the common carotid artery.

Species studied

By Garrod	By Glenny
Steatornis caripensis Humboldt	*Steatornis caripensis* Humboldt

Family Podargidae

Unicarotid (see list of species below); coracoid artery types B, C, and D (see list of species below); ligamentum botalli absent, or present as a linea botalli; vertebrals and superficial cervicals arise separately, for the most part, from the common carotid; an ascending oesophageal artery arises from the right common carotid artery.

In a single specimen of *Podargus papuensis* a patent ductus caroticus was observed. This group appears to be undergoing further evolution of the aortic arch system.

Species studied

By Glenny

Podargus strigoides (Latham) (B–4–s) (B)

Podargus papuensis Quoy and Gaimard (B–4–s) (D)

Podargus ocellatus Quoy and Gaimard (B–2–d) (A/B)

Batrachostomus hodgsoni indochinae Stresemann (B–4–s) (C)

Family Nyctibiidae

Carotids B–4–s; type C coracoid artery; ligamentum botalli absent; vertebrals and superficial cervicals arise from the common carotid artery at about the same site, or may have a short common root from the common carotid.

Species studied

By Glenny

Nyctibius griseus (Gmelin)

Family Aegothelidae

Carotids A–1; type D coracoid artery; ligamentum botalli absent; vertebrals and superficial cervicals arise separately from the common carotid arteries.

Species studied

By Glenny

Aegotheles sp. (Lake Habbema, New Guinea)

Family Caprimulgidae

Carotids A–1; coracoid artery types A, B, and C occur (see list of species below); ligamentum botalli may be complete, reduced, or absent; vertebrals and superficial cervicals arise separately from the common carotids.

Species studied

By Garrod

Chordeiles acutipennis texensis Lawrence
Caprimulgus europaeus Linné

By Glenny

Lurocalis semitorquatus (Gmelin) (A)
Chordeiles minor minor (J. R. Forster) (B)
Chordeiles minor vicinus Riley (B, C)
Nyctiprogne leucopyga (Spix) (C)
Podager nacunda (Vieillot) (2) (A)
Nyctidromus albicollis (Gmelin) (A)
Caprimulgus carolinensis Gmelin (C)
Caprimulgus longirostris Bonaparte (B)
Scotornis fossii (Hartlaub) (A)
Semeïophorus vexillarius Gould (A)
Hydropsalis brasiliana furcifera (Vieillot) (A)

Order APODIFORMES

Both bicarotid and unicarotid arrangements occur, but the unicarotid arrangement is of more frequent occurrence; coracoid artery types A and E occur; type 1 thoracic artery; ligamentum aortae present; ligamentum botalli usually absent but may be found in a few individuals; vertebrals and superficial cervicals generally have separate points of origin from the common carotids, but usually are very close together.

References: Garrod, 1873; Glenny, 1953b.

Family Apodidae

Both bicarotid and unicarotid arrangements (see list of species below); type A coracoid artery; ligamentum botalli absent.

Species studied

By Garrod

Chetura caudacuta=*Hirund-apus caudacutus* (Latham) (B–4–s)
Chetura vauxi=*Chaetura vauxi* (J. K. Townsend) (B–4–s)
Chetura spinicauda=*Chaetura spinicauda* (Temminck) (B–4–s)
Cypseloides fumigatus (Streubel) (A–1)
Cypselus alpinus=*Apus melba* (Linné) (B–4–s)
Cypselus apus=*Apus apus* (Linné) (B–4–s)

By Glenny

Collocalia inexpectata bartschi Mearns (B–4–s)
Streptoprocne zonaris pallidifrons (Hartert) (A–1)
Streptoprocne zonaris albicincta (Cabanis) (2) (A–1)
Chaetura vauxi (J. K. Townsend) (B–3b–d)
Chaetura pelagica (Linné) (3) (B–4–s)
Chaetura cinereiventris guianensis Hartert (2) (B–3b–d)
Nephoecetes niger (Gmelin) (A–1)
Apus andecolus (d'Orbigny and Lafresnaye) (B–4–s)
Aëronautes saxatalis (Woodhouse) (3) (B–4–s)
Tachornis phoenicobia Gosse (B–3b–d)

Family Hemiprocnidae

Carotids B–4–s; type A coracoid artery; ligamentum botalli may be present, but much reduced.

Species studied

By Garrod	By Glenny
Dendrochelidon coronata=Hemiprocne longipennis (*coronata*) (Tickell) (B–4–s)	*Hemiprocne comata major* (Hartert) *Hemiprocne mystacea aëroplanes* Stresemann

Family Trochilidae

Carotids B–4–s; coracoid artery types A and E (see list of species below); ligamentum botalli absent. The functional equivalent of the systemic arch usually arises as a branch of the right innominate artery

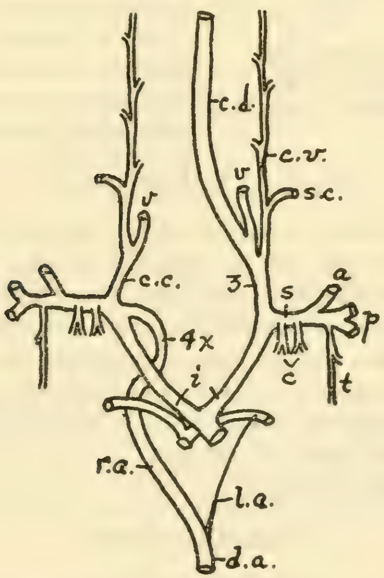

Figure 118.—Main cervical and thoracic arteries in the Trochilidae, ventral view. (For explanation of symbols see p. 551.)

just posterior to the point of origin of the subclavian and common carotid arteries (fig. 118).

The right ductus caroticus comes to serve as the functional systemic arch (Glenny, 1953c, 1954c).

Species studied

By Garrod

Chlorolampis osberti=*Chlorostilbon canivetii osberti* Gould
Patagona gigas (Vieillot)

By Glenny

Glaucis hirsuta (Gmelin) (E)
Phaethornis sp. (E)
Campylopterus falcatus (Swainson) (E)
Florisuga mellivora (Linné) (E)
Anthracothorax dominicus (Linné) (E)
Eulampis jugularis (Linné) (E)
Sericotes holosericeus (Linné) (E)
Chrysolampis mosquitus (Linné) (E)
Orthorhynchus cristatus exilis (Gmelin) (E)
Klais guimeti (Bourcier) (E)
Lophornis sp. (E)
Chlorostilbon canivetii caribaeus Lawrence (E)
Chlorostilbon ricordii (Gervais) (E)
Cynanthus latirostris Swainson (E)
Thalurania furcata colombica (Bourcier) (A)
Lepidopyga goudoti (Bourcier) (E)
Hylocharis xantusii (Lawrence) (E)
Hylocharis chrysura (Shaw) (E)
Trochilus polytmus Linné (E)
Leucippus fallax (Bourcier) (E)
Amazilia tobaci feliciae (Lesson) (3) (E)
Amazilia tzacatl (de la Llave) (E)
Chalybura buffonii aeneicauda Lawrence (E)
Chalybura buffonii subsp. (A)
Oreotrochilus leucopleurus Gould (E)
Patagona gigas (Vieillot) (E)
Sephanoides fernandensis (King) (E)
Sephanoides sephanoides (Lesson) (E)
Aglaiocercus kingi margarethae (Heine) (2) (E)
Sappho sparganura sapho (Lesson) (E)
Heliomaster furcifer (Shaw) (E)
Philodice evelynae (Bourcier) (E)
Archilochus colubris (Linné) (2) (E)
Mellisuga minima vieilloti (Shaw) (E)
Stellula calliope (Gould) (A)
Selasphorus platycercus (Swainson) (E)

Order COLIIFORMES

Carotids B–4–s; type A coracoid artery; thoracic artery types 3 and 4; ligamentum aortae present; ligamentum botalli greatly reduced and may fuse with the radix aortae and remain as a linea botalli; vertebral and superficial cervical of the left side arise as branches of a common root from the common carotid; an accessory oesophageal artery arises as a branch of the common carotid on the left side, while the complimentary right oesophageal artery arises from the common carotid at the base of the right vertebral artery.

References: Glenny, 1944e.

Family Coliidae

Species studied

By Glenny

Colius striatus Gmelin
Colius indicus Latham
Colius macrourus (Linné)

Order TROGONIFORMES

Carotids B–4–s; type A coracoid artery except for a specimen of *Trogon rufus* (type B); type 1 thoracic artery; ligamentum aortae present; ligamentum botalli greatly reduced (may remain as a ligamentous button or as a linea botalli); left vertebral and superficial cervical arteries have a common origin from the common carotid artery; an accessory oesophageal artery arises as a branch from either the common carotid or left vertebrocervical root.

References: Garrod, 1873; Glenny, 1943a, 1945b.

Family TROGONIDAE

SPECIES STUDIED

By Garrod

Trogon mexicanus Swainson
Trogon puella=*Trogon collaris puella* Gould

By Glenny

Pharomachrus mocino costaricensis Cabanis
Priotelus temnurus (Temminck)
Temnotrogon roseigaster (Vieillot)
Trogon massena Gould
Trogon melanuras macroura Gould
Trogon strigilatus Linné
Trogon citreolus melanocephala Gould
Trogon collaris exoptatus Cabanis and Heine
Trogon rufus tenellus Cabanis
Trogon rufus Gmelin (B)
Trogon surrucura Vieillot
Trogon curucui behni Gould
Trogon violaceus caligatus Gould
Apaloderma narina (Stephens)
Harpactes erythrocephalus (Gould)

Order CORACIIFORMES

Carotids both bicarotid and unicarotid arrangements occur; type A coracoid artery except in one species thus far noted; thoracic artery varies in the several families; ligamentum aortae present, except in a few instances in which the radix aortae of the left side remains as a functional vessel; presence of the ligamentum botalli is variable; origin of the vertebrals and superficial cervicals varies in the different families.

References: Beddard, 1898; Bhaduri and Biswas, 1945; Garrod, 1873, 1876; Glenny, 1939, 1943b; Ottley, 1879.

Family ALCEDINIDAE

Carotids A-1; thoracic artery usually type 1, but may vary (see list of species below); ligamentum botalli may be present or absent; vertebrals and superficial cervicals usually arise as branches from a common root from the common carotid; an accessory oesophageal may be present and arise as a branch of the left carotid artery.

SPECIES STUDIED

By Garrod

Ceryle maxima (Pallas)
Ceryle amazona=*Chloroceryle amazona* (Latham)
Alcedo atthis ispida Linné
Dacelo gigantea=*Dacelo novaguineae* (Hermann)
Dacelo leachii cervina Gould
Cittura cyanotis (Temminck)
Halcyon sp.

By Glenny

Ceryle torquata (Linné) (2)
Ceryle alcyon (Linné) (7) (Type 2 thoracic)
Ceryle rudis (Linné) (Type 3 thoracic)
Chloroceryle amazona (Latham) (2)
Chloroceryle americana septentrionalis (Sharpe)
Chloroceryle americana isthmica (Goldman)

Alcedo atthis bengalensis Gmelin
Alcedo coerulescens Vieillot
Alcedo cristata Pallas
Dacelo novaeguineae (Hermann)
Halycon senegalensis (Linné) (Type 6 thoracic, type D coracoid)
Halcyon chelicuti (Stanley) (Type 3 thoracic)
Halcyon cinnamomina Swainson (Type 6 thoracic)
Halcyon chloris (Boddaert)

Family Todidae

Carotids A–1 generally (see list of species below); type 1 thoracic artery; ligamentum botalli usually absent; origin of vertebrals and superficial cervicals variable; an accessory oesophageal artery arises as a branch of the left common carotid artery.

Species studied

By Glenny

Todus multicolor Gould
Todus angustirostris Lafresnaye (B–4–s)
Todus mexicanus Lesson
Todus subulatus G. R. Gray

Family Momotidae

Carotids A–1; type 1 and type 2 thoracic artery (see list of species below); ligamentum botalli present—may be much reduced or remain as a linea botalli; vertebrals and superficial cervicals arise separately from the common carotid artery.

Species studied

By Garrod

Eumomota superciliaris = *Eumomota superciliosa* (Sandbach)
Momotus momota lessonii Lesson

By Glenny

Eumomota superciliosa (Sandbach) (Type 1 thoracic)
Baryphthengus ruficapillus martii (Spix) (2) (Type 2 thoracic)
Momotus momota coeruliceps (Gould) (Type 1 thoracic)
Momotus momota conexus Thayer and Bangs (Type 1 thoracic)

Family Meropidae

Carotids A–1 and B–4–s (see list of species below); type 1 thoracic artery; ligamentum botalli usually absent, or may remain as a linea botalli; vertebrals and superficial cervicals usually arise separately from the common carotids, but the points of origin of these vessels are very close to each other; an accessory oesophageal artery is generally present as a branch of the left common carotid artery.

Species studied

By Garrod

Merops apiaster Linné (B–4–s)
Merops ornatus Latham (B–4–s)

By Glenny

Melittophagus pusillus (P. L. S. Müller) (A–1)
Melittophagus variegatus (Vieillot) (A–1)
Aerops albicollis (Vieillot) (B–4–s)
Merops apiaster Linné (B–4–s)
Merops superciliosus Linné (B–4–s)
Merops orientalis Latham (B–4–s)

Families Leptosomatidae and Brachypteraciidae

No information is available.

Family Coraciidae

Carotids A–1; type 1 thoracic artery; presence of the ligamentum botalli is variable; origin of vertebrals and superficial cervicals variable, although these vessels tend to have a common root from the common carotid arteries.

Species studied

By Garrod	By Glenny
Coracias garrulus Linné	*Coracias caudata* Linné
Eurystomus sp.	*Eurystomus orientalis* (Linné)

Family Upupidae

Carotids B–4–s; type 3 thoracic artery; ligamentum botalli reduced to a linea botalli; vertebrals and superficial cervicals have a common root from the common carotids.

Species studied

By Garrod	By Glenny
Upupa epops Linné	*Upupa epops epops* Linné
	Upapa epops africana Bechstein

Family Phoeniculidae

Carotids B–4–s; type 2 thoracic artery; ligamentum botalli reduced to a linea botalli; vertebrals and superficial cervicals arise separately from the common carotids; an accessory oesophageal artery arises as a branch of the left carotid artery.

Species studied

By Glenny

Phoeniculus purpureus erythrorhynchos (Latham)

Family Bucerotidae

Both bicarotid and unicarotid arrangements occur (see list of species below); type 1 thoracic artery; ligamentum botalli usually present, but may be reduced or lacking in some species; there is considerable variation in the cervical arteries, but the vertebrals and superficial cervicals appear to arise separately from the common carotid arteries; the left superficial cervical generally sends off an accessory oesophageal artery.

SPECIES STUDIED

By Beddard

Aceros sp.
Bucorvus sp.

By Fürbringer

Bucorvus abyssinicus (Boddaert)

By Garrod

Toccus melanoleucus = *Tockus alboterminatus australis* (Roberts) (B–4–s)
Buceros plicatus = *Aceros plicatus* (J. R. Forster) (A–1)
Buceros coronatus = *Anthracoceros coronatus* (Boddaert) (A–1)
Buceros atratus = *Certogymna atrata* (Temminck) (A–1)
Buceros rhinoceros Linné (A–1)
Buceros bicornis Linné (A–1)
Bucorvus abyssinicus (Boddaert) (A–4)

By Glenny

Tockus alboterminatus (Büttikofer) (B–3a–d)
Tockus alboterminatus australis (Roberts) (2) (B–3a–d)
Tockus flavirostris (Rüppell) (B–3a–d)
Aceros undulatus (Shaw) (A–1)
Anthracoceros coronatus convexus (Temminck) (A–1)

By Ottley

Bucorvus abyssinicus (Boddaert) (A–4)

Order PICIFORMES

Carotids B–4–s, except in the Galbulidae (A–1); both the coracoid and thoracic arteries are variable in location; ligamentum aortae present but may be much reduced in some species; presence of the ligamentum botalli is variable; vertebrals and superficial cervicals variable in origin from the common carotid arteries.

References: Bhaduri and Biswas, 1945, 1947; Garrod, 1873, Glenny, 1944a.

Family GALBULIDAE

Carotids A–1; both coracoid and thoracic arteries may be variable (see list of species below); ligamentum botalli absent; vertebrals and superficial cervicals variable in origin, but usually arise separately from the common carotid.

SPECIES STUDIED

By Garrod

Galbula albirostris Latham
Urogalba paradisea = *Galbula dea amazonum* (Sclater)

By Glenny

Galbula ruficauda Cuvier (A) (Type 4 thoracic)

Family BUCCONIDAE

Carotids B–4–s; coracoid and thoracic arteries variable (see list of species below); ligamentum botalli reduced to a linea botalli or lacking; origin of vertebrals and superficial cervicals variable; an accessory oesophageal artery arises as a branch of the left common carotid artery.

SPECIES STUDIED

By Glenny

Notharchus macrorhynchos cryptoleucus van Rossem (A) (Type 1 thoracic)
Notharchus macrorhynchos hyperrhynchus (Sclater) (A) (Type 1 thoracic)
Notharchus pectoralis (G. R. Gray) (A) (Type 3 thoracic)
Nystalus maculatus striatipectus (Sclater) (B) (Type 4 thoracic)
Nonnula frontalis (Sclater) (B) (Type 4 thoracic)
Monasa morphoeus (Hahn and Kuster) (A) (Type 4 thoracic)

Family Capitonidae

Carotids B–4–s (one reported instance of B–4–d); coracoid and thoracic arteries variable (see list of species below: type 3 unless otherwise noted); ligamentum botalli reduced, may occur as a linea botalli or be entirely lacking; vertebrals and superficial cervicals usually arise separately from the common carotid, or may have a short common root; accessory oesophageal artery arises as a branch of the common carotid or left superficial cervical artery.

SPECIES STUDIED

By Bhaduri and Biswas

Thereiceryx zeylanicus caniceps=*Megalaima zeylanica caniceps* (Franklin) (B–4–s and B–4–d) (A) (Type 4 thoracic)
Cyanops a. asiatica=*Megalaima a. asiatica* (Latham) (A)
Xantholaema haemacephala lutea=*Megalaima haemacephala indica* (Latham) (B)

By Garrod

Megalaima asiatica (Latham)
Barbatula duchaillui=*Pogoniulus duchaillui* (Cassin)

By Glenny

Semnornis frantzii (Sclater) (A)
Psilopogon pyrolophus S. Müller (B) (Type 4 thoracic)
Megalaima zeylanica (Gmelin) (A)
Megalaima rafflesii borneensis (W. Blasius) (A)
Megalaima asiatica (Latham) (A)
Megalaima rubricapilla (Gmelin) (B)
Megalaima haemacephala rosea (Dumont) (A)
Megalaima haemacephala (P. L. S. Müller) (B)
Tricholaema leucomelan (Boddaert) (A) (Type 4 thoracic)
Tricholaema diadematum (Heuglin) (A) (Type 5 thoracic)
Lybius leucocephalus albicauda (Shelley) (A) (Type 2 thoracic)

Family Indicatoridae

Carotids B–4–s; type A coracoid artery; type 1 thoracic artery; ligamentum botalli reduced to a small basal button or completely lacking; vertebrals and superficial cervicals usually arise separately from the common carotids; accessory oesophageal artery arises as a branch of the left carotid artery.

SPECIES STUDIED

By Glenny

Prodotiscus insignis (Cassin)
Indicator minor Stephens
Indicator indicator (Sparrman)
Indicator xanthonotus fulvus D. Ripley

By Garrod

Indicator major=*Indicator indicator* (Sparrman)

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Family Ramphastidae

Carotids B–4–s; type A coracoid artery; thoracic artery varies (see list of species below); ligamentum botalli may be present or absent; vertebrals and superficial cervicals arise separately from the common carotid arteries; accessory oesophageal artery arises as a branch of the left carotid, left superficial cervical, or near the base of the left vertebral artery.

Species studied

By Garrod

Ramphastos ariel=*Ramphastos vitellinus ariel* Vigors
Ramphastos carinatus=?*Ramphastos sulfuratus* Lesson
Ramphastos cuvieri Wagler

By Glenny

Aulacorhynchus sulcatus (Swainson) (2) (Type 4 thoracic)
Pteroglossus torquatus (Gmelin) (Type 3 thoracic)
Pteroglossus torquatus frantzii Cabanis (Type 3 thoracic)
Selenidera spectabilis Cassin (Type 3 thoracic)
Ramphastos sulfuratus brevicarinatus Gould (2) (Type 1 thoracic)
Ramphastos cuvieri Wagler (Type 1 or 2 thoracic)
Ramphastos tucanus Linné (Type 2 thoracic)
Ramphastos toco P. L. S. Müller (Type 2 thoracic)

Family Picidae

Carotids B–4–s, except for a specimen of *Piculus rubiginosus* (B–3a–d); type A coracoid; type 3 thoracic artery; presence of a ligamentum botalli variable; origin of vertebrals and superficial cervicals variable, but are usually in close association; an accessory oesophageal artery arises as a branch of the left carotid, or from the left superficial cervical artery; in several species, a pair of vessels supplying the trachea and syrinx arises as a branch from the common carotid artery near its base.

Species studied

By Garrod

Jynx torquilla Linné
Chloronerpes yucatanensis=*Piculus rubiginosus yucatanensis* (Cabot)
Gecinus viridis=*Gecinulus viridis* Blyth
Mulleripicus fulvus (Quoy and Gaimard)
Tiga javensis=*Dryocopus javensis* (Horsfield)
Melanerpes formicivorus (Swainson)
Leuconerpes candidus (Otto)
Picus major=*Dendrocopos major* (Linné)
Picus minor=*Dencrocopos minor* (Linné)
Picoïdes tridactylus (Linné)

By Glenny

Picumnus pumilus Cabanis and Heine
Picumnus cirratus pilcomayensis Hargitt
Picumnus squamulatus röhli Zimmer and Phelps
Nesoctites micromegas (Sundevall)
Colaptes cafer collaris Vigors
Colaptes auratus luteus Bangs
Colaptes auratus chrysocaulosus Grundlach
Colaptes pitius (Molina)
Colaptes campestris campestroïdes (Malherbe)
Nesoceleus fernandinae (Vigors)
Chrysoptilus melanochloros nigroviridis C. Grant
Piculus rubiginosus (Swainson) (B–3a–d)
Piculus rubiginosus tucumanus (Cabanis)
Piculus flavigula (Boddaert)
Piculus chrysochloros (Vieillot)

Campethera permista (Reichenow)
Celeus flavescens kerri Hargitt
Celeus flavus (P. L. S. Müller)
Picus canus zimmermanni Reichenow
Picus canus dedemi (van Oort)
Dinopium benghalense erythronothon (Vieillot)
Dryocopus javensis parvus (Richmond)
Dryocopus pileatus (Linné)
Asyndesmus lewis (G. R. Gray)
Melanerpes hypopolius uropygialis (Baird)
Melanerpes carolinus (Linné) (2)
Melanerpes superciliaris (Temminck)
Melanerpes striatus (P. L. S. Müller)
Melanerpes pucherani (Malherbe)
Melanerpes rubricapillus terricolor (Berlepsch)
Melanerpes cruentatus (Boddaert)
Leuconerpes candidus (Otto)
Sphyrapicus varius ruber (Gmelin)
Sphyrapicus varius (Linné)
Sphyrapicus thyroideus (Cassin)
Trichopicus cactorum (d'Orbigny)
Veniliornis spilogaster (Wagler)
Veniliornis passerinus olivinus (Natterer and Malherbe)
Veniliornis frontalis (Cabanis)
Veniliornis kirkii cecilii (Malherbe)
Dendrocopos villosus villosus (Linné) (3)
Dendrocopos villosus audubonii (Swainson)
Dendrocopos pubescens medianus (Swainson) (3)
Dendrocopos borealis (Vieillot) (2)
Picoïdes tridactylus dorsalis Baird
Picoïdes arcticus (Swainson)
Xiphidiopicus percussus (Temminck)
Phloeoceastes melanoleucos malherbii (G. R. Gray)
Phloeoceastes melanoleucos (Gmelin)
Phloeoceastes leucopogon (Valenciennes) (3)
Campephilus principalis (Linné)

Order PASSERIFORMES

Carotids B–4–s except for *Orthonyx*, which is said (Beddard, 1898) to be B–5–s; coracoid artery varies, but is usually type A; thoracic artery varies, but type 3 and type 4 are the most common; ligamentum aortae is present in most of the families, but this is somewhat variable and may not be detected due, perhaps, to the amount or level of atrophy; ligamentum botalli usually absent or reduced to a linea botalli; vertebrals and superficial cervicals vary in points of origin from the common carotids; an accessory oesophageal artery arises as a branch of the common carotid or one of the cervical arteries of the left side, when present.

It is difficult to determine the presence of the latter vessel in specimens that have been preserved for some time and as a result may be overlooked.

References: Bauer, 1825; Beddard, 1898; Biswas, 1946; Garrod, 1873; Glenny, 1940a, 1942a, 1944f, 1945a, 1945f, 1951b; Meckel, 1826; Stresemann, 1927–1934.

Family Eurylaimidae

No information available.

Family Dendrocolaptidae

Type A coracoid artery; type 3 thoracic artery; ligamentum aortae present but reduced; vertebrals and superficial cervicals usually have a common root.

Species studied

By Glenny

Sittasomus griseicapillus griseus Jardine
Xiphorhynchus picus choicus (Wetmore and Phelps)
Xiphorhynchus triangularis hylodromus Wetmore
Lepidocolaptes souleyetii littoralis (Hartert and Goodson)
Campylorhamphus trochilirostris venezuelensis (Chapman)

Family Furnariidae

Type A coracoid artery; type 3 thoracic artery; ligamentum aortae small but usually present; vertebrals and superficial cervicals may have a short common root or arise separately.

Species studied

By Glenny

Cranioleuca subcristata (Sclater)
Anabacerthia striaticollis venezuelana (Hellmayr)
Phylidor rufus columbianus Cabanis and Heine
Xenops rutilans heterurus Cabanis and Heine

Family Formicariidae

Type A coracoid artery; type 3 thoracic artery; ligamentum aortae present; vertebrals and superficial cervicals arise separately, or have but a short common root; the ascending oesophageal artery (right side) is usually prominent.

Species studied

By Glenny

Dysithamnus mentalis cumbreanus Hellmayr and Seilern
Dysithamnus plumbeus tucuyensis Hartert
Myrmotherula schisticolor sanctae-martae Allen
Drymophila caudata klagesi Hellmayr and Seilern
Formicarius analis saturatus Ridgway
Formicarius nigricapillus Ridgway

Family Conopophagidae

No information available.

Family Rhinocryptidae

Type A coracoid artery; type 3 thoracic artery; ligamentum aortae present; vertebrals and superficial cervicals arise from a common, short root or separately from the common carotid artery; the ascending oesophageal artery of the right side is prominent.

Species studied

By Garrod	By Glenny
Hylactes megapodius = *Pteroptochos megapodius* Kittlitz	*Pteroptochos* sp.

Family Cotingidae

Type A coracoid, except in *Tityra inquisitor* (type D); type 1 thoracic artery; ligamentum aortae present; ligamentum botalli present in a specimen of *Pyroderus scutatus*, which also presented two pairs of superficial cervical arteries, and an accessory oesophageal artery arising as a branch of the secondary or ventral superficial cervical artery of the left side; vertebrals and superficial cervicals have a short common root from the common carotid.

A specimen of *Lipaugus cineraceus* was found to be type A coracoid artery and type 3 thoracic artery.

Species studied

By Garrod	*Pachyramphus albogriseus* Sclater
Lipaugus cineraceus (Vieillot)	*Tityra inquisitor* (Lichtenstein)
Rupicola crocea = *Rupicola rupicola* (Linné)	*Pyroderus scutatus* (Shaw)
By Glenny	*Procnias nudicollis* (Vieillot)
Lipaugus cineraceus (Vieillot)	

Family Pipridae

Type A coracoid artery; type 3 or type 4 thoracic artery; vertebrals and superficial cervicals arise separately, or from a short, common root; ligamentum aortae may be absent.

Species studied

By Glenny

Pipra pipra anthracina Ridgway

Family Tyrannidae

Type A coracoid artery; type 3 or more rarely type 4 thoracic artery; ligamentum aortae present; vertebrals and superficial cervicals arise as branches of a common root from the common carotid; the right carotid sends off an ascending oesophageal artery.

Species studied

By Garrod

Tyrannus satrapa = *Tyrannus melancholicus* Vieillot	*Pitangus sulphuratus* (Vieillot)

By Glenny

Xolmis cinerea (Vieillot)
Xolmis murina (Lafresnaye and d'Orbigny)
Xolmis rubetra (Burmeister)
Pyrocephalus rubinus dubius Gould
Muscivora forficata (Gmelin)
Tyrannus tyrannus (Linné) (2)
Tyrannus vociferans Swainson
Tyrannus melancholicus Vieillot (2)
Tyrannus dominicensis (Gmelin)
Pitangus sulphuratus derbianus (Kaup)
Myiarchus crinitus (Linné)
Eribates magnirostris (Gould)
Empidonax virescens (Vieillot)
Empidonax traillii (Audubon)
Myiophobus fasciatus (P. L. S. Müller)
Todirostrum cinereum (Linné)
Pogonotriccus ophthalmicus Taczanowski
Pogonotriccus venezuelanus Berlepsch
Pogonotriccus flaviventris (Hartert)

Families Oxyruncidae and Phytotomidae

No information available.

Family Pittidae

Type B coracoid artery; type 1 thoracic artery; ligamentum aortae present; vertebrals and superficial cervicals have a short, common root from the common carotid; the right common carotid sends off an ascending oesophageal artery.

Species studied

By Garrod

Pitta sp.

By Glenny

Pitta erythrogaster Temminck

Families Acanthisittidae and Philepittidae

No information available.

Family Menuridae

No details available.

Species studied

By Garrod

Menura superba Davies

Family Atrichornithidae

No information available.

Family Alaudidae

No details available.

Species studied

By Garrod

Alauda arvensis Linné
Melanocorypha calandra (Linné)

Family Hirundinidae

Type A coracoid artery; type 3 thoracic artery; ligamentum aortae usually present but reduced; vertebrals and superficial cervicals usually arise as branches from a common root; an ascending oesophageal artery arises as a branch from the right common carotid artery.

Species studied

By Garrod	By Glenny
Hirundo rustica Linné	*Progne subis* (Linné)
Chelidon urbica=*Hirundo urbica* Linné	*Hirundo rustica erythrogaster* Boddaert
	Phaeoprogne tapera (Linné)

Family Campephagidae

No details available.

Species studied

By Garrod

Graucalus macei Lesson

Family Dicruridae

Type A coracoid artery; type 3 thoracic artery; ligamentum aortae present; vertebral and superficial cervical arteries have a common root from the common carotid artery; the ascending oesophageal artery arises as a branch of the right common carotid artery.

Species studied

By Garrod	By Glenny
Dicrurus leucops Wallace	*Dicrurus ater cathoecus* (Swinhoe)

Family Oriolidae

Type A coracoid artery; types 1 to 4 thoracic artery; ligamentum aortae present; vertebrals and superficial cervicals have a common root from the common carotids; ascending oesophageal artery arises as a branch of the right common carotid artery.

Species studied

By Garrod	By Glenny
Oriolus sp.	*Oriolus xanthornus* Linné
	Oriolus chinensis diffusus Sharpe

Family Corvidae

Type A coracoid artery; types 1 to 4 thoracic artery; ligamentum aortae present; vertebrals and superficial cervicals arise from a common root from the common carotid arteries; ascending oesophageal artery arises as a branch of the right common carotid artery.

Species studied

By Garrod

Cissa speciosa=*Cissa chinensis* Boddaert
Cyanocorax cyanopogon (Wied)
Garrulus glandarius (Linné)
Corvus corax Linné
Corvus frugilegus Linné
Corvus australis Gmelin
Struthidea cinerea Gould

By Glenny

Corvus brachyrhynchos Brehm
Coloeus monedula dauuricus (Pallas) (2)
Cyanopica cyanus interopsita Hartert
Cyanocitta cristata bromia Oberholser
Xanthoura yncas (Boddaert)
Perisoreus canadensis (Linné) (2)

Families Cracticidae and Grallinidae

No information available.

Family Ptilonorhynchidae

No details available.

Species studied

By Garrod

Ptilonorhynchus holosericeus=*Ptilonorhynchus violaceus* (Vieillot)

Families Paradiseidae and Paradoxornithidae

No information available.

Family Paridae

Type A coracoid artery; type 3 thoracic artery; ligamentum aortae present but reduced; vertebrals and superficial cervicals arise separately or as branches of a short common root from the common carotids; ascending oesophageal artery arises as a branch of the right common carotid artery.

Species studied

By Garrod

Parus major Linné

By Glenny

Parus atricapillus (Linné) (2)
Parus bicolor (Linné) (3)
Parus palustris hellmayri (Bianchi)
Parus major artatus Thayer and Bangs

Family Sittidae

Type A coracoid artery; type 3 thoracic artery; ligamentum aortae usually present but reduced; vertebrals and superficial cervicals may arise separately or from a short common root from the common carotid arteries; ascending oesophageal artery arises as a branch of the right common carotid artery.

SPECIES STUDIED

By Garrod	By Glenny
Sitta europaea Linné	*Sitta carolinensis* Latham (2)

Family HYPOSITTIDAE

No information available.

Family CERTHIIDAE

Type A coracoid artery; types 3 and 4 thoracic artery; ligamentum aortae much reduced; vertebrals and superficial cervicals arise separately or from a short common root from the common carotids; ascending oesophageal artery arises as a branch of the right common carotid artery.

SPECIES STUDIED

By Glenny

Certhia familiaris americana (Bonaparte)

Families CHAMAEIDAE AND TIMALIIDAE

No information available.

Family PYCNONOTIDAE

Type A coracoid artery; type 3 thoracic artery; ligamentum aortae not observed; vertebrals arise separately from superficial cervicals or from a short root from the common carotids; ascending oesophageal artery arises as a branch of the right common carotid artery.

SPECIES STUDIED

By Glenny

Aegithina tiphia zelonica (Gmelin)	*Chlorocichla flaviventris* (Smith)

Family CINCLIDAE

No details available.

SPECIES STUDIED

By Garrod

Cinclus aquaticus = *Cinclus cinclus aquaticus* Bechstein

Family TROGLODYTIDAE

Type A coracoid artery; types 3 or 4 thoracic artery; ligamentum aortae greatly reduced or lacking; vertebrals and superficial cervicals arise from a common root from the common carotid arteries; ascending oesophageal artery arises as a branch from the right common carotid artery.

SPECIES STUDIED

By Garrod	By Glenny
Troglodytes parvulus = *Troglodytes troglodytes* (Linné)	*Troglodytes aëdon* Vieillot (2)
	Telmatodytes palustris Wilson
	Thryothorus genibarbis Swainson

Family MIMIDAE

Type A coracoid artery; types 3 or 4 thoracic artery; ligamentum aortae much reduced or absent; vertebrals and superficial cervicals arise from a short common root from the common carotid artery; ascending oesophageal artery arises as a branch of the right common carotid artery.

SPECIES STUDIED

By Glenny

Toxostoma rufum (Linné)

Family TURDIDAE

Type A coracoid artery; types 3 and 4 thoracic artery; ligamentum aortae reduced or absent; vertebrals and superficial cervicals arise as branches of a common root from the common carotid artery; ascending oesophageal artery arises as a branch of the right common carotid artery.

SPECIES STUDIED

By Garrod	By Glenny
Sialia wilsonii = *Sialia sialis* (Linné)	*Sialia sialis* (Linné)
Turdus grayi Bonaparte	*Turdus migratorius* Linné
Myiadestes obscurus Lafresnaye	*Hylocichla ustulata swainsoni* (Cabanis) (2)
Turdus merula Linné	*Hylocichla minima minima* (Lafresnaye)
Pratincola rubetra (Linné)	*Hylocichla guttata pallasi* (Cabanis)
Ruticilla phoenicura = *Phoenicurus phoenicurus* (Linné)	*Hylocichla mustelina* (Gmelin)
Erithacus rubecula (Linné)	
Luscinia vera = *Luscinia megarhynchos* Brehm	

Family ZELEDONIIDAE

No information available.

Family SYLVIIDAE

Type A coracoid artery; type 3 thoracic artery; ligamentum aortae reduced; vertebrals and superficial cervicals arise as branches of a common root from the common carotid arteries; ascending oesophageal artery arises as a branch of the right common carotid artery.

SPECIES STUDIED

By Garrod	By Glenny
Anthornis melanura=*Polioptila melanura* Lawrence	*Polioptila plumbea* (Gmelin)
Sylvia hippolais=*Hippolais icterina* (Vieillot)	*Polioptila caerulea* Linné

Family REGULIDAE

Type A coracoid artery; type 3 or 4 thoracic artery; ligamentum aortae not observed; vertebrals and superficial cervicals arise from a common root from the common carotid artery; ascending oesophageal artery arises as a branch of the right common carotid artery.

SPECIES STUDIED

By Glenny

Regulus satrapa Lichtenstein

Family MUSCICAPIDAE

No details available.

SPECIES STUDIED

By Garrod

Muscicapa grisola=*Muscicapa striata* (Pallas)

Family PRUNELLIDAE

No information available.

Family MOTACILLIDAE

Type A coracoid artery; types 3 and 4 thoracic artery; ligamentum aortae not observed; vertebrals and superficial cervicals arise from a common root from the common carotid artery; ascending oesophageal artery arises as a branch of the right common carotid artery.

SPECIES STUDIED

By Garrod	By Glenny
Anthus pratensis (Linné)	*Anthus spinoletta rubescens* (Tunstall)
Motacilla flava Linné	

Family BOMBYCILLIDAE

Type A coracoid artery; type 3 thoracic artery; ligamentum aortae present; vertebrals and superficial cervicals arise as branches from a common root from the common carotid artery; a pair of ascending oesophageal arteries were observed to arise as branches of the common carotid arteries.

Species studied

By Garrod	By Glenny
Ampelis garrulus=*Bombycilla garrulus* (Linné)	*Bombycilla cedrórum* Vieillot

Family Ptilogonatidae

No details available.

Species studied

By Garrod

Ptilogonys cinereus Swainson

Family Dulidae

No information available.

Family Artamidae

No details available.

Species studied

By Garrod

Artamus sp.

Family Vangidae

No information available.

Family Laniidae

No details available.

Species studied

By Garrod

Lanius collurio Linné	*Strepera graculina* (White)

Family Prionopidae

No details available.

Species studied

By Garrod

Sigmodus caniceps Bonaparte.

Families Cyclarhidae, Vireolaniidae, and Callaeidae

No information available.

Family Sturnidae

Type A coracoid artery; type 3 thoracic artery; ligamentum aortae reduced or absent; ligamentum botalli observed in *Aplonis tabuensis;* vertebrals and superficial cervicals arise as branches of a common root from the common carotids; ascending oesophageal artery arises as a branch of the right common carotid artery.

SPECIES STUDIED

By Garrod	By Glenny
Sturnus vulgaris Linné	*Sturnus vulgaris* Linné
Heteralocha gouldi=*Heteralocha acutirostris* (Gould)	*Aplonis tabuensis* (Gmelin)
Gracula religiosa (Linné)	

Family MELIPHAGIDAE

No details available.

SPECIES STUDIED

By Garrod

Tropidorhynchus sp. | *Posthemadera novae-zealandiae* (Gmelin)

Family NECTARINIIDAE

No details available.

SPECIES STUDIED

By Garrod

Nectarinia sp.

Family DICAEIDAE

No details available.

SPECIES STUDIED

By Garrod

Dicaeum sp.

Family ZOSTEROPIDAE

No details available.

SPECIES STUDIED

By Garrod

Zosterops albogularis=*Zosterops albigularis* Gould.

Family VIREONIDAE

Type A coracoid artery; types 3 and 4 thoracic artery; ligamentum aortae reduced; vertebrals and superficial cervicals arise from a short common root from the common carotid arteries; ascending oesophageal artery arises as a branch of the right common carotid artery.

SPECIES STUDIED

By Glenny

Vireo solitarius (Wilson) | *Vireo virescens* Vieillot

Family COEREBIDAE

Type A coracoid artery; type 4 thoracic artery; ligamentum aortae reduced; vertebrals and superficial cervicals arise as branches of a common root from the common carotid arteries; ascending oesophageal artery arises as a branch of the right common carotid artery.

SPECIES STUDIED

By Garrod

Coereba cyanea = *Cyanerpes cyaneus* (Linné)
Diglossa baritula Wagler

By Glenny

Cyanerpes caeruleus (Linné) (3)

Family DREPANIDIDAE

No information available.

Family PARULIDAE

Type A coracoid artery; types 3 and 4 thoracic artery; ligamentum aortae reduced or absent; vertebrals and superficial cervicals arise from a common root from the common carotid arteries; ascending oesophageal artery arises as a branch of the right common carotid artery.

SPECIES STUDIED

By Garrod

Mniotilta varia (Linné)

By Glenny

Protonotaria citrea (Boddaert)
Vermivora peregrina (Wilson)
Vermivora ruficapilla (Wilson)
Dendroica coronata (Linné)
Dendroica cerulea (Wilson)
Dendroica fusca (Müller)
Dendroica breviunguis (Spix)
Seiurus aurocapillus (Linné)
Seiurus noveboracensis (Vieillot)
Oporornis formosus (Wilson)
Geothlypis trichas (Linné)
Setophaga ruticilla (Linné) (2)
Myioborus miniatus (Swainson)
Basileuterus tristriatus (Tschudi)
Basileuterus culicivorus (Lichtenstein)

Family PLOCEIDAE

Type A coracoid artery; type 3 thoracic artery; ligamentum aortae reduced; vertebrals and superficial cervicals arise as branches of a common root from the common carotid artery; ascending oesophageal artery arises as a branch of the right common carotid artery

In a single specimen of *Ploceus p. philippinus*, both left and right systemic arches and radices aortae were present, as well as the right and left ligamenti botalli (Biswas 1946).

SPECIES STUDIED

By Biswas

Ploceus philippinus philippinus (Linné)

By Garrod

Ploceus manyar (Horsfield)
Poephila cincta (Gould)
Munia major=*Munia maja* (Linné)
Euplectes capensis (Linné)
Estrelda melpoda=*Sporaeginthus melpodus* (Vieillot)
Hyphantornis castaneo-fuscus=*Melanopteryx castaneofusca* (Lesson)
Padda oryzivora=*Munia oryzivora* (Linné)
Donacola castaneothorax=*Munia castaneothorax* (Gould)
Quelea occidentalis=*Quelea quelea quelea* Linné

By Glenny

Passer domesticus Linné (2)
Passer montanus saturatus (Stejneger)

Family Icteridae

Type A coracoid artery; types 3 and 4 thoracic artery; ligamentum aortae much reduced or absent; vertebrals and superficial cervicals arise as branches of a common root from the common carotids; ascending oesophageal artery arises as a branch of the right common carotid artery.

Species studied

By Garrod

Cassicus persicus = *Cacicus vitellinus* Lawrence
Agelaeus ludovicianus = ?*Sturnella magna* (Linné)
Icterus abeillei (Lesson)
Molothrus bonariensis = *Molothrus bonariensis atronitens* (Cabanis)

By Glenny

Xanthornus angustifrons (Spix)
Molothrus ater (Boddaert)
Ptiloxena atroviolacea (d'Orbigny)
Icterus galbula (Linné)
Icterus dominicensis (Linné)
Agelaius phoeniceus (Linné)

Family Tersinidae

No information available.

Family Thraupidae

Type A coracoid artery; type 3 thoracic artery; ligamentum aortae somewhat reduced or lacking; vertebrals and superficial cervicals arise as branches from a common root from the common carotids; ascending oesophageal artery arises as a branch of the right common carotid artery.

Species studied

By Garrod

Euphonia violacea = *Tanagra violacea* (Linné)
Tanagra cana = *Thraupis episcopus cana* (Swainson)
Cissopis leveriana (Gmelin)

By Glenny

Calospiza chrysophrys (Sclater)
Calospiza arthus (Lesson)
Calospiza gyrola (Linné)
Compsocoma flavinucha (Lafresnaye and d'Orbigny)
Thraupis episcopus (Linné)
Thraupis palmarum (Wied)
Thraupis cyanocephala (Lafresnaye and d'Orbigny)
Ramphocelus carbo (Pallas)
Ramphocelus dimidiatus isthmicus Ridgway
Tachyphonus rufus (Boddaert)

Family Catamblyrhynchidae

No information available.

Family Fringillidae

Type A coracoid artery; type 3 thoracic artery, but type 4 may also be present occasionally; ligamentum aortae usually present; ligamentum botalli rarely present; vertebrals and superficial cervicals arise from a common root from the common carotid arteries; ascending oesophageal artery arises as a branch of the right common carotid artery.

SPECIES STUDIED

By Garrod

Coccothraustes vulgaris = *Coccothraustes coccothraustes* (Linné)
Hedymeles ludoviciana = *Pheucticus ludovicianus* (Linné)
Cardinalis virginianus = *Richmondena cardinalis* (Linné)
Corythus enucleator = *Pinicola enucleator* (Linné)
Cyanospiza ciris = *Passerina ciris* (Linné)
Emberiza sp.
Liniaria cannabina (Linné)
Pyrrhula vulgaris = *Pyrrhula pyrrhula europaea* Vieillot

By Glenny

Geospiza fuliginosa Gould
Geospiza septentrionalis (Rothschild and Hartert)
Certhidea olivacea cinerascens Ridgway
Pheucticus ludovicianus (Linné)
Guiraca caerulea (Linné)
Loxigilla violacea affinis (Baird)
Loxigilla noctis sclateri (Allen)
Loxipasser anoxanthus (Gosse)
Sporophila aurita (Bonaparte)
Tiaris olivacea (Linné)
Tiaris bicolor omissa Jardine
Melopyrrha nigra (Linné)
Amaurospiza concolor Cabanis
Richmondena cardinalis (Linné)
Saltator albicollis isthmicus (Sclater)
Fringilla coelebs Linné
Fringilla montifringilla Linné
Hesperiphona vespertina (W. Cooper)
Serinus canaria (Linné)
Pyrrhula pyrrhula (Linné)
Melospiza melodia (Wilson)
Pinicola enucleator leucura (Müller) (2)
Leucosticte tephrocotis griseonucha (Brandt)
Carduelis carduelis (Linné)
Acanthis flammea (Linné)
Spinus tristis (Linné)
Coryphospingus pileatus (Wied)
Arremonops conirostris (Bonaparte)
Pipilo erythrophthalmus (Linné)
Pipilo fuscus mesoleucus Baird (2)
Passerculus sandwichensis savanna (Wilson)
Junco hyemalis (Linné)
Spizella arborea (Wilson) (2)
Spizella passerina (Bechstein)
Spizella pusilla (Wilson)
Zonotrichia albicollis (Gmelin)
Passerella iliaca (Merrem)
Emberiza flaviventris Stephens
Emberiza aureola Pallas
Paroaria capitata (Lafresnaye and d'Orbigny)

Paramorphogenesis in the aortic arch system

Paramorphogenesis is, quite simply, parallel structural development and evolution. The term can be applied when structures are homologous, and when developmental evolution of a structure follows the same pattern and general course of events to arrive at the same or similar end insofar as structure is concerned. This term should be applied only when such patterns of structural evolution occur in distantly related forms, as in orders and classes of organisms, and when there is no apparent link or graded series leading from some known ancestral form to its present-day descendents in any of several different orders.

Paramorphogenesis is not to be confused with the term convergence; rather, it implies a general tendency toward structural evolution along the same or similar lines in separate or diverse groups of allied forms, especially those forms which are presumed to be related—as orders and classes of vertebrates, especially as in the amniotes.

All birds, insofar as presently known, develop a complete aortic arch system, and this system undergoes a series of developmental (atrophic) deletions and other modifications which result in the adult arterial arrangement-patterns, most of which have been set forth in the previous chapter. It is now a question as to whether the fourth and fifth aortic arches make an appearance in at least several of the Trochilidae, and, if they do, for what period of time they are present. Glenny (1953b, 1954c) has shown that the right systemic arch may be absent in several species of hummingbirds, and that the ductus caroticus serves the function of the fourth arch in these instances.

That widely separated orders of birds should undergo similar evolutionary changes in the aortic arch system is in itself a fact worthy of note, but that a somewhat similar instance of deletion of the dorsal carotid should occur in *Alligator mississippiensis* is of still greater interest (Reese, 1914), especially in view of the fact that some zoologists have linked the Crocodilia and Aves to the same basic reptilian stem (Archosauria). In the alligator, the left dorsal carotid remains as the functional vessel and, as in most birds, this vessel enters the hypapophysial canal and passes anteriorly to the head where it sends off left and right branches which then further divide and supply the various parts of the cranial region. Thus the carotid arrangement in the alligator would be referred to as laevocarotidinae, and, as has already been demonstrated, this arrangement is quite common among the present-day birds.

Within the class Aves there is abundant evidence to show that evolution of the aortic arch system is still in progress, and that culmination of this evolution may be the complete loss of the dorsal carotids anterior to the carotid arch. In such instances where this condition has been found, the vertebrals and the superficial cervicals take over the function of supplying blood to the head.

Reduction and loss of the dorsal carotids may take place either by a series of microdeletions or by macrodeletion. Two known instances of the latter are found in *Bucorvus abyssinicus* and *Rhopodytes viridirostris*, while a macrodeletion of but one dorsal carotid is known to occur in *Rhamphococcyx curvirostris erythrognathus*. Such unilateral macrodeletions may be of more frequent occurrence than is known at present, and further studies of the aortic arch system in birds may reveal still other instances of bilateral atrophy and deletion of the dorsal carotids. These instances of carotid atrophy have been found to occur in the Coraciiformes and the Cuculiformes. The macrodeletions mentioned above were found in normally bicarotid (A–1) forms.

Evolution of the aortic arch system from a bicarotid to a unicarotid condition is of interest when considering the implications of paramorphogenesis. Presumably, for the most part, the two dorsal carotids become conjugate vessels. This is followed by reduction and ultimate loss of the basal portion of either the left or right side, and the functional adult condition is either dextrocarotidinae or laevocarotidinae, respectively.

The level of ordinal evolution may be inferred by the level of evolution of the dorsal carotids, at least insofar as the members of the order are concerned. Within an order or family in which partial or complete loss of one of the dorsal carotids has occurred, some estimate of the relative level of evolution of the species may be made. A graded series in the levels of atrophic evolution of the dorsal carotid arteries can be observed in several orders of birds (fig. 119).

In the macroevolution of the dorsal carotids the levels of evolution are quite simplified, but in the microevolution of these same vessels there are several important steps in the reduction and ultimate deletion of a vessel.

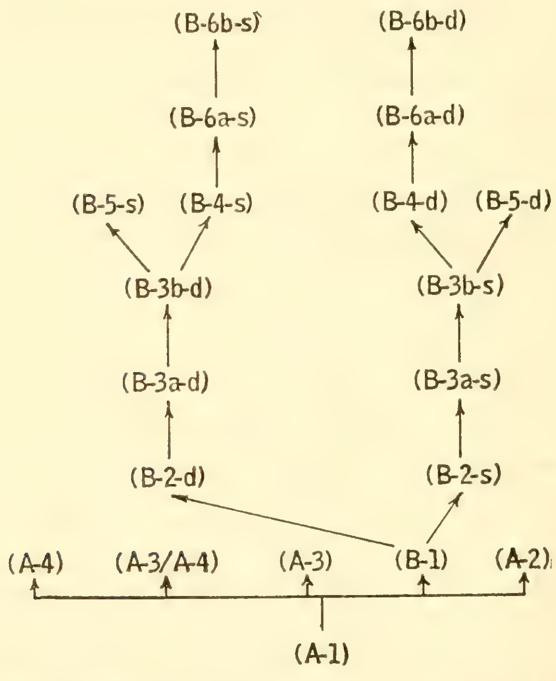

Figure 119.—Graded series or levels in the evolution of the dorsal carotid arteries in birds.

The following orders and families, in which there is evidence of some carotid artery evolution, are listed according to the carotid arrangements reported for each group. Orders and families of birds not included in this list either are bicarotidinae normales (A–1) or the condition of the carotid arrangement has not been established.

ORDERS

B–4–s

Rheiformes
Apterygiformes
Colymbiformes
Coliiformes
Trogoniformes
Piciformes, with a single case of B–4–d
Passeriformes except in *Orthonyx*, B–5–s

FAMILIES AND SUBFAMILIES

B–4–s

Anhingidae
Balaenicipitidae
Turnicidae
Nyctibiidae
Hemiprocnidae
Trochilidae
Upupidae
Phoeniculidae

A–1, A–2–s

Loriinae
Psittacinae

A–2–s

Nestorinae

A–1, A–3

Cuculidae

A–1, A–4

Cuculidae
Bucerotidae

A–1, A–3–s/A–4–d

Cuculidae

A–1, B–1, B–2–s

Ardeidae

A–1, B–2–s

Kakatoeinae

B–2–s

Phoenicopteridae
Megapodidae

A–1, B–2–d, B–3b–d

Kakatoeinae

A–1, B–3a–d

Procellariidae
Bucerotidae

A–1, B–3b–d, B–4–s

Apodidae

B–2–d, B–4–s

Podargidae

B–3b–d

Pelecanidae

B–3b–d, B–4–s

Megapodidae

A–1, B–4–d

Otidae

A–1, B–4–s

Casuariidae
Pelecanoididae
Sulidae
Fregatidae
Alcidae
Meropidae

It will be noted in the above list that, for the most part, there is a major trend toward deletion of the right dorsal carotid artery. In the Ciconiiformes, however, the trend is more generally in the direction of a dextral evolution and deletion of the left carotid artery. This can be observed in both the Ardeidae and the Phoenicopteridae. *Balaeniceps rex*, on the other hand, has evolved along the sinistral course.

Retention of the bicarotidinae normales (A–1) arrangement should be regarded as a more basic condition with respect to the evolution of the carotid arteries.

It is felt that from the above information sufficient evidence has been presented to demonstrate a high degree of paramorphogenesis in the aortic arch system of birds.

Discussion and conclusions

The arrangement of the thoracic and cervical derivatives of the aortic arch system—especially the branches of the subclavian and pectoral stem arteries—in the ostrich, rhea, and cassowary clearly substantiates the view that these forms are secondarily modified and are not extant species derived from holocursorial ancestors. In the kiwi, on the other hand, the arrangement and supply of the arteries can hardly be interpreted as having been derived from an ancestor possessing the normal flight-function, although a volant ancestor cannot be excluded from their line of evolution.

Carotid evolution of the Colymbiformes is such as to indicate a considerable advance over the bicarotid ancestral forms, and the wide distribution of species of this order tends to further substantiate the view that the origin of this order of birds occurred early in avian history. A similar interpretation may be made for the very early origin of the kiwis.

The dextral evolution of the carotids in both the Ardeidae and Phoenicopteridae tends to further indicate the affinities of the flamingos with the herons rather than with the ducks, which are altogether bicarotidinae normales. In addition, the laevocarotid arrangement in *Balaeniceps rex* is further evidence for its singular position among the Ciconiiformes, and warrants its allocation to a separate family (Balaenicipidae).

Affinities between the tinamous and gallinaceous birds are apparent, but close and recent relationships can hardly be substantiated. While these two orders may well have had a very early, common origin, most of the gallinaceous birds have evolved along many more diverse lines of specialization than has been the case among the tinamous.

In discussing the generic relationships of the parrots, Amadon (1942) has pointed out that Latham considered *Prosopeia tabuensis* and *Alisterus scapularis* to be varieties of one species. This I cannot properly ascribe to, since two subspecies of *Prosopeia tabuensis* were found to have the A–2–s carotid arrangement while *Alisterus scapularis* has the A–1 carotid arrangement and is more closely allied with *Polytelis*, but not with *Cyanoramphus* or *Platycercus*. Both of these latter genera show closer affinities with *Prosopeia* in that they all present the A–2–s carotid arrangement. The platycercine lack a furcula, as they have class 3 clavicles (Glenny, 1954b). Among the Psittacinae, it is my opinion that the A–2–s forms are more closely related by way of some common ancestral form than as a result of the comingled relationship with A–1 carotid types. It is suggested that the species *Lathamus discolor* be completely reexamined to determine its exact relationships, for it may well be a monotypic form, not properly placed among the Loriinae, since the carotid arrangement is of the A–2–s type, while all other members of this subfamily, thus far examined, have the A–1 carotid arrangement. Other similarities to the Loriinae may be instances of paramorphogenesis and, as a relict evolutant, it may constitute a monotypic subfamily, or be reassigned to the Psittacinae.

Certain phyletic relationships may be ascertained reasonably well on the basis of the carotid artery arrangement, and the arterial arrangement-patterns appear to have a phylogenetic significance. The constancy of occurrence of the basic bicarotid condition and the progressive developmental steps that lead to several modifications of the system tend to point to this conclusion and to substantiate, in part, the theory that ontogeny recapitulates phylogeny.

As a result of early dispersal movements of birds and mammals from their center(s) of origin, a large number of fossil forms might well be expected in many parts of the land areas. Few of these fossils can well be considered as true ancestral forms which led to the present-day species, but strong similarities in structure might show their affinities with extant species.

Occurrence of relict species and families of birds and mammals in Australia, New Zealand, and South America tends to support the view that birds and mammals may well have originated in Antarctica, and that as a result of protective isolation in these localities they were able to survive and undergo considerable speciation.

Evolution of both birds and mammals must have been from reptilian forms which had a reasonably well developed sternum, since this structure is found in both classes but is more highly developed in birds than in mammals. This tends to preclude any relationship between the Neornithes and the so-called Archaeornithes (*Archaeopteryx* and *Archaeornis*). Simpson (1946) has summarized Lowe's views with respect to *Archaeopteryx* and *Archaeornis:* In most respects they are purely reptilian, in all respects they are as reptilian as avian, and in some respects they are too specialized to be ancestral to birds. It is suggested, therefore, that the forms now placed in the Archaeornithes be placed in the Sauropsida with the Reptilia, since mere presence of feathers is not sufficient grounds for placing them in close association with modern birds and cannot be construed as sufficient evidence for a closer phyletic relationship. The presence of scales on birds and some mammals is as sound single evidence for placing both of these classes of vertebrates in the Sauropsida as the presence of feathers on reptiles is for placing them among the birds.

During the earliest stages of avian and mammalian evolution, a rapidly evolving group of profamily types probably took place, with the result that the predecessors for all major avian and mammalian groups might well have been developed. Subsequent to their origin and early radiation, further evolution of the major groups could have taken place in other and more widely separated areas with the resultant complex distribution of forms, both fossil and living.

On the assumption that evolution is greatly accelerated in a tropical climate and that the arboreal habit in a tropical climate tends to be predominant, it may be concluded that ancestral primates and ancestral marsupials were more or less contemporaries (Simpson, 1945), and that the eutherians were not evolved from the metatherians but that both groups have evolved independently and simultaneously along somewhat different and more specialized lines (Romer, 1945). The same view then may be taken with respect to the evolution of the major orders of birds. Thus, once the earliest avian ancestors had become established, the pro-order and perhaps even the profamily types probably developed quite rapidly and these may well have been contemporaries. Since the earliest beginnings of proavian forms there has been a notable degree of specialization of structures, feeding habits, and environmental adjustments resulting in the complex avian fauna as we know it today.

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FISHES OF THE FAMILY PERCOPHIDIDAE FROM THE COASTS OF EASTERN UNITED STATES AND THE WEST INDIES, WITH DESCRIPTIONS OF FOUR NEW SPECIES

By Isaac Ginsburg

Fishes of the family Percophididae from the coasts of eastern United States and the West Indies have, to my knowledge, hitherto been recorded under one name, (*Hypsicometes*) *Bembrops gobioides* (Goode). Four new species are added here, making a total of five species divided into two genera. Specimens of all five species have been preserved in the collection of the U. S. National Museum for some time, where they have been cataloged as *gobioides*. Adequate samples of two species that appear to be common offshore in the Gulf of Mexico have been collected during recent years by the U. S. Fish and Wildlife research boats *Pelican* and *Oregon*. This added material made it possible to determine and distinguish these two species satisfactorily and aided in the proper distinction of the other species. Three of the four new species were obtained by the *Caroline* of the Johnson-Smithsonian Expedition. Specimens of two of the latter species were also collected by the *Albatross*, 68 and 69 years ago; they were identified as *gobioides* by Goode and Bean and were included in their account of that species as noted below.

Family PERCOPHIDIDAE

CHARACTERS COMMON TO THE FIVE SPECIES HERE TREATED: Notably elongate, slender. Head and anterior part of body depressed, the width in relation to the depth gradually decreasing from head backward, becoming somewhat compressed at caudal peduncle; ventral aspect flat, especially anteriorly, forming a nearly horizontal plane. Snout notably depressed, flat, broad, rounded anteriorly, somewhat ducklike. Hard part of upper jaw with a narrow emargination on upper surface at symphysis, producing a bilobate effect on a dorsal view, the small space between the lobes more or less bridged with a yellowish, moderately soft tissue. Nostrils small or moderate; one behind the other on a horizontal approximately through upper margin of pupil, at some distance in front of eye; close to each other or rather widely spaced, depending on the genus; anterior one with a slightly raised rim; posterior one with a well raised, somewhat tubular rim, hind part of tubule higher. A lengthwise mucous channel dorsad of the nostrils, opening by two pores of variable size, one at its anterior end not far from upper jaw, the other at some distance from its posterior end, near posterior nostril. Mouth rather large, nearly horizontal, superior, lower jaw extending beyond upper. Eyes large, interorbital narrow. Mandibular rami notably expanded, placed in a ventral position. Maxillary reaching to under posterior margin of pupil or a little behind. Teeth in bands on jaws, vomer, and palatines, the band in upper jaw broadening at symphysis; some inner teeth of vomer, of palatines, and at symphysis of upper jaw moderately enlarged in some species. Gill cover having its posterior and greater part thin and flexible, somewhat tapering and prolonged posteriorly, its upper margin horizontal and free for a considerable distance, its lower margin sharply oblique, running upward and backward; with three moderate spinous points, the upper spine close to upper margin, the middle spine moderately spaced, the two forming apical points of two moderate or slight ridges converging forward, the lower spine widely separated, placed at lower margin of gill cover and constituting part of subopercle. Preopercle with one to three spinous points at angle present or absent (subject to individual variability). Gill opening wide, branchiostegal membranes overlapping under anterior margin of eye or a little more forward. Gill rakers in moderate numbers or rather numerous. Pseudobranchiae well developed. Scaled nearly all over, including head, chest, fleshy pectoral base, and mandibular rami; snout scaled posteriorly, incompletely scaled to nearly scaleless anteriorly; anterior space between mandibular rami scaleless except in *Chriomystax squamentum;* pelvic and pectoral fins scaled on a small area near base, scaleless in larger part; caudal scaled on a larger area near base; dorsal and anal scaleless; scales on sides of body moderately ctenoid, others cycloid, at least in large part. (The scalation is incomplete or nearly all missing in almost all specimens examined and not all details are accurately determinable; consequently, the above statements might be subject to a moderate revision.) Lateral line beginning at upper angle of gill opening, running horizontally over upper margin of opercle, curving directly behind head, except in individual variants of *Bembrops anatirostris* (p. 636), and dipping rather sharply down, posterior end of curve approximately at end of pectoral, thence running nearly straight backward and nearer to lower than upper profile. First dorsal with six flexible spines (the count constant as determined in 124 specimens of all five species). Second dorsal with 14–18 rays, all segmented; anal similar to second dorsal, with 17–19 segmented rays; the rays in the two fins notably well spaced. Pelvic horizontally placed on ventral aspect of abdomen, its base well in advance of pectoral, approximately under preopercular margin, its end falling considerably short of anus; with one flexible spine rather well developed and five segmented rays. Pectoral extending moderately behind a vertical through anal origin, with 22–28 rays. (Caudal damaged in nearly all specimens examined; seems to be moderately emarginate with the rays near the upper margin somewhat longer than the corresponding lower rays.)

METHODS OF STUDY: The dorsal and anal fins are very often damaged, many of the rays being broken off, leaving only a short stump. However, the rays are widely separated and readily countable even when damaged and in the small specimens. The last ray is split to its base and the two branches have been counted as one ray.

The scales are deciduous and most or nearly all of them are missing in almost all specimens examined. However, when the scales are missing their pockets are prominently outlined. The counts of the scales here given generally refer to the number of oblique rows of scale pockets, beginning with the row that is wholly or partly behind the short, rather sharp spine at the upper anterior angle of the gill opening and ending at the caudal base. Some of the counts here recorded may be off by one or two scales, especially for specimens on which part of the count was made of the rows of actual scales and part of the rows of pockets, or in case of specimens having the rows somewhat irregular in places. But, on the whole, the counts made closely approach the true numbers.

The gill raker standing squarely within the angle of the arch is the longest, and it has one "root" on the upper limb and one on the lower. Following my usual procedure, it has been uniformly included in the count of the lower limb. The tuberclelike outgrowths at both ends of the arch, when present, have been included in the gill raker count as discussed under *Bembrops*.

The given length of the pectoral fin and the pelvic fin is that of the longest ray, from its point of articulation; that of the caudal from end of hypural to tip of longest ray, which is located at upper margin of the fin. The depth was measured at the origin of the first dorsal. The measurement of the "peduncle" refers to the least depth of the caudal peduncle. The head was measured from the apex of the lobe on the snout (not the middle anterior point) to the posterior margin of the flexible opercle. The snout was measured from the same anterior point as the head to the anterior soft margin of the eye. The eye measurement represents the horizontal distance between its soft margins. Numerical values of proportional measurements are expressed as a percentage of the standard length unless otherwise stated.

Specimens examined: This study is based chiefly on the western Atlantic specimens of this family in the collection of the U. S. National Museum and the museum catalog numbers are given under the accounts of the species. In addition, the types of *Chrionema chryseres* and *C. squamiceps* that Gilbert described from off Hawaii have been examined for comparative purposes as discussed below. Also, single specimens of four other species of the genus *Bembrops* from the Pacific and Indian Oceans were examined and some of their characters are discussed under the account of that genus.

Brazilian species: Two percophidid species are known from the coast of Brazil, from which the marine fish fauna has much in common with the regions here considered. One species, *Percophis brasiliensis* Quoy and Gaimard, a notably long and slender fish, is readily distinguishable by its much more numerous fin rays (D IX; 31. A 41 in one specimen, USNM 77325) and other well marked characters. The other species, *Hypsicometes heterurus* Miranda Ribeiro (1915, pls.), of which no specimens are available for examination, is described as having the following combination of characters: D VI; 14. A 17. P 25; lateral line about 59; eye 1½ times in snout. The combination of the given counts is close to that of the species here designated as *Bembrops macromma*, but the eye is smaller than in that species. Miranda Ribeiro's photograph shows that the anterior straight part of the lateral line extends for some distance behind the head, which, except in individual variants of *B. anatirostris*, is different than in the specimens examined of the species treated here.

Nomenclature: The question of what family name to apply to the two genera here considered is one of biology rather than of mere nomenclature. The problem is how the genera *Bembrops*, *Chriomystax*, and their near relatives are to be classified into families and how to determine the proper limits between the families. The two genera mentioned fall into the larger groups that Regan designates as Trachiniformes and Jordan as Percophidiformes.

Regan (1913, pp. 140–144), subdivides his "Division 10. Trachiniformes," which is a subordinate category in his "Suborder Percoidea" and apparently roughly corresponds to the superfamily category of other taxonomists, into 13 families, 9 of which contain only 1–3 genera each. However, such splitting of the relatively few, seemingly more or less related genera into an excessive number of families is not based on an adequate comparative study of their morphology; at least such a study is not included in the published record. After an examination of the external characters of a number of the genera concerned, it seems that Regan's family category as applied to these fishes is equivalent to the category designated as subfamily or even tribe by other modern taxonomists, or, in other groups, by Regan himself.

A classification published later by Jordan (1923, pp. 228–231) agrees in the main with that of Regan. Jordan likewise divides these genera among many families. But the two classifications differ in some particulars, two of which may be mentioned here: Jordan also groups the families into a next higher category which he calls "Series" that corresponds roughly with Regan's "Division," but the families that Regan includes in his Trachiniformes are placed by Jordan in four "Series;" and, in some instances, Jordan shuffles the genera from one family to another so that the content of some families is different from that of Regan. These differences cast some doubt on the adequacy of both classifications.

The genera that are of immediate concern in this paper are placed in three families in both classifications, but the genera are differently distributed and the two authors use different names for one of the families. Both recognize the family Percophididae with one genus, although Regan does not expressly state so. Besides that family, Regan recognizes the Bembropsidae with two genera, *Bembrops* and *Chrionema*, and the Hemerocoetidae with *Hemerocoetes* and *Acanthaphritis*. He also indicates that *Pterosaron* Jordan and Snyder is the same as *Acanthaphritis* Gunther. This suggested synonymy is open to question.

In Jordan's classification, the Hemerocoetidae includes only the type genus; while the third family, which is designated Pterosaridae instead of Bembropsidae, contains *Bembrops*, *Chrionema*, *Acanthaphritis*, *Pterosaron*, and *Osopsaron*. The last-named genus is possibly the same as *Acanthaphritis*, while the other two genera placed by Jordan in his Pterosaridae, *Hypsicometes* Goode and *Bathypercis* Alcock, are presumably synonyms of *Bembrops*.

The six or seven genera discussed above, which evidently are of close relationship, are placed in three families and the content of two of these families differs in the two classifications. If this process of splitting the families is carried to its logical conclusion, four families should be recognized for the following four diverging groups of genera: *Percophis*, *Bembrops* and *Chrionema*, *Acanthaphritis* and *Pterosaron*, and *Hemerocoetes*. Such excessive splintering of the families seems out of line with family divisions in other groups of fishes and in zoology in general and serves no useful purpose. Therefore, it would seem best to place all these genera in one family. At any rate, the terminology used in this paper is in line with this viewpoint. Perhaps other related genera should be included in the Percophididae.

Key to five Western Atlantic percophidid species

1*a*. Maxillary without a tentacle. Anterior part of space between mandibular rami scaled. Caudal without a definite spot behind its base. Gill rakers 7–9+20–21, those at the ends slender, moderately developed. Pectoral rays 21–22. Dorsal rays usually 15, sometimes 16. Scales 55–61.
Chriomystax squamentum (p. 629)

1*b*. Maxillary with a broad tapering tentacle. Space between mandibular rami scaleless. The smaller specimens with a caudal spot disappearing with growth (unknown for *macromma*). Gill rakers 4–6+14–16, including 1–4 at both ends of arch in form of low tubercles.

2*a*. Scales 47. Pectoral rays 24. Dorsal rays 15. Eye larger than snout.
Bembrops magnisquamis (p. 633)

2*b*. Scales 55–59. Pectoral rays 25. Dorsal rays 14. Eye subequal to snout, varying slightly both ways (well divergent in this character from *anatirostris* and approaching *gobioides*, see table 4). Without a prolonged dorsal spine in three males examined (185–202 mm.). A lateral series of four spots . . . . **Bembrops macromma** (p. 634)

2*c*. Scales 61–71. Pectoral rays 26–28. Eye smaller than snout.

3*a*. Dorsal rays usually 15, sometimes 14. The larger males having the second dorsal spine filamentous. With a lateral row of about 10 spots better marked in the smaller specimens.
Bembrops anatirostris (p. 635)

3*b*. Dorsal rays usually 17, sometimes 18. Without a filamentous dorsal spine. Without a definite lateral row of spots.
Bembrops gobioides (p. 637)

Chriomystax, new genus

GENOTYPE: *Chriomystax squamentum*, new species.

COMPARISON: *Chriomystax* agrees with *Chrionema* Gilbert (genotype *Chrionema chryseres* Gilbert (1905, p. 645) by original designation) in lacking a maxillary tentacle, the presence of which is a constant feature of *Bembrops*. *Chriomystax* differs from *Chrionema* in having the ventral aspect of the head, that is, the mandibular rami and the space between them, scaled instead of naked. (In the species of

Bembrops examined the mandibular rami are more or less scaled, but the area between them is naked.) *Chriomystax* further differs in having 18 anal rays, instead of 24 as in *Chrionema chryseres*. The latter character ordinarily, in fishes in general, would not be deemed of generic importance. However, in the species of the two genera here treated the number of anal rays varies intraspecifically and differs interspecifically within comparatively narrow limits. In eight species of *Bembrops* and two of *Chriomystax* the total range is 16–19 (see table 1 and the counts of extralimital species, p. 632). Consequently, it seems that in this family this difference sometimes indicates a higher degree of divergence than that of species.

Chrionema chryseres, the type species of its genus, differs in three other characters: The gill rakers are fewer and those at both ends of the arch are much reduced, in the form of low tubercles, while in the two species of *Chriomystax* in addition to being more numerous in total count, those at the ends of the arch are slenderer and longer, not in the form of tubercles; the bands of teeth are conspicuously wider in *C. chryseres;* and it is a much rougher fish, the scales being more strongly ctenoid. However, any one or all three of these differences might possibly be governed by growth, the single available specimen of *C. chryseres* being considerably larger, 181 mm. in standard length, while the two species of *Chriomystax* examined are 29–55 mm. in the same length.

In the original account of his *Chrionema*, Gilbert (1905, pp. 645–646) included two species—*chryseres*, the genotype, and *squamiceps*. The latter species is near *Chriomystax squamentum* in its structural characters and should be placed in the same genus with it. The differences between these two congeneric species are discussed below.

Chriomystax squamentum, new species

Description: D VI; 15–16. A 18. P 21–22. Sc 55–61. GR 7–9+20–21. Dorsal rays usually 15, sometimes 16. Anal rays constantly 18. Pectoral rays 21–22. (The uppermost pectoral ray has a slight ridge along its upper aspect that may be separated cleanly when some pressure is applied to it with a dissecting needle, and it then appears like a very thin distinct ray. However, the ridge does not seem to be separated basally from the ray. It apparently does not represent a separate ray and was not included in the count of the pectoral rays.) Gill rakers at both attached ends of the outer arch slender, graduated, not in the form of short stumpy tubercles, except one short gill raker, abruptly shorter than the others, intermediate in development between a gill raker and a tubercle, occasionally present at either end of the arch; gill rakers, including the short one when present, 7–9+20–21 or 27–30 in total number on both limbs. Anterior area between mandibular rami covered with imbricated cycloid scales. Posterior pore of lengthwise mucous channel on snout placed between the two rather widely separated nostrils.

Measurements of two specimens, including the holotype, 53.2–55.3 mm. in standard length, the caudal and pectorals damaged: pelvic 20.0–21.5, depth 14.3–14.7, peduncle 5.2–5.6, head 36.0–36.5, maxillary 13.4–13.9, snout 9.4–10.0, eye 11.8–12.7; snout 0.71–0.74 as long as eye.

Body with a lengthwise, nearly median row of eight rather diffuse spots, the first a little behind pectoral base, the last at caudal base; the second spot largest and most prominent, rounded, elongate with

Table 1.—*Frequency distribution of the number of dorsal, anal, and pectoral rays in five Western Atlantic percophidid species*

Species	*Dorsal rays*					*Anal rays*			*Pectoral rays*							
	14	15	16	17	18	17	18	19	21	22	23	24	25	26	27	28
Chriomystax squamentum		25	3				28		17	11						
Bembrops magnisquamis		2				2						2				
B. macromma	3						3						3			
B. anatirostris	4	37				8	33							7	30	4
B. gobioides				49	2	2	45	4						6	36	8

its longer axis longitudinal, centered approximately over anal origin; some irregular smudges over median row, very diffuse; two diffuse smudges on caudal, at its base, at upper and lower margin; no well marked spot on caudal at some distance behind its base and no other prominent markings.

In small specimens, every spot in the median row is made up of very small, black, somewhat stellate spots. Another row of small, rounded, rather crowded, almost solidly bluish black spots above the median row, every spot with many very fine radiating lines, presenting a stellate appearance in gross effect. Two rows of similar but somewhat smaller spots below the median row. The two spots on caudal, at its base, likewise in form of two groups of very small spots, the groups somewhat confluent. The juvenile color pattern is present in specimens about 29–32 mm. in standard length, while the pattern of the larger specimens is described above from specimens 30–55 mm. in the same length.

Holotype: USNM 108394. *Caroline* Sta. 102; lat. 18°51′ N., long. 64°33′ W.; off Virgin Islands, 140 fathoms; Mar. 4, 1933; 53.2 mm. in standard length.

Paratypes: 27 specimens, 29.3–55.3 mm. in standard length, taken at same station as holotype; the caudal damaged in all specimens (USNM 108393, 108396).

COMPARISON: This species is near (*Chrionema*) *Chriomystax squamiceps* (Gilbert, 1905) from Hawaii, agreeing with it in its structural characters, including the presence of scales between the mandibular rami. The holotype of *squamiceps* was examined and its counts are as follows: D VI; 16. A 18. P 23. Sc 66. GR 7+20. Therefore, the Atlantic species here described differs in having fewer scales and pectoral rays. Possibly it will also prove to average fewer dorsal rays.

ETYMOLOGY: The name *squamentum* is a contracted form of squamimentum (scaled chin).

Genus *Bembrops* Steindachner

Bembrops Steindachner, Icthyologische Beiträge, (V) p. 163, 1876 (genotype *Bembrops caudimacula* Steindachner, by monotypy).

Hypsicometes Goode, Proc. U. S. Nat. Mus., vol. 3, p. 347, 1880 (genotype *Hypsicometes gobioides* Goode, by monotypy).

DESCRIPTION: Maxillary with a broad tentacle at its end, of moderate length, its base nearly as wide as maxillary, tapering. Space between mandibular rami scaleless. The smaller specimens having a spot on the caudal near its base, nearer to upper than lower margin, disappearing with growth (not determined for *macromma*). The two nostrils rather close together, as compared with *C. squamentum*.

TABLE 2.—*Frequency distribution of the number of oblique rows of scales over lateral line in five Western Atlantic percophidid species*

Species	Scales																		
	47		55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
Chriomystax squamentum			2	3	6	3	1	1	2										
Bembrops magnisquamis	1																		
B. macromma			1			1	1												
B. anatirostris									2	5	3	5	8	13	3		1		
B. gobioides										1	5	7	9	11	8	3	3	1	1

Posterior pore of lengthwise mucous channel on snout close to and slightly dorsad of posterior nostril.

The gill rakers in *macromma*, *anatirostris*, and *gobioides* are as follows. The upper limb of the outer gill arch has two graduated gill rakers at the angle and usually two tuberclelike outgrowths at the attached end. One outgrowth in between varies in its development. At one extreme it can be classed with the tubercles and at the other it may be taken to represent a short gill raker; and it occurs in all degrees of development in between the extremes. On the lower limb the gill rakers decrease in length from the one on the angle (here included in the count of the lower limb) forward. At the attached end 1–4 tubercles occur that are similar to those of the upper limb, and the outgrowth behind the tubercles varies in development in a similar manner as the corresponding one on the upper limb. As the number of tubercles is readily determinable and no sharp line can be drawn between them and the gill rakers, all are included in one count in this comparative study.

In one small specimen each of *anatirostris* and *gobioides*, 58 and 43.5 mm. standard length, respectively, the gill rakers near both ends of the arch are relatively better developed and sharply delimitable from the two tubercles at both ends. Therefore, the relative development of the gill rakers as compared with the tubercles appears to change with growth, in these two species anyway.

Development in the two available specimens of *magnisquamis* (p. 633) is somewhat different than in *macromma*, *anatirostris*, and *gobioides*. Although an adequate sample is not available to determine growth

TABLE 3.—*Frequency distribution of the number of gill rakers, including tubercles, in five Western Atlantic percophidid species*

Species	Upper limb						Lower limb						Total both limbs								
	4	5	6	7	8	9	14	15	16		20	21	18	19	20	21		27	28	29	30
Chriomystax squamentum				10	4	1					8	7						6	6	2	1
Bembrops magnisquamis	1	1					2						1	1							
B. macromma		3					3							3							
B. anatirostris	1	39	1				4	31	6				1	3	30	7					
B. gobioides	3	48					13	29	9				2	12	28	9					

changes satisfactorily, it seems that in the latter three species the anterior gill rakers are not in the form of tubercles in small fish, and one at both ends changes to a tubercle with growth.

EXTRALIMITAL SPECIMENS EXAMINED: Counts of four extralimital specimens in the U. S. National Museum, examined for comparative purposes, are as follows. Taken off Kagoshima, Japan, now labeled as *Bembrops maculicauda* (59647, 134 mm.): D VI; 14. A 16. P 24. Sc 52. GR 4+13. Holotype of *B. filifera* Gilbert from off Hawaii (51613): D VI; 14. A 18. P 27. Sc 63. GR 4+15. Holotype of *B. filifer* Fowler from east of Masbate Island, Philippines (98866): D VI; 14. A 16. P 28. Sc 51. GR 5+14. Paratype of *B. nematopterus* Norman from off Zanzibar (109489): D VI; 14. A 16. P 25. SC 47. GR 5+15. While it is necessary to study adequate samples to determine the intraspecific variability of these species, the combinations of the foregoing counts as compared with those of the five Western Atlantic species given in tables 1–3 show that the extralimital species examined are different. Also, in three of these species, excluding *caudimacula*, the first spine is filamentous and prolonged, while among the Atlantic species only *anatirostris* is now known to have a prolonged dorsal spine, and in that species it is the second instead of the first spine that is prolonged in large males.

***Bembrops magnisquamis*, new species**

DESCRIPTION.—D VI; 15. A 17. P 24. Sc 47. GR 4–5+14. Fin ray counts the same in both available specimens. Scales in 47 rows over lateral line in holotype; some scales missing in paratype and number not definitely determinable, but approximately the same. Anterior gill rakers in the smaller specimen (paratype) short, slender,

TABLE 4.—*Frequency distribution of the numerical value of the measurement of the snout divided by that of the eye in three Western Atlantic species of* Bembrops, *segregated in size groups*

Species	*Standard length in mm.*	*Ratio*							
		0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6
anatirostris	58–115			1	3	2			
gobioides	81	1							
anatirostris	117–146				2	1	2		
gobioides	123–145			3					
macromma	154–168	1	1	1					
anatirostris	154–180					3	3		
gobioides	162–181				5	2			
anatirostris	186–221					1	8	5	
gobioides	183–224			8	21	8			
anatirostris	231–271					1	4	4	1

graduated, not tuberclelike; in larger specimen end outgrowth on upper limb a low tubercle, anteriormost one on lower limb intermediate in development.

Following are the proportional measurements of the holotype and paratype, respectively (caudal, pectoral, and pelvic damaged in both specimens): Depth 14.5, 13.5; peduncle 6.3, 6.0; head 36, 34; maxillary 14.5, 13.3; snout 10.2, 8.9; eye 10.5, 9.6.

First dorsal with a large subtriangular black spot at its base extending from first interspinal membrane to fifth spine, a whitish area above spot, anterior produced part above whitish area again black; a similar smaller black spot at base of second dorsal from first interradial membrane to third ray; in gross effect the two spots appearing partly ocellated above (described from the holotype). The specimen appears to be now largely faded, but the following marks are more or less faintly evident: A dusky transverse bar on upper half of caudal at its base; a better marked spot on midline below bar; an elongate narrow, short, dusky band behind the transverse bar in the approximate position of the caudal spot usually present in the smaller specimens of the species of *Bembrops;* three short elongate bands on mid-dorsal line in front of first dorsal; anal with blackish margin. The paratype has the spot on the first dorsal reduced, the transverse bar on the caudal very faint, and a few black scattered points on peduncle; otherwise it seems faded.

Holotype: USNM 45985. *Albatross* Sta. 2134; lat. 19°56′06″ N., long. 75°47′32″ W.; off Santiago, Cuba; 254 fathoms; Feb. 27, 1884; 85.5 mm. in standard length.

Paratype: *Caroline* Sta. 99; lat. 18°14′ N., long. 64°51′ W.; 220 fathoms; off Virgin Islands, Mar. 3, 1933; 50 mm. in standard length (USNM 108395).

Comparison: This species is easily distinguishable from the other four Western Atlantic species treated here by its large scales. The predominant number of anal rays in the other four species is decidedly 18, while in the two available specimens of this species the number is 17. It has, or at least averages, fewer pectoral rays than the three Western Atlantic species of *Bembrops*. The gill raker count averages rather low, comparatively.

Bembrops macromma, new species

Description: D VI; 14. A 18. P 25. Sc 55–59. GR 5+14. Dorsal, anal, and pectoral rays and combined number of gill rakers and tubercles constant in the three specimens examined.

Measurements of three specimens 185–202 mm. (154–169 mm. in standard length): Caudal 20.0–21.5, pectoral 23.5–24.5, ventral 17.0–18.5, depth 13.8–14.8, peduncle 5.5–6.2, head 37.5–38.5, maxillary 14.6–14.9, snout 10.5–11.1, eye 10.6–11.3; ratio of snout divided by eye 0.9–1.1.

A series of three large, diffuse, dusky spots, equally spaced, the first over anus, the third under end of dorsal fin; the first placed just below lateral line, the other two just above it; each of the two interspaces between the spots with two rather faint transverse dusky bands more or less developed; a fainter and smaller spot on caudal peduncle at base of caudal fin in a line with the above three somewhat more prominent spots; three faint smudges at dorsal profile over interspaces of the four median spots; anterior part of the first dorsal to the third spine black for entire height of fin, posterior part abruptly light, without pigment (in one specimen a small black spot at base of fin behind third spine); anal whitish, broadly margined with black; other fins more or less dusky, especially distally.

HOLOTYPE: USNM 108392. *Caroline* Sta. 81; lat. 18°35′30″ N., long. 65°23′54″ W.; off Virgin Islands, 300 fathoms; Feb. 26, 1933; 186 mm., 154 mm. in standard length.

PARATYPES: *Caroline* Sta. 100; lat. 18°40′15″ N., long. 64°50′15″ W., off Virgin Islands, 150 fathoms; Mar. 4, 1933; 2 specimens, 185–202 mm. (USNM 108391).

COMPARISON: In general appearance, as compared with *anatirostris* and *gobioides*, this species seems to be a somewhat more compact fish, not as slender as its two near congeners, with a shorter snout, larger eye and somewhat different color pattern. Differences in the proportional measurements of the depth of the body and caudal peduncle do not show up well even in the few specimens measured (compare accounts of the species). As the eye is larger and the snout shorter, at least on the average, in this species than in the other two, the numerical value of the ratio of the snout divided by the eye for all three species is given in table 4. When specimens of approximately like size are compared (table 4), *macromma* differs from both species, the extent of divergence being greater when compared with *anatirostris*. This species has lower counts of scales and pectoral and dorsal rays, at least on the average, than the other two species (tables 1, 2). In the number of dorsal rays it intergrades with *anatirostris*, but is well distinguished from *gobioides*. Taking all the marked structural differences and the color pattern into consideration, it is not difficult to distinguish *macromma* from *anatirostris* and *gobioides*. Its distinction from the other two Western Atlantic percophidid species is indicated under their accounts. It is compared with *Hypsicometes heterurus* Miranda Ribeiro on page 626.

***Bembrops anatirostris*, new species**

Description: D VI; 14–15. A 17–18. P 26–28. Sc 61–69. GR 4–6+14–16. Dorsal and anal rays usually 15 and 18, often 14 and 17, respectively. Pectoral rays with the mode at 27, varying 26–28. Gill rakers, including the 1–4 tubercles at both ends of the arch, nearly always 5 on upper limb, infrequently 4 or 6, modally 15, varying 14–16 on lower limb; usually 20 in combined number on both limbs, varying 18–21. The larger males having the second dorsal spine filamentous, considerably prolonged, reaching base of second dorsal ray in one male 177 mm., base of fourth to sixth ray in six males 195–250 mm., base of sixth to ninth ray in six males 250–315 mm., not prolonged in 7 males 185 mm. or less. (This development is not present in *B. gobioides,* of which a good composite sample was examined. It is also not present in the specimens examined of the other three percophidid species treated here, but the available samples are not adequate for a final determination of this point in the latter species.) Lateral line sloping downward directly behind posterior margin of head or continued horizontally and beginning to slope at some distance behind head (only species having variants showing the latter conditions, both variations sometimes shown on the two sides of the same specimen).

Measurements of five specimens 241–261 mm. in standard length and five specimens 142–167 mm. in same length, the latter in parentheses: Caudal 19.5 in 1 (22 in 1), pectoral 21.0–22.5 (22.0–23.5),

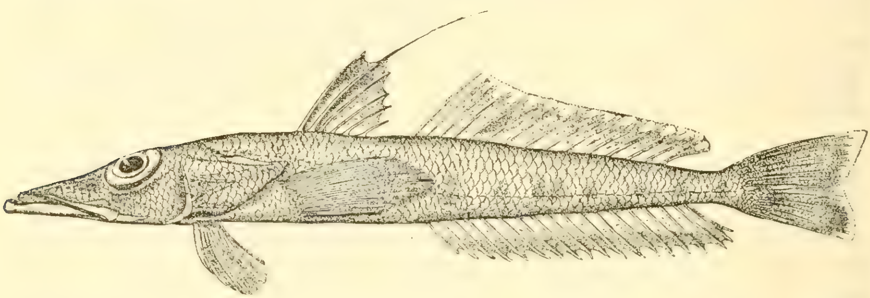

FIGURE 120.—*Bembrops anatirostris,* from a paratype (USNM 157735) 261 mm. in standard length, about 315 mm. long, from off Cape San Blas, Fla. (Drawn by Mildred H. Carrington.)

pelvic 14.2–15.7 (15.1–16.2), depth 12.7–14.2 (12.8–14.7), peduncle 5.0–5.8 (5.0–5.7), head 38.5–41.5 (36–37), maxillary 14.2–16.0 (14.2–14.6), snout 12.5–13.2 (11.3–12.2), eye 8.1–9.7 (8.4–8.9). The ratio of the eye in the snout is shown in table 4.

With a lengthwise, somewhat irregular row of about 10 diffuse irregular spots running along lateral line and continued forward under its anterior arch; the spots of various sizes and shapes and irregularly spaced, some of them doubled; fleshy pectoral base and anterior part of opercle with a silvery wash; anal whitish with a supramarginal blackish band; other fins more or less dusky, the pigment somewhat better developed distally; filament of second dorsal spine in male black.

HOLOTYPE: USNM 155470. *Pelican* Sta. 9; lat. 29°02′ N., long. 88°45′30″ W.; east of the Mississippi Delta; 170 fathoms; male 235 mm. in standard length, the caudal damaged, approximately 284 mm. long.

PARATYPES: 11 specimens 117–245 mm. in standard length obtained with the holotype (USNM 155471). Also, 29 specimens 58–271 mm.

in standard length, approximately 71–327, mm. long, obtained in 60–200 fathoms by the *Oregon*, the *Caroline*, and the *Albatross* off the following localities: Tampa (USNM 157734), Cape San Blas (USNM 44609, 157735, 157738) and Pensacola (USNM 157736–7, 157739–40), Fla.; Chandeleur Islands, La. (USNM 45976); Mississippi Delta (USNM 157733); Puerto Rico (USNM 117867–8).

Comparison: This species is near *gobioides.* The chief character that proves the distinctness of the two species and the one that is most useful in separating them refers to the number of dorsal rays, usually 15 or 17, sometimes 14 or 18, in *anatirostris* and *gobioides,* respectively (table 1). This difference seems to be absolute, as in 92 specimens of both species examined not one had 16 rays. This species also differs from *gobioides* in having the second dorsal spine of large males filamentous and in the presence of a lateral row of spots. On the average, the snout is longer and the eye smaller in *anatirostris.* The two species diverge considerably in the numerical value of the ratio of the eye in the snout (table 4) when specimens of approximately like size are compared, but they intergrade in this character.

Populations: The two specimens from Puerto Rico examined have the gill raker count near the upper limit of the range of distribution of the rest of the specimens, which were taken on the coast of the United States, while that of the scale count is near the lower limit of the range of the United States specimens, namely, GR 5+16, Sc 62, in both specimens from Puerto Rico. The counts of these two specimens are included in tables 2 and 3.

Bembrops gobioides (Goode)

Hypsicometes gobioides Goode, Proc. U. S. Nat. Mus., vol. 3, p. 348, 1880 (off Long Island, N. Y.).—Goode and Bean (in part), Oceanic ichthyology, p. 290, pl. 74, figs. 263–263a, 1895 (specimens of at least three species included in this account; those from *Albatross* Sta. 2378 and 2402 included in account of *anatirostris* (p. 635); specimen from Sta. 2134 designated as holotype of *magnisquamis* (p. 633); other specimens are included below in account of *gobioides;* some of the listed specimens not now available for examination).
Bembrops gobioides Longley, Carnegie Inst. Washington Publ. 535, p. 237, 1941 (Tortugas, Fla.).

Description: D VI; 17–18. A 17–19. P 26–28. Sc 62–71. GR 4–5 + 14–16. Dorsal rays most predominantly 17, rather infrequently 18. Anal rays with the mode decidedly at 18, sometimes 17 or 19. Pectoral rays modally 27, varying 26–28. Gill rakers, including tubercles, on upper limb predominantly 5, sometimes 4; on lower limb modally 15, varying 14–16; total on both limbs modally 20, varying 18–21.

Measurements of four specimens 162–176 mm. in standard length, approximately 191–208 mm.: Caudal 18–19 (in two), pectoral 23.5–24.5, pelvic 15.2–16.7, depth 11.2–14.1, peduncle 4.9–5.6, head 33.5–37.0, maxillary 13.1–14.9, snout 10.5–11.9, eye 8.6–10.2. Ratio of eye in snout given in table 4.

Nearly all available specimens have almost all scales on body missing and normal color pattern not evident. They have a dark reticulate

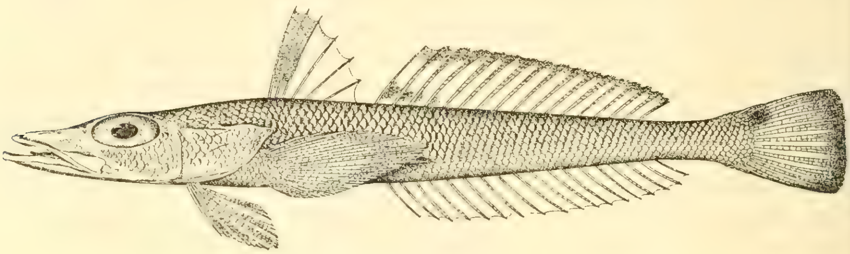

FIGURE 121.—*Bembrops gobioides*, from Goode and Bean, from a specimen (USNM 44233) taken off the Mississippi Delta. Caudal fin damaged in specimen figured; normally, caudal somewhat emarginate with the upper rays slightly longer than lower. Caudal spot disappears in large specimens.

pattern made up of the prominent outlines of the scale pockets. Some specimens show two or three faint dusky smudges along lateral line. First dorsal usually black or dusky for its anterior upper and greater part, hyaline basally and posteriorly, often dark nearly all over; second dorsal moderately dusky margined with blackish and a basal blackish area at its anterior part; anal moderately dusky, rather narrowly margined with black, often dusky or black nearly all over; caudal dusky, usually with a rather wide black area at its distal end, and a dark area at its upper margin and in juxtaposition to the caudal

FIGURE 122.—*Bembrops gobioides*: *a*, dorsal aspect of head; *b*, ventral aspect of head; mandible more extensively scaled than shown in figure. (Both from Goode and Bean.)

peduncle, the latter probably representing a transformation of the juvenile caudal spot; pectoral usually more or less dusky all over and with a dark, transverse, curved band at its base; pelvic nearly pigmentless basally, dusky distally.

Specimens examined: Tortugas, collected by Longley (USNM 92040). Collected by the *Oregon* and the *Albatross* in 65–280 fathoms off the following localities: Cape San Blas, Fla. (USNM 45744, 45975, 45973, 157727). Pensacola, Fla. (USNM 157726). Mississippi Delta (USNM 44233, 157728–30). Corpus Christi Pass, Tex. (USNM 157731–2). The preceding 12 lots comprise 50 specimens 81–220 mm. in standard length, approximately 95–260 mm. The foregoing account of the species is based chiefly on these specimens from southern Florida and the northern coast of the Gulf of Mexico. The single small specimen (26007) on which the species was originally based had been taken farther north as follows: *Fish Hawk* Sta. 871, lat. 40°02′54″ N., long. 70°23′40″ W., off Long Island, N. Y., 115 fathoms, Sept. 4, 1880. This holotype, about 43.5 mm. in standard length, the caudal damaged, is now in bad condition and altogether faded. The number of pectoral rays and scales are not definitely determinable. Other counts are as follows: D VI; 17. A 18. GR 5+15. Judged by these determinable counts it is apparently conspecific with the 50 southern specimens listed above; but it is of course necessary to examine a well preserved sample from the type locality to be certain of this identification.

Comparison: This species averages the highest fin ray and scale counts. It is nearest *anatirostris* and the differences between them are discussed under that species (p. 637).

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NEOTROPICAL MIRIDAE, LXV: NEW GENERA AND SPECIES OF BUGS OF THE TRIBE TERMATOPHYLINI (HEMIPTERA: DERAEOCORINAE)

By José C. M. Carvalho [1]

Through the courtesy of Dr. Reece I. Sailer I was able to study some specimens of mirids in the collection of the U. S. National Museum, among which were the new genera and species of Termatophylini described in this paper.

The Termatophylini, recently brought within the Miridae as a tribe of Deraeocorinae (Carvalho, Anais Acad. Brasileira Cienc., vol. 24, pt. 1, p. 31, 1952) were represented in the Neotropical region only by the genus *Termatophylidea* Reuter and Poppius (Öfv. Finska Vet.-Soc. Förh., vol. 54A, pt. 1, p. 4, 1912). Two new genera and four new species are added here.

Termatophyloides, new genus

Deraeocorinae, Termatophylini. General aspect small, elongate, ovoid with head drawn to a point apically; smooth, densely, long and erected pilose.

[1] Museu Nacional, Rio de Janeiro, Brazil; John Simon Guggenheim Memorial Fellow, 1953. Additional help granted by the Brazilian National Research Council.

Head almost conical in shape, about as long as wide, eyes elongate, internal margins divergent anteriorly, slightly removed from pronotum; seen from the side almost touching basal segment of antennae, reaching the gula below, upper margin of eye slightly below upper margin of head, beset with short, erect hairs. Rostrum reaching approximately to apical margin of first coxae, first segment shorter than the others, which are subequal in length.

Antennae inserted near middle of front margin of eye, first segment about three times shorter than the second, thicker than the remaining, shortly pilose, second segment incrassate towards the apex, at widest portion subequal to first, third and fourth slender, longer than the first, pilose; first segment attaining only the apex of clypeus.

Pronotum with two distinct, transversally impressed grooves minutely punctate at bottom (punctures only visible with high magnification), imparting trilobed appearance to pronotum; the middle lobe bisected longitudinally by a similarly impressed furrow, collar wide, convex, and prominent, disc smooth with very long, semierect setiform pubescence, lateral margins almost straight, roundish posteriorly, almost carinate behind collar, hind margin broadly rounded; mesoscutum covered, scutellum flat with pointed apex.

Hemielytra smooth with pubescence similar to that of pronotum, clavus with a line of punctures along claval vein, brachial vein scarcely attaining apex of clavus, embolium almost evanescent on apical third, linear and slightly incrassate basally, cuneus declivous, about as long as wide at base, cuneal fracture well marked with distinct incisure, external margin noticeably emarginate near incisure; membrane with one areola, the vein rather wide and noticeably thickened with a slight fold along apical third of inner margin of cuneus.

Underside distinctly more shining, abdomen becoming prominently pilose towards the apex, peritreme large and pruinose; legs of moderate length, femora incrassate, covered by short pubescence, hind pair with two or three long setae about as long as width of femur arising from a pruinose area on apical lower third; tibiae without spines, finely pubescent, the hairs arranged in rows; tarsi with two basal segments about equal in length, together longer than the third, claws very small with a blunt basal lobe, of the Deraeocorinae type.

Type of genus: *Termatophyloides pilosulus*, new species.

This genus differs from *Termatophylum* Reuter, 1884, in the very long and semierect setiform pubescence and the characteristic transverse punctate furrow of the pronotum.

Termatophyloides pilosulus, new species

FIGURE 123,*a*,*d*,*g*

Characterized by its color and dimensions.

Female: Length 2.1 mm., width 0.99 mm. Head length 0.35 mm., width 0.33 mm., vertex 0.17 mm. Antennae segment I length 0.12 mm.; II, 0.21 mm.; III, 0.16 mm.; IV, 0.18 mm. Pronotum length 0.49 mm., width at base 0.78 mm. Rostrum length 0.63 mm., segment I length 0.10 mm.; II, 0.17 mm.; III, 0.17 mm.; IV, 0.18 mm.

Color: General color dull black with silvery pubescence; apex of head subrufescent, basal segment of antennae fuscous, apex of third segment and apical four-fifths of fourth segment reddish, otherwise yellow, eyes rufescent, membrane brown; underside darkish to castaneous; femora and tibiae black, tarsi black except for basal segment which is yellowish.

Morphological characters: As given for the genus.

Male: Unknown.

Holotype: Female, Tamazunchale, San Luis Potosí, México, on orchids, Dec. 30, 1948, "Insp. Leary, coll., Laredo, Tex., 49529," USNM 61946.

Paratype: Female, Guatemala, on dried leaves with stalk of bananas, "Brownsville [Tex.], No. 53658 Lot. 433570," Apr. 10, 1943. One nymph with same data.

Termatophylella, new genus

Deraeocorinae, Termatophylini. Genus of small size, very shortly and adpressedly pilose, body ovoid, compact.

Head inclined, pointed, vertex faintly sulcate longitudinally, carinate; eyes roundish, small, orbita divergent towards the clypeus forming a right angle on vertex, contiguous to pronotum; seen from side, the eyes are rounded in front, subtruncate posteriorly; seen from below, buccula prominent, pilose, gula noticeably concave, transversally striate. Rostrum reaching middle coxae, first segment very short, not reaching beyond level of antennal peduncle, remaining segments subequal in length.

Antennae inserted in front of eyes, very short, finely pilose; segment I thicker than the others; segment II slender at base, incrassate towards the apex; segments III and IV very slender.

Pronotum strongly declivous, punctate, calli large, occupying the anterior two-thirds of pronotum, surrounded by a furrow with a well marked series of punctures, collar thicker than diameter of first antennal segment, lateral margins carinate and reflexed anteriorly, posterior margin straight; mesoscutum exposed, vertically inclined; scutellum small, acute apically, with an excavated depression basally.

Hemielytra with a very wide embolium, distinctly laminate basally, cuneus large, rounded externally, about as long as wide at base, cuneal fracture long and distinct; a well marked row of punctures visible on claval and costal veins, as well as on scutello-claval commissure of scutellar side; radial vein well delineated; membrane very small, uniareolate, coriaceous.

Legs fairly short, tarsi long and slender; segments in order of length: III, I, II; claws toothed at base, of the Deraeocorinae type.

Type of genus: *Termatophylella fulvioides*, new species.

This genus differs from the other of the Termatophylini, especially from *Termatophyloides*, in the coriaceous membrane, the well-marked rows of punctures on the hemielytra, in the very short pubescence, and in the large pronotal calli which recall those of the genus *Fulvius* Stäl.

Termatophylella fulvioides, new species

Figure 123, *c,f;* Plate 31,b

Characterized by its color and male genitalia.

Male: Length 2.6 mm., width 1.3 mm. Head length 0.3 mm., width 0.5 mm., vertex 0.27 mm. Antennae segment I length 0.1 mm.; II, 0.3 mm.; III, 0.2 mm.; IV, 0.2 mm. Pronotum length 0.5 mm., width at base 0.9 mm. Rostrum length 0.8 mm.; segment I length 0.20 mm.; II, 0.25 mm.; III, 0.21 mm.; IV, 0.21 mm.

Color: Castaneous (female) or dark castaneous (male). Female with head, pronotum, and scutellum darker; eyes reddish; membrane castaneous with yellowish tinge; antennae pale castaneous; underside castaneous; rostrum, tibiae, and tarsi tending to yellow. Male with eyes reddish; antennae pale castaneous becoming lighter toward the apex; legs reddish castaneous; tibiae and tarsi tending to pale castaneous; rostrum pale.

Morphological characters: As given for the genus.

Genitalia: Left clasper and pygophore as seen in figure 123,*c*.

Female: Identical to male in morphology and size.

Holotype: Male, San Luis Potosí, México, "Bt. Tex. 69391," on orchids, Mar. 7, 1950, USNM 61947. Allotype: Female, same data as type.

The name of this species is derived from its resemblance to *Fulvius* Stäl (Cylapinae, Fulviini).

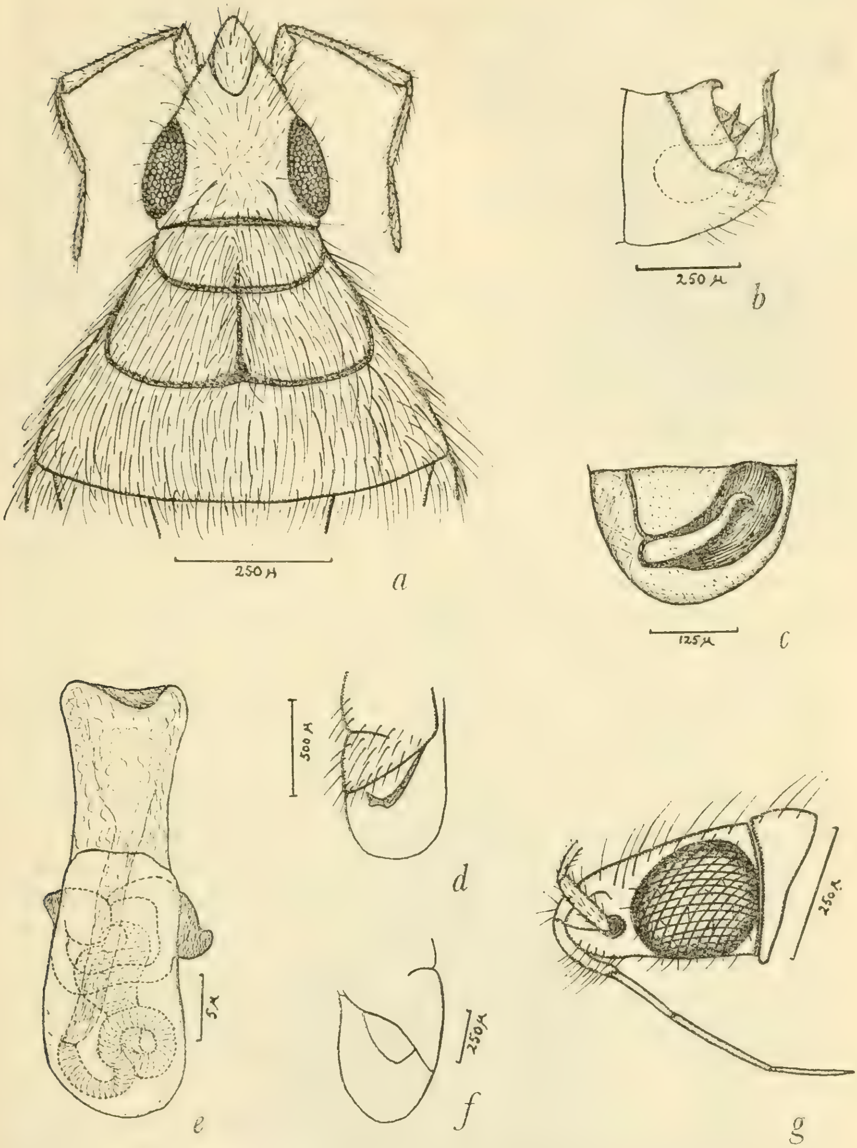


FIGURE 123.—*a*, Head, pronotum, and antennae of *Termatophyloides pilosulus*, new species; *b*, pygophore of *Termatophylidea pilosa* Reuter and Poppius; *c*, pygophore of *Termatophylella fulvioides*, new species; *d*, cuneus and membrane of *Termatophyloides pilosulus*, new species; *e*, aedeagus of *Termatophylidea pilosa* Reuter and Poppius; *f*, membrane of *Termatophylella fulvioides*, new species; *g*, head, side view, of *Termatophyloides pilosulus*, new species.

Genus *Termatophylidea* Reuter and Poppius

Termatophylidea Reuter and Poppius, Öfv. Finska Vet.-Soc. Förh., vol. 54A, pt. 1, p. 4, 1912.—Usinger, Ent. News, vol. 46, p. 271, 1935.

Type of genus: *Termatophylidea pilosa* Reuter and Poppius (1912, loc. cit.).

Termatophylidea ocellata, new species

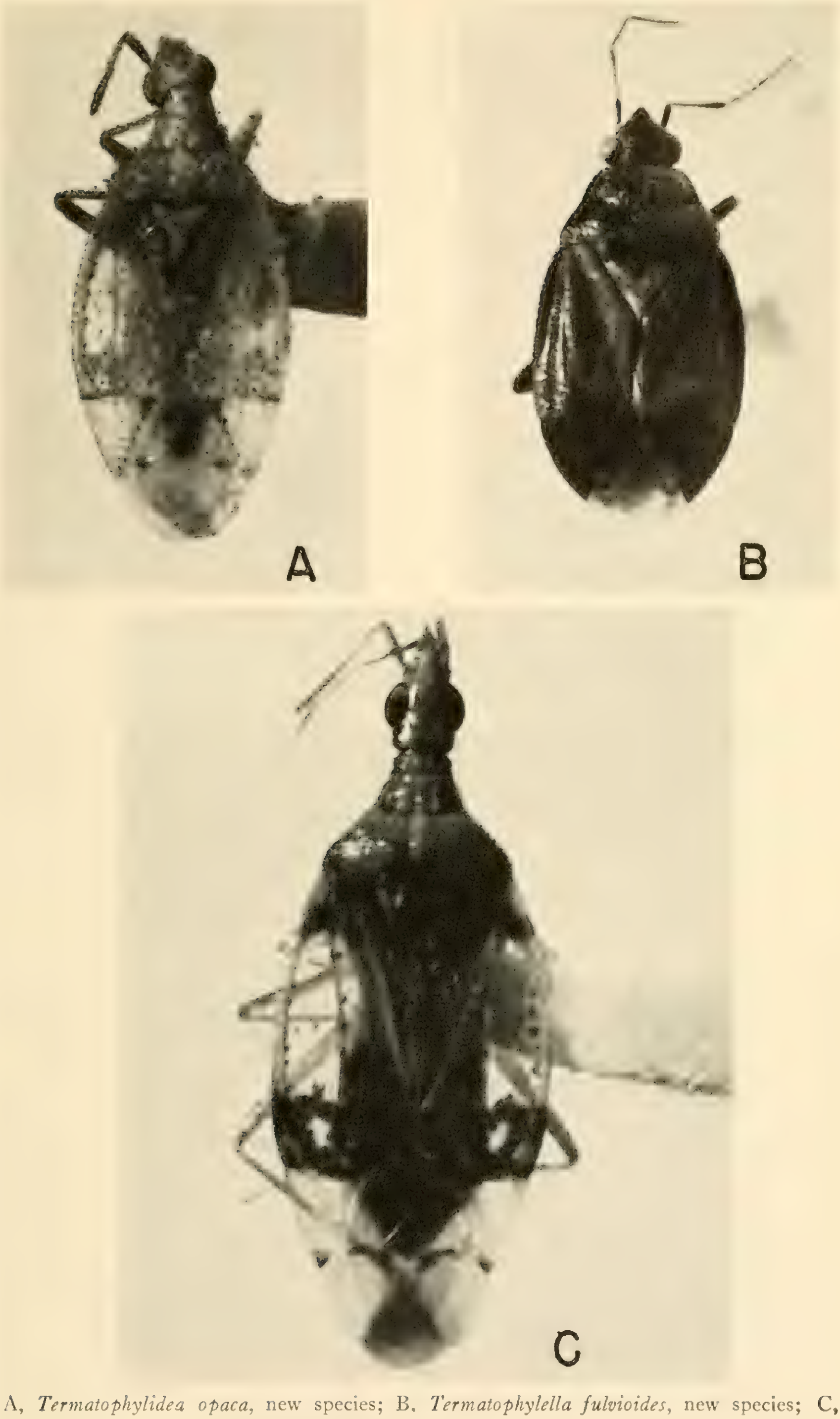
PLATE 31, C

Characterized by its color, tubercle on apex of scutellum and corium, structure of pronotum, and position of eyes on the head.

Female: Length 4.7 mm., width 1.6 mm. Head length 0.8 mm., width 0.6 mm., vertex 0.26 mm. Antennae segment I length 0.3 mm.; II, 0.8 mm.; III and IV broken. Pronotum length 0.8 mm., width at base 1.1 mm. Rostrum length 1.3 mm., segment I length 0.14 mm.; II, 0.53 mm.; III, 0.28 mm.; IV, 0.35 mm.

Color: Pale translucent with dark spots or areas; head and pronotum sordid yellow, clypeus with a reddish longitudinal fascia on each side, these fasciae uniting at the labrum, eyes dark brown; side of head behind each eye with two brownish fasciae; antennae pale yellowish, the basal joints darker with traces of red externally; pronotum with fuscous to brownish fasciae above callused line of lateral margin, the pleural region brownish, median longitudinal carina of pronotum whitish; mesoscutum and scutellum yellowish, brown at middle; hemielytra glassy, clavus with regular brownish spots at base of hairs, corium with the same spots bordering clavus and embolium, denser near corial commissure adjoining apex of clavus and near median portion of embolium, a blackish brown area on outer apical portion of corium and embolium enclosing internally a well marked hyaline spot and bordering another light area between dark area and dark spots of corial commissure; extreme base and apex of cuneus and extreme base of corium dark brown; tubercle on apex of scutellum and extreme apex of embolium (the latter with a yellow area at base) black; membrane infumate at extreme base, with a dark fascia at each apical angle of areola, the fasciae uniting towards the apex where they form a large dark brown area bordering distal margin of membrane; transversal apical portion of vein areola red; legs and abdomen pale yellow, the latter with a lateral fascia showing some darker areas, claws brown.

Head strongly pointed, vertex with a V-shaped depression level with posterior margin of eyes, carinate; eyes large, touching the gula below, distant from collar by a space equal to half the length of eye or half the length of first antennal segment; rostrum reaching the



A, *Termatophylidea opaca*, new species; B, *Termatophylella fulvioides*, new species; C, *Termatophylidea ocellata*, new species.

anterior coxae, segment I very short and thick; pronotum finely punctate with longitudinal crests and a median longitudinal carina, calli reaching the sides of pronotum, posterior margin of disc biconcave; scutellum and mesoscutum hairy, the first convex, with acute apex ending by a characteristic, minutely pubescent, black tubercle; hemielytra with claval area internally to claval vein raised and very minutely pilose, this pubescence denser along claval vein, embolium wide and incrassate with a raised, minutely pubescent tubercle at apex; cuneus about as long as wide at base, distinctly curved internally on basal two thirds; membrane very minutely pilose (visible only with good illumination), uniareolate; body beset with very long, fine, erect setae, the eyes distinctly pilose.

Male: Unknown.

Holotype: Female, San Pedro de Montes de Oca, Costa Rica, on *Vernonia brachiata*, C. H. Ballou, Oct. 15, 1936; USNM 61948.

This species differs from *T. maculata* Usinger, 1935, in the presence of a tubercle on apex of scutellum and apex of embolium, in color of hemielytra (in *maculata* there is no ocellate hyaline spot surrounded by black at apex of corium), in the less prominent crests of pronotum, in larger eyes, and in greater separation of eyes from pronotal collar. From *T. pilosa* Reuter and Poppius, 1912, it is readily separated by color markings and larger size.

A redescription of Reuter and Poppius' *T. pilosa* is here given and attention is called to the illustrations given for this species and for *T. maculata* Usinger (Ent. News, vol. 46, p. 271, 1935). In the paper referred to, Usinger describes *maculata* and points out critical differences between these two species.

Termatophylidea pilosa Reuter and Poppius

FIGURE 123,*b*,*e*

Termatophylidea pilosa Reuter and Poppius, Öfv. Finska Vet.-Soc. Förh., vol. 54A, pt. 1, p. 4, 1912.—Usinger, Ent. News, vol. 46, p. 271, 1935.

Female: Length 3.8 mm., width 1.3 mm. Head length 0.7 mm., width 0.4 mm., vertex 0.17 mm. Antennae segment I length 0.3 mm.; II, 0.8 mm.; III and IV broken. Pronotum length 0.7 mm., width at base 0.9 mm. Rostrum length 1.2 mm.; segment I length 0.11 mm.; II, 0.45 mm.; III, 0.28 mm.; IV, 0.40 mm.

Color: Pale translucent, head and pronotum dirty yellowish; eyes dark brown, sides of head behind each eye with a brown fascia, apical portion in front of clypeal suture and first antennal segment dull orange with traces of red, second antennal segment pale with reddish apex and base; pronotum dirty yellow with a brown to black longitudinal fascia on both sides of lateral, longitudinal, marginal furrow; hemielytra hyaline, apical tubercle of scutellum and embolium black; the latter yellow at base and surrounded by a small fuscous area at external apical angle of corium and apex of embolium; a spot on internal portion of corium near claval commissure slightly above apex of clavus, another on internal basal angle of cuneus, and apex of cuneus fuscous; membrane infumate with a median apical fuscous spot not bordering external margin, transversal portion of vein of membrane reddish; underside brownish, legs pale yellow, posterior femora with a subapical fuscous band; ostiolar peritreme and extreme base of coxae black to brownish.

Head strongly pointed, vertex carinate; pronotum with a deep lateral, marginal, longitudinal furrow, callused area subtrapezoidal, distinctly set off from collar, disc constricted at middle without median longitudinal carina, which is present only at posterior portion of calli, finely punctate and faintly crested, posterior margin biconcave; scutellum long, acute at apex, terminating in a compressed tubercle; hemielytra hyaline, clavus with minute pubescence only over claval vein, embolium widened apically where a conical tubercle may be seen, cuneus as long as wide at base, rounded internally on basal two-thirds; membrane finely pilose; rostrum reaching the apex of anterior coxae; eyes pilose.

Male genitalia: Aedeagus (fig. 123,*e*) simple, without teeth or other chitinized structures internally. Left clasper (fig. 123,*b*) pointed apically with a dilated base bearing a few setae. Left clasper small, simple, pointed apically.

Geographical distribution: Central and South America.

This species is distinguished from *T. maculata* Usinger, 1935, by the presence of a tubercle on the apex of the scutellum and on each embolium, by the much less crested pronotal surface, and especially by the absence of brownish spots at the base of the hairs on the hemielytra.

Termatophylidea opaca, new species

PLATE 31,A

Characterized by its color, roundish hemielytra with opaque surface, and eyes set close to pronotum.

Female: Length 3.1 mm., width 1.3 mm. Head: Length 0.5 mm., width 0.4 mm., vertex 0.17 mm. Antennae segment I length 0.2 mm.; II, 1.3 mm.; III and IV broken. Pronotum length 0.5 mm., width at base 0.9 mm. Rostrum length 3.1 mm.; segment I length 0.44 mm.; II, 1.3 mm.; III, 0.88 mm.; IV, 0.53 mm.

Color: Dirty yellow with some minute brown to fuscous spots; eyes, first antennal segment, and anterior portion of head with reddish markings; fascia behind eye and anterior lateral portion of pronotum and propleura also with reddish markings; hemielytra with brownish to fuscous spots at base of hairs, these spots more visible at middle of clavus, apex of corium, and basal internal angle of pronotum; membrane dirty yellow at base, hyaline apically; distal portion of vein of areola with a reddish spot; legs hyaline, underside of body and abdomen yellow suffused with red.

Species of small size, the hemielytra distinctly rounded laterally, cuneus as long as wide at base, membrane short, minutely pilose, vein without an apparent transverse portion apically; crests of pronotum globose, callused area with a median carina dividing two calli, lateral furrow of anterior portion of pronotum shallow; vertex without a V-shaped depression, concave, frons prominent, eyes only slightly removed from anterior margin of pronotum.

Male: Unknown.

Holotype: Female, Georgetown, British Guiana, Sept. 26, 1918, "H. Morrison col., Botanic Gardens (on *Sarcocephalus esculentus*)," USNM 61949.

This species is nearer to *Termatophylidea pilosa* Reuter and Poppius, but can be easily distinguished by the more rounded hemielytra, by the absence of tubercle on apex of scutellum and embolium, by the opaque hemielytra, and by the color. From the other species it is differentiated by its color, eyes set close to pronotum, and smaller size.

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